The 15th Hellenic Astronomical Conference
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Book of Abstracts

Organizing Committees

Scientific Organizing Committee (SOC)

SOC Chair: V. Charmandaris, President of Hel.A.S.
SOC Members: M. Chatzopoulos, K. Dasyra, A. Georgakakis, C. Gontikakis, E. Hatziminaoglou, P. Kalas, S. Patsourakos, V. Pavlidou, M. Petropoulou, A. Solomonidou, K. Tassis, N. Vlahakis

Conference Sessions

Session 1: "Heliophysics and the Solar System"
Convenors: C. Gontikakis, S. Patsourakos, A. Solomonidou
Session 2: "Extragalactic Astronomy and Astrophysics"
Convenors: K. Dasyra, A. Georgakakis, E. Hatziminaoglou
Session 3: "Cosmology and Relativistic Astrophysics"
Convenors: V. Pavlidou, M. Petropoulou, N. Vlahakis
Session 4: "Stars, Planets and the Interstellar Medium"
Convenors: M. Chatzopoulos, P. Kalas, K. Tassis

Local Organizing Committee (LOC)

LOC Chair: K. Gourgouliatos
LOC Members: Ch. Anastopoulos, V. Karageorgopoulos, V. Loukopoulos

In the following we present the abstracts submitted to the 15th Hellenic Astronomical Conference. They are grouped by Session and oral/poster type and are presented in alphabetical order with the name of the first author.

If you spot a mistake please let us know.

Session 1: Heliophysics and the Solar System

ORAL CONTRIBUTIONS

Solar Energetic Particle Event occurrence prediction using Solar Flare Soft X-ray measurements and Machine Learning

Aminalragia-Giamini Sigiava, NKUA, SPARC

Abstract

The prediction of the occurrence of Solar Energetic Particle Events has been investigated over many years and multiple works have presented significant advances in this problem. The accurate and timely prediction of SEPs is of interest to the scientific community as well as mission designers, operators, and industrial partners due to the threat SEPs pose to satellites, spacecrafts and manned missions. In this work we present a methodology for the prediction of SEPs from the soft X-rays of Solar Flares associated with SEPs that were measured in 1 AU. We use an expansive dataset covering 25 years of solar activity, 1988-2013, which includes thousands of flares and more than two hundred of identified and catalogued SEPs. Neural networks are employed as the predictors in the model providing probabilities for the occurrence or not of an SEP which are converted to yes/no predictions. The neural networks are designed using current and state-of the-art tools integrating recent advances in the machine learning field. The results of our methodology are extensively evaluated and validated using all the available data and it is shown that we achieve very good levels of accuracy with correct SEP occurrence prediction higher than 85% and correct no-SEP predictions higher than 92%. Finally further work is discussed towards potential improvements and the applicability of the model in real life conditions.

Magnetic flux emergence and eruptive activity in the Sun

Archontis Vasileios, University of St. Andrews

Abstract

A key process which leads to eruptive activity in the Sun, is the emergence of the magnetic flux from the solar interior to the solar surface and into the outer solar atmosphere. We present results from 3D numerical simulations, which show the onset of eruptive jets and CME-like structures in emerging flux regions. We discuss the physical connection between jets and large-scale eruptions and the mechanism which drive their eruptivity.

Identification and characterisation of asteroid families

Avdellidou Chrysa, Nice Observatory Delbo Marco (Nice Observatory), Walsh Kevin (SwRI, Boulder, CO), Fornasier Sonia (Paris Observatory), Bourdelle de Micas Jules (Paris Observatory)

Abstract

During the first steps of the solar system formation, the planetesimals, the building blocks of planets, accreted directly from the protoplanetary disk. However, a number of planetesimals survived the planetary formation process and are still present in the Main Belt. During the history of the solar system the initial planetesimal population suffered catastrophic collisions which led to the formation of clusters of fragments, the asteroid families. Family members keep their orbital elements, semimajor axis, eccentricity and inclination (a,e,i), similar to that of their parent body. Family members disperse over time. A non-gravitational effect, called the Yarkovsky effect, slowly changes asteroidsβ€™ orbital semimajor axis a at a rate da/dt proportional to 1/D, where D the diameter of the body. Prograde rotating asteroids have da/dt>0 and move at larger heliocentric distances while retrograde ones with da/dt<0 move at smaller. This creates correlations of points in the (a vs. 1/D) plane called V-shapes, as they resemble the letter β€�Vβ€�, whose slope (K) indicates the family age. There are catalogues of asteroid family membership based on asteroid family identification typically performed by Hierarchical Clustering Methods (HCMs), which look for clusters of asteroids in the orbital element space of (a,e,i), with significant contrast with respect to the local background. These methods work well for young (compact) families, but they are only capable to identify the core of the older and more dispersed families and potentially fail to detect the very old ones (> 2 Gyr).

The detection of asteroid families and their physical characterisation has great implications:

Their (i) detailed composition characterisation will construct the compositional map of the asteroid Main Belt. This will (ii) allow the link of the characterised asteroid families with the meteorites that we have in our collections by comparing their spectra and albedos. The ages of meteorites and meteorite components can be used to date the formation of their parent bodies. The project will (iii) serve studies on the near-Earth asteroid population, which originates from the main belt families. The identification of asteroid families will (iv) clear the Main Belt of a substantial amount of what are considered now as background asteroids. This will make easier the future task to identify more asteroid families and also to pin-point the population of surviving intact planetesimals. The discovery of asteroid families and the estimation of their ages (v) also provide more accurate information about when the giant impacts events that formed them occurred. The results of our investigation (vi) will set constraints and inform the modelling of planetesimal formation and evolution that will in turn serve to understand the solar system evolution.

Our team has established a new method of family detection that uses this V-shape. Here we will present the detection of two primordial and one ancient asteroid families of the inner Bain Belt. In addition, we will present the preliminary results of their spectroscopic characterisation.

Information Theory Perspectives for Geospace Research

Balasis Georgios, National Observatory of Athens/IAASARS

Abstract

Recent works point to a considerable importance of information theory in Space Physics and Space Weather. In the field of space physics, an early and accurate detection of characteristic dissimilarity between normal and abnormal states (e.g. pre-storm activity vs. magnetic storms) has the potential to vastly improve space weather diagnosis and, consequently, the mitigation of space weather hazards. Information theory techniques have great potentials to identify previously unrecognized precursory structures and, thus, to contribute to a better understanding of the evolution of geomagnetic field perturbations along with extreme space weather phenomena like geospace magnetic storms. The associated nonlinear time series analysis methods like various entropy measures, and approaches of statistical interdependence, causality and information transfer can be used to disentangle the effects and response lag times of different solar wind drivers as well as characteristic observables of the near-Earth electromagnetic environment derived from spaceborne and ground-based measurements that play

important roles in the solar-terrestrial coupling. These approaches can provide a novel way to anticipating and predicting incipient transitions in the dynamical regime of geomagnetic field variations between quite-time and storm-time geospace conditions. Furthermore, the dynamical relationship between magnetic storms and magnetospheric substorms is one of the most controversial issues of contemporary space research. In addition to improved space weather diagnosis, we expect a better understanding of the relationship between storms and substorms by disentangling the manifold processes interlinking both types of geospace phenomena. This presentation reviews recent findings in this field of geospace research.

A Mechanism Driving Recurrent Eruptive Activity on the Sun

Chintzoglou Georgios, Lockheed Martin Solar and Astrophysics Lab

Abstract

In Chintzoglou et al (2019) it was demonstrated that collision and shearing between opposite non-conjugated polarities from emerging bipoles produces "collisional polarity inversion lines" (cPILs) in emerging and evolving solar active regions and drive rapid photospheric cancellation of magnetic flux. In the same paper it was demonstrated that collisional shearing occurred in two emerging flare- and CME-productive ARs (NOAA AR11158 and AR12017) by measuring significant amounts of magnetic flux canceling at the cPILs. This finding supported the formation and energization of magnetic flux ropes before their eruption as CMEs and the associated flare activity. Here, we provide additional evidence from HINODE observations that confirm the occurrence of strong magnetic cancellation at the cPIL of these ARs. In addition, we provide theoretical results from data-driven 3D modeling of the coronal magnetic field, capturing the recurrent formation and eruption of energized structures during the collisional shearing process. We discuss our results in relation to flare and eruptive activity.

Improving nowcasting and forecasting of the Sun-to-Belts space weather chain through the H2020 SafeSpace project

Daglis Ioannis, University of Athens Bourdarie Sebastien (ONERA), Cueto Juan (TAS-E), Darrouzet Fabien (BIRA-IASB), Lavraud Benoit (CNRS), Poedts Stefaan (KU Leuven), Sandberg Ingmar (SPARC), Santolik Ondrej (IAP), Balasis Georgios (NOA/IAASARS), Botek Edith (BIRA-IASB), Brunet Antoine (ONER

Abstract

The H2020 SafeSpace project aims at advancing space weather nowcasting and forecasting capabilities and, ultimately, at contributing to the safety of space assets. This will be achieved through the synergy of five well-established space weather models covering the complete Sun-interplanetary space- Earth’w magnetosphere radiation belts chain. The combined use of these models will enable the delivery of a sophisticated model of the Van Allen electron belt and of a prototype space weather service of tailored particle radiation indicators. Moreover, it will enable forecast capabilities with a target lead time of 2 to 4 days, which is a tremendous advance from current forecasts that are limited to lead times of a few hours. SafeSpace will improve radiation belt modelling through the incorporation into the SalammbΓ΄ model of magnetospheric processes and parameters of critical importance to radiation belt dynamics. Furthermore, solar and interplanetary conditions will be used as initial conditions to drive the advanced radiation belt model and to provide the link to the solar origin and the interplanetary drivers of space weather. This approach will culminate in a prototype early warning system for detrimental space weather events, which will include indicators of particle radiation of use to space industry and spacecraft operators. Indicator values will be

generated by the advanced radiation belt model and the performance of the prototype service will be evaluated in collaboration with space industry stakeholders. The work leading to this paper has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870437 for the SafeSpace (Radiation Belt Environmental Indicators for the Safety of Space Assets) project.

Automated Chromospheric Swirl Detection method: evaluation and results

Dakanalis Ioannis, National Observatory of Athens/IAASARS

Abstract

High-resolution solar observations from both space-borne and ground-based telescopes have revealed ubiquitous photospheric vortical motions in quiet, as well as, in active solar regions. In chromospheric observations, obtained in several spectral lines, such as the Hα and the Ca II IR, they appear as spiral-shaped or circular dark patches. These so called "chromospheric swirls" are considered to be of great significance due to their ubiquity, as well as, to their suggested contribution in the energy transfer from the sub-photospheric layers to the transition region and corona. Therefore, a statistical information concerning their population and a number of significant physical properties, such as radii and lifetimes, are important in order to understand their nature and estimate the upwards energy transfer. We have developed a novel, automated chromospheric swirl detection method based on their morphological characteristics, in an attempt to complement visual inspection methods and velocity field derivation techniques used to date, with a more compatible to chromospheric observations method. The designed algorithm has been evaluated on different datasets of observations sampling the Hα, as well as, the Ca II IR spectral lines, obtained with the CRisp Imaging SpectroPolarimeter (CRISP) instrument installed at the Swedish 1-m Solar Telescope (SST). We will be presenting a brief description of the designed algorithm, followed by the detection results from its application to the aforementioned datasets. In addition, representative results from the statistical analysis conducted with the use of the detection results will be discussed.

North-South Interhemispheric Asymmetry in Geomagnetic Disturbance (GMD) and Pc5 wave power: Solar Cycle and MLT Variations

Dimitrakoudis Stavros, University of Alberta

Abstract

Interhemispheric measurements of conjugate ground stations have been conducted sparingly in the past, mostly because of issues with data availability. As a result, previous studies have produced seemingly contradictory results. The recent availability of new data from southern magnetometers through Supermag allows us to compare a set of magnetometer stations, in Antarctica and Canada, across a whole solar cycle, in addition to several other conjugate pairs with sparser coverages. Specifically, the Antarctic station Dome Concordia (at L = 5.8), operated by INTERMAGNET and BCMT has been recording magnetometer measurements at a 1 minute sampling rate ever since 2009 and that data is now available through SuperMAG. Its conjugate point in the north lies close to Gillam (L = 6.2), in the CARISMA network, and Sanikiluaq (L = 6.2) in CANMOS. These and other pairs of conjugate stations corresponding to lower L-shells paint a clear seasonal and solar cycle dependence on the ratio of observed power, with stations in the north experiencing both more power in general and higher dB/dt

fluctuations, which affect the generation of geomagnetically induced currents. The ratio in favour of the geographic north is stronger in northern summer and weaker at around noon in magnetic local time. It is also stronger at solar maximum and weaker for lower-L pairs of stations. The results suggest a potentially important northern preference for GMDs, and therefore potentially an increased vulnerability of electric power transmission networks in the northern hemisphere to damaging space weather effects.

Solar Flare Forecasting: a Brief How-To, Including Progress and Challenges

Georgoulis Manolis, Academy of Athens, RCAAM

Abstract

I attempt a brief overview of existing flare forecasting methodologies, mono- or multi-variate, relying on statistical or machine learning concepts. The focus will be on the methodological principals, rather than on individual methods. It is argued that forecasting is based on the general philosophical context of a theory, which is to make testable predictions. To generate and test these predictions, one needs relevant data, a model and verification practices in place. Verification involves all three levels of data, model, and the modelβ€™s performance. I briefly touch on the concept of benchmark datasets as essentially the only way to accurately compare between different models. As to performance verification, it is shown that from a plethora of statistical metrics, indices and skill scores, first, one must rely on the metrics most pertinent to the problem at hand; second, no single metric can fully capture a model's performance; and third, impressive progress notwithstanding, no method tested so far has perfect scores in a single metric, let alone a multitude of them. Finally, we show how benchmark datasets can be expanded, horizontally and vertically, to take on more complex problems and physically meaningful extensions in the general framework of space weather forecasting. Results shown have received partial support by the ESA Contract No. 4000113186/15/D/MRP with the RCAAM of the Academy of Athens, the European Union FLARECAST Project (Grant Agreement No. 640216), the US National Science Foundation Award No. 1931555 and the NASA/SRAG - Georgia State University CON014225 on Data Set for the ISEP Project.

A study of the solar transition region using IRIS observations of a solar flare

Gontikakis Costis, Academy of Athens, RCAAM Antiochos Spiro (NASA/GSFC)

Abstract

A X1.6 class solar flare was observed with the IRIS spectrograph on September 2014, recording the Si IV 1402Ang, Fe XII 1349Ang, and Fe XXI 1354Ang lines. We measure IRIS spectral line intensities, along with co-temporal images from the AIA telescope. These high-temporal-and-spatial resolution data afford the unique opportunity to test the widely-used 1D models for the solar transition region. We compute Emission Measures for selected pixels on the flare ribbons and follow the evolution of the Emission Measure during the flare. The key point of focusing on the flare ribbons is that it allows us to isolate the transition region footpoint of a coronal loop, albeit a flaring one. The flare impulsive energy release is important for the initial brightening of the ribbon, but according to standard theory, the flare transition region must quickly evolve to the standard state of radiation balanced by conduction from above. We discuss the implications of our results for the standard model and for understanding the transition region, in general.

Oscillatory reconnection of a 2D magnetic X-point for systems with different base temperatures.

Karampelas Konstantinos, Northumbria University, McLaughlin J. A. (Northumbria University), Botha G. J. J. (Northumbria University), Regnier S. (Northumbria University)

Abstract

The propagation of magnetoacoustic waves about a 2D magnetic X-point has revealed the existence of oscillatory reconnection, which is a series of horizontal and vertical current sheets with associated changes in magnetic connectivity. Oscillatory reconnection has been proposed as a wave-generation mechanism to explain some of high-speed, quasi-periodic outflows/jets in the solar atmosphere, as well as one possible physical mechanism behind quasi-periodic pulsations (QPPs). In this study we expand the results of McLaughlin et al. (2009) by performing a parameter study over a wide range of base temperatures. We solve the full set of 2D MHD equations for a magnetic X-point with the use of the PLUTO code, with explicit resistivity included. Through a nonlinear wave, we initiate the collapse of the X-point into a current sheet, initiating oscillatory reconnection for systems of different base temperatures. We study the evolution of plasma beta and its effects on the oscillatory process. By increasing the base temperature of the system, we see that both the amplitude and the period of the oscillating current density profile change. Finally, we will discuss how thermal conduction affects the temperature evolution of our systems, and by extension the final non-potential state of our systems.

Decay-less coronal loop oscillations as self-oscillatory processes

Karampelas Konstantinos, Northumbria University Van Doorsselaere Tom (KU Leuven)

Abstract

Observations of solar coronal loops with the Atmospheric Imaging Assembly (AIA) instrument of SDO have revealed the existence of a low amplitude decay-less regime of transverse oscillations. Despite appearing similar to the well understood large amplitude and rapidly decaying fast kink-mode oscillations observed in loops, their means of excitation and exact nature are still debated. Addressing these two questions is essential for coronal seismology, as well as determining their potential role in wave heating of the solar corona. In this talk, we explore the concept of these standing waves being self-oscillatory processes, expanding two older studies through 3D magnetohydrodynamic simulations using the PLUTO code. Our models consist of weak plasma flows around a cylindrical flux tube. The first model is reminiscent of supergranulation flows around a loop footpoint. The second is reminiscent of upflows associated with coronal mass ejections, generating Alfvenic vortex shedding. We show that both methods lead to the development of low-amplitude transverse standing waves, for the first time in full 3D simulations. The power spectral density for each model reveal that the frequency of the fundamental standing kink mode is the dominant one in the excited oscillation. We also argue that both of these mechanisms are essentially self-oscillations, since the dominant excited frequencies are dependent upon the characteristics of the oscillating loops, and not those of the drivers. We thus present two models acting as a proof-of-concept for self-oscillations in coronal loops, and we propose them as possible mechanisms for interpreting the observed decay-less transverse loop oscillations.

On the generation of Pi2 pulsations due to plasma flow patterns around magnetosheath jets

Katsavrias Christos, University of Athens

Abstract

We report observations of a magnetosheath jet followed by a period of decelerated background plasma. During this period, THEMIS-A magnetometer showed abrupt disturbances which, in the wavelet spectrum, appeared as prominent and irregular pulsations 'in two frequency bands (7.6-9.2 and 12-17 mHz) within the Pi2 range. The observations suggest - for the first time to our knowledge - that these pulsations were locally generated by the abrupt magnetic field changes driven by the jet's interaction with the ambient magnetosheath plasma. Furthermore, similar pulsations, detected by THEMIS-D inside the magnetosphere with a 140 seconds time-lag (which corresponds to the propagation time of a disturbance travelling with Alfvenic speed), are shown to be directly associated with the ones in the magnetosheath, which raises the question of how exactly these pulsations are propagated through the magnetopause.

This research is co-financed by Greece and the European Union (European Social Fund - ESF) through the Operational Programme "Human Resources Development, Education and Lifelong Learning 2014-2020" in the context of the project ULFpulse (MIS: 5048130).

High-resolution spectroscopy of a minifilament eruption

Kontogiannis Ioannis, Leibniz-Institute for Astrophysics Potsdam Dineva Ekaterina (AIP, University of Potsdam), Diercke Andrea (AIP, University of Potsdam), Verma Meetu (AIP), Kuckein Christoph (AIP), Balthasar Horst (AIP), Kamlah Robert (AIP, University of Potsdam), Pal Partha S. (AIP, University of Delhi), Denker Car

Abstract

Minifilaments are miniature versions of filaments, forming in regions where weak opposite-polarity magnetic concentrations converge or cancel. They were first observed in H-alpha filtergrams of quiet Sun and were further studied in EUV imaging observations, made available by the Solar Dynamics Observatory. Recent studies have shown their association with small-scale eruptive events, showcasing their importance in energetic processes of the quiet Sun. Here we present the first detailed study of a minifilament eruption, using high-cadence, high-resolution spectral and imaging observations, acquired with a new observing setup at the Vacuum Tower Telescope, Tenerife, Spain. This setup facilitates high spectral resolution scans of extended regions in three spectral regions, H-alpha, H-beta, and Cr I, with fast cadence (20 s). Spectra were cleaned using Principal Component Analysis (PCA) and physical parameters were extracted with Gaussian spectral fitting and cloud model analysis. The minifilament formed between small-scale, opposite-polarity magnetic concentrations, through a series of small reconnection events, and it erupted within an hour after its appearance in H-alpha. It exhibited a twisted, thread-like structure and it erupted in two phases (slow and fast), producing a coronal dimming, while part of the erupting material returned to the chromosphere. The observed similarities to large-scale filament eruptions indicate the action of common mechanisms. Their properties, combined with their abundance in quiet Sun, constitute minifilaments ideal targets for the new generation of ground-based solar telescopes. We highlight the importance of high spectral resolution observations provided by the new observing setup at VTT and discuss the prospects of future observations with an upgraded setup.

Retrograde periodic orbits of asteroids in 2/1 mean motion resonance with Jupiter

Kotoulas Thomas, University of Thessaloniki Voyatzis George (Department of Physics, A.U.Th.)

Abstract

In the last years a large number of asteroids has been detected having orbits which are retrograde with respect to the planetary orbits. In this work we study two and three-dimensional resonant retrograde periodic orbits in the framework of the restricted three-body problem with the Sun and Jupiter as primaries. The starting point of the present study is the planar circular model. We compute the families of retrograde periodic orbits in 2/1 mean motion resonance with Jupiter and we compute their linear stability type. Then, by applying the method of Henon, we obtain bifurcation orbits and extend our computations to the three-dimensional case including the whole inclination domain $0<i<180^0$ i.e. both prograde and retrograde orbits. The position and the stability character of the periodic orbits are very useful for the study of the phase space structure and this will provide an important piece of information on the stability and long term evolution of potential asteroids which are in retrograde motion with Jupiter in the 2/1 resonance.

Solar Energetic Particle event forecasting with the use of Machine Learning techniques

Lavasa Eleni, University of Athens Giannopoulos Giorgos (IMIS Institute, Athena Research Center, 15125 Marousi, Greece), Papaioannou Athanasios (Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS), National Observatory of Athens, I.Metaxa & Vas. Pavlou St

Abstract

We present a consistent Machine Learning (ML) framework for the binary prediction of Solar Energetic Particle (SEP) events, based on solar flare and coronal mass ejection (CME) observational data. A thorough investigation for optimal solutions is performed under our proposed approach, across diverse classification algorithms and extended hyper-parameter spaces. We conduct a thorough experimental evaluation of our method, with the two-fold purpose to uncover informative combinations of the selected SXR flare and/or CME input variables, as well as to establish the proper setting for the inherently imbalanced problem at hand. Random Forest, a tree-based ensemble model is depicted as the best performing and more robust solution in our evaluation setting, running on both flare and CME data to achieve a Probability of Detection (POD) = 0.76(B±0.06), a False Alarm Rate (FAR) = 0.34(B±0.10), true skill statistic (TSS) = 0.75(B±0.05) and Heidke skill score (HSS) = 0.69(B±0.04). Post-hoc analysis is finally performed, to relate the recovered ML models to the underlying physics of SEP drivers. CME speed and width, along with flare SXR fluence are highlighted as the features with the strongest discriminatory capabilities in our setting.

NELIOTA: A status update

Liakos Alexios, National Observatory of Athens/IAASARS Bonanos Alceste (IAASARS/NOA), Xilouris Manolis (IAASARS/NOA), Koschny Detlef (ESA/ESTEC & TU Munich), Boumis Panayotis (IAASARS/NOA), Bellas-Velidis Ioannis (IAASARS/NOA), Dapergolas Anastasios (IAASARS/NOA), Moissl Richard (ESA/ESTEC), Maroussis Athanasios

Abstract

We present scientific results from the first phase (2017-2021) of the ESA-funded NELIOTA lunar monitoring program. Using the 1.2 m Kryoneri telescope and the fast frame cameras of the system, NELIOTA has recorded over 100 validated lunar impact flashes since the beginning of its operation in early 2017, while other ~50 have been characterized as suspected. We will present updated results concerning the dimensions, the masses and the appearance frequency of the meteoroids in the vicinity of the Earth. Moreover, updated statistics for the temperatures of the collisions and the calculation of the meteoroid frequency on various distances from the Earth and the Moon provide for the first time quantitative results for the risk assessment for space and satellite missions as well as for future establishment of lunar bases. The second phase of NELIOTA is expected to start in early summer 2021 and to last for two years, as part of the ESA CARMEN project, while NELIOTA observations are continuing in the interim period.

Energetic particle observations near the Sun by Solar Orbiter and Parker Solar Probe

Malandraki Olga, National Observatory of Athens/IAASARS

Abstract

Solar Energetic Particles (SEPs) constitute an important contributor to the characterization of the space environment. They are emitted from the Sun in association with solar flares and Coronal Mass ejection (CME)-driven shock waves. SEP radiation storms may have durations from a period of hours to days or even weeks and have a large range of energy spectrum profiles. These events pose a threat to modern technology strongly relying on spacecraft, are a serious radiation hazard to humans in space, and are additionally of concern for avionics and commercial aviation in extreme circumstances. However, after decades of observations of SEPs from space-based observatories, relevant questions on particle injection, transport, and acceleration remain open. Understanding how the Sun accelerates particles to relativistic energies and how these propagate from their acceleration site to fill the heliosphere is one of the key questions that the Solar Orbiter (SoLO) ESA mission has set out to answer by means of the Energetic Particle Detector (EPD) measurements. Furthermore, the NASA Parker Solar Probe (PSP) mission also addresses key questions regarding SEP events, utilizing measurements by the Integrated Science Investigation of the Sun (IS0IS) instrument suite. In this talk, unique energetic particle observations obtained in the inner heliosphere by these two pioneering missions as well as the exciting new results derived will be presented, highlighting how SoLO and PSP observations are advancing our current knowledge and understanding of SEPs.

Relative field line helicity of active region 11158

Moraitis Kostas, University of Ioannina Patsourakos Spiros (University of Ioannina), Nindos Alexander (University of Ioannina)

Abstract

Magnetic helicity is a physical quantity of great importance in the study of magnetized plasmas as it is conserved in ideal magneto-hydrodynamics and slowly deteriorating in non-ideal conditions such as magnetic reconnection. A meaningful way of defining a density for helicity is with field line helicity, which, in solar conditions, is expressed by relative field line helicity (RFLH). In this work we study in detail the behaviour of RFLH, for the first time, in a solar active region (AR). The target AR is the large, well-studied, eruptive AR 11158. The computation of RFLH and of all other quantities of interest is based on a high-quality non-linear force-free reconstruction of the AR coronal magnetic field, and on the recent developments in its computational methodology. The derived photospheric morphology of RFLH is very different than that of the magnetic field or the electrical current. The large decrease in the value of helicity during an X-class flare of the AR is also depicted in the photospheric morphology of RFLH. Moreover, the area of the RFLH decrease coincides with the location of a flux rope, that is, of the magnetic structure that later erupted. The use of RFLH can thus provide important information about the value and location of the magnetic helicity expelled from the solar atmosphere during eruptive events.

Coordinated observations of the effect of consecutive HSS pulses on relativistic electron enhancement

Nasi Afroditi, University of Athens Daglis Ioannis A. (Department of Physics, National and Kapodistrian University of Athens, Athens, Greece), Katsavrias Christos (Department of Physics, National and Kapodistrian University of Athens, Athens, Greece), Sandberg Ingmar (Space Applications & R

Abstract

During the second half of 2019, a series of recurring, moderate geomagnetic storms (Dstmin >= - 70 nT) emerged after a sequence of high-speed solar wind streams (VSW >= 600 km/s) impacted the magnetosphere. During one of these storms, intense substorm activity was also recorded (SML < - 2000 nT on August 31 and September 1), as well as a longer-lasting solar wind pressure pulse.

We investigate this series of events, using particle measurements from three missions that recorded significant enhancements of relativistic electron fluxes: the Van Allen Probes, Arase and Galileo 207 & 215 satellites. We use both the flux intensity and the phase space density (PSD) of electrons, along with interplanetary parameters and information on ultra-low frequency (ULF) and chorus wave activity for a detailed analysis of this event.

Our study demonstrates the importance of substorm injections, even during moderate or weak geomagnetic storms. The presence of seed electrons at L* = 4-5, in addition to intense ULF and chorus wave activity, seems to result in very efficient electron acceleration to relativistic and ultra-relativistic energies.

This work has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 870437 for the SafeSpace project.

Association of relativistic electron enhancements with VLF/ULF wave activity and seed electrons

Nasi Afroditi, University of Athens Daglis Ioannis A. (Department of Physics, National and Kapodistrian University of Athens, Athens, Greece), Katsavrias Christos (Department of Physics, National and Kapodistrian University of Athens, Athens, Greece), Li Wen (Center for Space Physics, Bosto

Abstract

Local acceleration driven by whistler mode chorus waves is fundamentally important for the acceleration of seed electrons in the outer radiation belt to relativistic energies. This mechanism depends strongly on substorm activity and on the source and seed electron populations injected by substorms into the inner magnetosphere.

In this work, a selection of geospace disturbance events, emerging from single and isolated interplanetary drivers, is divided into two groups, one resulting in enhancement and one in depletion of the average relativistic electron Phase Space Density (PSD). Because substorm activity does not always coincide with or depend on magnetic storm occurrence, we have not limited our study to storms, but have included also non-storm events that are able to cause enhancements and depletions of the relativistic electrons in the outer radiation belt. We investigate solar wind and geomagnetic parameters, wave activity and the seed electron PSD in the outer Van Allen radiation belt, looking for the occurrence of characteristic patterns, by performing a Superposed Epoch Analysis (SEA).

Our study indicates the importance of substorm-associated enhancements of seed electrons, along with prolonged, intense ULF and VLF wave activity and an earthward displaced plasmapause, as conditions leading to substantial enhancements of relativistic electrons in the outer Van Allen belt.

This work has received funding from the European Unionβ€™s Horizon 2020 research and innovation programme under grant agreement No 870437 for the SafeSpace project.

A Comparison of the Effective Acceleration Model with ENLIL and DBEM Models: Further testing with heliospheric imaging observations

Paouris Evangelos, National Observatory of Athens/IAASARS Vourlidas Angelos (The Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, USA), Papaioannou Athanasios (IAASARS-NOA), Anastasiadis Anastasios (IAASARS-NOA)

Abstract

The Effective Acceleration Model (EAM) predicts the Time-of-Arrival (ToA) of the Coronal Mass Ejection (CME) driven shock and the average speed within the sheath at 1 AU. A validation of the upgraded EAMv3 model is performed via comparisons to predictions from the ensemble version of the Drag-Based model (DBEM) and the WSA-ENLIL+Cone ensemble model. A common sample of 16 CMEs/ICMEs, in 2013 β€“ 2014, is used for the comparison. Basic performance metrics such as the mean absolute error (MAE), mean error (ME) and root mean squared error (RMSE) between observed and predicted values of ToA are presented. MAE for EAM model was 8.7 B± 1.6 hours while for DBEM and ENLIL was 14.3 B± 2.2 and 12.8 B± 1.7 hours, respectively. ME for EAM was β�’1.4 B± 2.7 hours in contrast with β�’9.7 B± 3.4 and β�’6.1 B± 3.3 hours from DBEM and ENLIL. We also study the hypothesis of stronger deceleration in the interplanetary (IP) space utilizing the EAMv3 and DBEM models. In particularly, the DBEM model perform better when a greater value of drag parameter, of order of a factor of 3, is used in contrast to previous studies. EAMv3 model shows a deceleration of ICMEs at greater distances, with a mean value of 0.72 AU. We study further the

deceleration of fast ICMEs by introducing, for the first time, wide-angle observations by the STEREO heliospheric imagers into the EAM model. The speed profiles for some test cases show deceleration in the interplanetary medium at greater distances compared with the field-of-view of the coronagraphs.

Indices of geomagnetic activity derived from space-born magnetic data from the Swarm mission

Papadimitriou Constantinos, National Observatory of Athens/IAASARS Georgios Balasis (National Observatory of Athens), Boutsi Adamantia Zoe (National Observatory of Athens), Daglis Ioannis A. (National and Kapodistrian University of Athens), Giannakis Omiros (National Observatory of Athens)

Abstract

Ground based indices, such as the Dst and AE, have been used for decades to describe the interplay of the terrestrial magnetosphere with the solar wind and provide quantifiable indications of the state of geomagnetic activity in general. These indices have been traditionally derived from ground based observations from magnetometer stations all around the Earth. In the last 7 years though, the highly successful satellite mission Swarm has provided the scientific community with an abundance of high quality magnetic measurements at Low Earth Orbit, which can be used to produce the space-based counterparts of these indices, such the Swarm-Dst and Swarm-AE Indices. In this work, we present the first results from this endeavour, with comparisons against traditionally used parameters, and postulate on the possible usefulness of these Swarm based products for space weather monitoring and forecasting.

The Probabilistic Solar Particle Event foRecasting (PROSPER) Model

Papaioannou Athanasios, National Observatory of Athens/IAASARS Vainio Rami (Department of Physics and Astronomy, University of Turku, 20014 Turku, Finland), Raukunen Osku (Department of Physics and Astronomy, University of Turku, 20014 Turku, Finland), Anastasiadis Anastasios (National Observatory of Athens | IAASARS

Abstract

A solar eruptive event (e.g. solar flare, coronal mass ejection - CME) that has been marked on the Sun may give rise to an upcoming Solar Energetic Particle (SEP) event. Therefore, it is critical to know which of the specific solar parameters (e.g. solar flare magnitude and location; CME width and velocity) point to a higher probability of SEP occurrence. Additionally, from a subset of solar flares and CMEs that do produce SEP events, one should further infer the SEP characteristics (e.g. peak flux). In this work, we present a novel data driven approach that resulted in the Probabilistic Solar Particle Event foRecasting (PROSPER) model. We utilize: (i) CME characteristics (e.g. width, speed); (ii) solar flare characteristics (e.g. longitude, magnitude) and - for the first time - (iii) combinations of solar flare and CME characteristics. For each case and for a set of integral proton energies (i.e. E>10-; >30; >100; >300 MeV) we derive the probability of SEP occurrence (with corresponding confidence intervals), as well as, the expected peak proton flux (with lower and upper limits). The outputs of the PROSPER model have been incorporated in the new operational Advanced Solar Particle Event Casting System (ASPECS) tool [http://tromos.space.noa.gr/aspecs/].

Acknowledgement. This research received funding through the ESA activity Solar Energetic Particle (SEP) Advanced Warning System (SAWS). ESA Contract No. 4000120480/NL/LF/hh.

Magnetosheath Jets Close to the Bow Shock: Generation Mechanisms Using MMS Fast and Burst Data

Raptis Savvas, KTH - Royal Institute of Technology Tomas Karlsson (Space and Plasma Physics, School of Electrical Engineering and Computer Science, KTH Royal Institute of Technology, Sweden), Ferdinand Plaschke (Space Research Institute, Austrian Academy of Sciences, Graz, Austria), Anita Kullen (Space an

Abstract

Magnetosheath jets are found downstream of the Earth's bow shock. They are transient dynamic pressure enhancements usually attributed to both a density and a velocity increase. Jets have been associated with a variety of magnetospheric phenomena such as, magnetopause reconnection, ULF wave activity, energization of the outer radiation belt, aurora enhancement and direct plasma inflow to the magnetosphere. Moreover, jets appear to be a universal phenomenon possibly occurring in astrophysical or other planetary shocks.

These localized fast plasma flows are mainly found downstream of the quasi-parallel shock (regions where the angle between the IMF and the bow shock normal vector (ΞΈ_Bn) is less than 45 degrees). It is believed that the majority of them are generated at the shock by the interaction of the solar wind with the shock ripples. However, there have been many generation mechanism proposed for jets found downstream of the quasi-parallel bow shock but also of the quasi-perpendicular (θ_Bn>45) . Currently there is no consensus on how prominent or effective each mechanism is and is it still under debate if some of them exist.

In this work we briefly discuss the current theories describing the different origin mechanisms. Then, we show how statistical results from MMS mission (fast measurements) that have been associated to different mechanism support some of them. Furthermore, we present observations of high-resolution MMS (burst measurements) for jet structures found very close to the bow shock. We discuss different examples and the overall likelihood of existent formation mechanisms (e.g. bow shock ripples, foreshock transient events) and of newly proposed ones (e.g. magnetic reconnection, flux tubes). The initial results support the pre-existing theories while providing information about other effects that may contribute.

A chemical composition map for Titan's surface

Solomonidou Anezina, Caltech / JPL

Abstract

The investigation of Titan's surface chemical composition is of great importance for the understanding of the atmosphere-surface-interior system of the moon. The Cassini cameras and especially the Visual and infrared Mapping Spectrometer has provided a sequence of spectra showing the diversity of Titan's surface spectrum from flybys performed during the 13 years of Cassini's operation. In the 0.8-5.2 ΞΌm range, this spectro-imaging data showed that the surface consists of a multivariable geological terrain hosting complex geological processes. The data from the seven narrow methane spectral "windows" centered at 0.93, 1.08, 1.27, 1.59, 2.03, 2.8 and 5 μm provide some information on the lower atmospheric context and the surface parameters. Nevertheless, atmospheric scattering and absorption need to be clearly evaluated before we can extract the surface properties. In various studies (Solomonidou et al., 2014; 2016; 2018; 2019; 2020a, 2020b; Lopes et al., 2016; Malaska et al., 2016; 2020), we used radiative transfer modeling in order to evaluate the atmospheric scattering and absorption and securely extract the surface albedo of multiple Titan areas including the major geomorphological units. We also investigated the morphological and microwave

characteristics of these features using Cassini RADAR data in their SAR and radiometry mode. Here, we present a global map for Titans surface showing the chemical composition constraints for the various units. The results show that Titan's surface composition, at the depths detected by VIMS, has significant latitudinal dependence, with its equator being dominated by organic materials from the atmosphere and a very dark unknown material, while higher latitudes contain more water ice. The albedo differences and similarities among the various geomorphological units give insights on the geological processes affecting Titan's surface and, by implication, its interior. We discuss our results in terms of origin and evolution theories.
[1] Solomonidou, A., et al. (2014), J. Geophys. Res. Planets, 119, 1729; [2] Solomonidou, A., et al. (2016), Icarus, 270, 85; [3] Solomonidou, A., et al. (2018), J. Geophys. Res. Planets, 123, 489; [4] Solomonidou, A., et al. (2020a), Icarus, 344, 113338; [5] Solomonidou, A., et al. (2020b), A&A 641, A16; [6] Lopes, R., et al. (2016) Icarus, 270, 162; [7] Malaska, M., et al. (2016), Icarus 270, 130; [8] Malaska, M., et al. (2020), Icarus, 344, 113764.

Minimum perihelion distances and associated dwell times for NEAs

Toliou Athanasia, Lulea University of Technology

Abstract

The observed near-Earth-asteroid (NEA) population contains very few objects with small perihelion distances (q). NEAs that currently have orbits with relatively large q might have had a past evolution during which they have approached closer to the Sun. We present a probabilistic assessment of the minimum q that an asteroid with given orbital elements and absolute magnitude (H) has had at some point in its orbital history. At the same time, we offer an estimate of the time that it has spent having such an orbit. We have re-analyzed orbital integrations by Granvik et al. (2017, 2018) of test asteroids from the moment they entered the near-Earth region (<1.3 AU) until they ended up in their respective sinks, such as a collision with the Sun or a planet, or an ejection from the inner regions of the Solar System. We considered a total disruption of asteroids at certain q as a function of H, as proposed in Granvik et al. (2016) in order for their NEO population model to match the observations. We calculated the probability that an asteroid with a given set of orbital elements (semi-major axis, eccentricity, inclination) and H has acquired a q value smaller than given threshold value, as well as its respective dwell time in that range. We have constructed a look-up table containing this information that can be used in studies of the past orbital and thermal evolution of asteroids, as well as meteorite falls and their possible parent bodies.

Solar system science in the era of asteroid exploration

Tsiganis Kleomenis, University of Thessaloniki Heliophysics and the Solar System

Abstract

As with all physical theories, those pertaining to the origins and evolution of the solar system must be validated by observations. Much of the information come from the distributions of orbital and physical properties of the minor planets (aka asteroids) -- the remains of the building blocks that formed the planets.
The advent of a 'golden era' of in situ asteroid exploitation -- with nearly a dozen missions in 20 years already deployed (e.g. Hayabusa 1 and 2, OSIRIS-ReX) or planned (e.g. Lucy, DART, Hera ...) -- represents, without doubt, a major turning point. At the

same time, the exquisite astrometry provided by GAIA greatly increases our potential for targeted, ground-based asteroid studies.
In this talk I am going to review the major advances made by asteroid exploration missions and describe future space-born and ground-based endeavors.

Space simulator of the near-Sun environment

Tsirvoulis Georgios, Lulea University of Technology

Abstract

The study of Near Earth Objects has gathered significant scientific interest over the past few decades. Although the primary drive for this research is the need to discover and quantify potential threats to Earth, we have also gained substantial information about the formation and evolution of the Solar System, regarding both dynamical and physical processes.
One such process, by which asteroids that approach very close to the Sun are disintegrated, has been proposed by the most recent population models of NEOs to match the observational data. We present a new experimental infrastructure that enables us to study such processes, by enabling us to simulate the extreme conditions of the Solar neighborhood.
The experimental setup consists of a large vacuum chamber, within which we place samples of Earth minerals commonly found on meteorites, such as olivine, pyroxene and serpentine, as well as specially manufactured asteroid simulants. To simulate the Solar radiation make use of a 7KW Xenon short-arc lamp capable of delivering an irradiative power up to 50 W/cm2 into the chamber and onto the sample. To monitor the processes taking place on the samples, we make use of an array of thermocouples to probe the internal temperature, two high speed and two regular cameras to record physical changes on the surface of the samples and a residual gas analyzer fitted to the vacuum chamber to measure the volatiles being outgassed.
Preliminary tests we have performed show promising results as we witnessed the formation of cracks on the samples and the ejection of material from the sample surface, as well as considerable mass loss to volatiles depending on the composition and more specifically on the hydration of each sample. These results, along with the planned experiments are expected to help us understand the correlation between the size and the disruption distance of asteroids close to the Sun.

The vortical Sun at small scales

Tziotziou Kostas, National Observatory of Athens/IAASARS Tsiropoula Georgia (IAASARS, National Observatory of Athens), Khomenko Elena (Instituto de Astrofisica de Canarias, Spain), Kontogiannis Ioannis (Leibniz-Institut fur Astrophysik Potsdam (AIP), Germany), Dakanalis Ioannis (IAASARS, National Observatory of

Abstract

Ubiquitous small-scale vortical motions, generated on the solar surface by the turbulent dynamics of solar convection are observed at dynamic timescales of a few minutes in the quiet-Sun atmosphere. With the majority of such convectively driven vortex flows harbouring magnetic fields, swirling photospheric motions lead to the formation of magnetic tornadoes that reach heights up to the low corona. The formation of such magnetic structures and their unimpeded rotation strongly depends on the co-local magnetic field environment and topology. These braided and twisted magnetic structures can drive and foster a wide variety of oscillations and wave modes, amongst them different Alfvenic type modes such as kink waves, sausage modes, and torsional

Alfven waves and, therefore, could provide an additional mechanism for the solar atmospheric heating. Recent high-temporal, high-resolution observations in Hα and Calcium lines (Ca II 8542 A, Ca II H, Ca II K), acquired with the Swedish Solar Telescope (SST), reveal that small-scale vortical motions are more abundant in the lower solar atmosphere than previously reported. Using state-of-the-art magnetoconvection simulations we explore the role of the magnetic field in the formation of vortical motions. Moreover, exploiting both simulations and observations we explore the role of vortical structures in the small-scale dynamics of the quiet Sun, investigate the presence of Alfvenic type waves within them and provide estimates of the related energy transfer towards higher solar atmospheric layers.

Relating coronal X-ray emission of the Sun and stars to surface magnetic flux in 3D MHD models

Zhuleku Eugene, Max Planck Institute for Solar System Research

Abstract

The X-ray activity of the Sun and solar-like stars is governed by the magnetic field on the stellar surface. This is observationally well established. In our study, we aim to provide a quantitative understanding of the power-law relation between X-ray emission and magnetic field through simple analytical analysis and 3D MHD models of solar and stellar coronae. In our analytical model, we start from the Rosner-Tucker-Vaiana (RTV) scaling laws for coronal loops, which relate temperature and pressure to heat input and loop length. To this, we add how the X-ray emission depends on coronal temperature for different X-ray instruments and different scalings for coronal heating mechanisms. Combining these, we derive a power-law scaling between X-ray emission and magnetic flux, where the power-law index depends mainly on the form of the heating mechanism and the temperature response of the instrument. In particular, for nanoflare heating, we find a good agreement between our simple model and observed power-law relations.

To get more flexibility and relax the assumptions of the RTV laws in the analysis, we also derive power-law scalings using 3D MHD models of solar and stellar coronae above active regions. Starting from a typical solar active region as a reference, we scale the magnetic flux of the active region by increasing (a) the peak magnetic field strength and (b) the area of the active region. In both cases, we find a power-law relation between X-ray emission and magnetic flux that is steeper than in most of the observational studies. With our study, we can better understand how different properties of stellar active regions, will scale with stellar activity and hence impact the X-ray emission. With our analytical model, we gain a good quantitative understanding of how the stellar X-ray emission increases with the surface magnetic flux following a power-law scaling. We can explain this increase as a combination of an increase in the number of active regions at the solar and stellar surface and the peak surface magnetic field strength of each active region.

Poster Contributions

The SAWS-ASPECS Solar Energetic Particle (SEP) Advanced Warning System

Anastasiadis Anastasios, National Observatory of Athens/IAASARS Papaioannou Athanasios (National Observatory of Athens/IAASARS), Paouris Evangelos (National Observatory of Athens/IAASARS), Basalos George (National Observatory of Athens/IAASARS), Vainio Rami (University of Turku, Finland), Miikka Paassilta (University

Abstract

Solar particle events (SPEs) are radiation storms induced by eruptive processes on the Sun, namely solar flares and, more prominently, Coronal Mass Ejections (CMEs). These SPEs represent a concern for the spacecraft, launch, human spaceflight and aircraft operators given the effects on electronics and human physiology.

The SAWS- ASPECS system is a web based tool (http://phobos-srv.space.noa.gr/), that collates and combines outputs from different modules providing forecasts of solar phenomena, solar proton event occurrence and solar proton flux and duration characteristics; tailored to the needs of different spacecraft and launch operators, as well as the aviation sector. This is achieved by a 3-tier system combining the forecasting of flares, the statistical forecast of events on the basis of flare and CME characteristics and physics and analytical modelling for predicting particle flux profiles. The predictions start with the solar flare forecasting and continuously evolve through updates based on near-real time inputs (e.g. solar flare and coronal mass ejections data/characteristics) received by the system. User requirements include a derivation of energies and thresholds important for different user-groups and warning levels. In addition, for the first time the complete time profile of the SEP event at respective energies is provided in near real-time, utilizing both simulations and observations.

The SAWS-ASPECS system was developed, receiving funding through the ESA activity Solar Energetic Particle (SEP) Advanced Warning System (SAWS) ESA Contract No. 4000120480/NL/LF/hh.

Search for high energy escaping electrons from Jupiter's and Saturn's magnetospheres: Cassini/MIMI observations.

Angelopoulou Pinelopi, University of Athens Daglis Ioannis A. (Department of Physics, National and Kapodistrian University of Athens, Greece), Roussos Elias (Max Planck Institute for Solar System Research, Germany), Dialynas Kostas (Office of Space Research and Technology, Academy of Athens)

Abstract

In this work, we attempt to understand the relativistic electron escape mechanism from Jupiter's magnetosphere, by searching for similar events in Saturn's magnetosphere. To achieve this, we analyze data from Cassini's LEMMS instrument, which consists of two individual particle telescopes, made for measuring electron energies in the ranges of 18 keV- 1 MeV and 0.1-20 MeV. Data evaluation is accomplished by the survey of time series of energetic electron measurements when Cassini traverses the solar wind or the magnetosheath in the vicinity of each planet and the application of Wavelet and Lomb-Scargle analysis in order to detect periodicities that are characteristic for dynamical processes pertained in the two magnetospheric systems. When it comes to Jupiter, the leakage of relativistic electrons through the planet’s magnetosphere in many

characteristic time scales is unambiguous, with a previously unreported periodicity of several days indicating that quasi-periodic internaly-driven reconnection contributes to the escape of electrons . With the exception of a few hundreds keV electrons or below, we have not detected relativistic electrons escaping Saturn's magnetosphere thus far, even though such particles have been observed at the planet's outer magnetosphere, in association to 60-minute quasi-periodic electron injections. The lack of such electrons escaping from Saturn indicates that a similiar quasi-periodic electron injection process at Jupiter may not be the answer to the source of relativistic electrons escaping from that planet.

Study of the inclination of transition region loops observed with IRIS

Athanasiou Stathis, University of Athens Gontikakis Costis (Academy of Athens)

Abstract

Understanding the physics of loops is of great importance for the study of the solar atmosphere. In this work we calculate the inclination Ξ^2 of loops relative to the normal on the solar surface. We analyze loops observed in AR12529 with spectrograph IRIS in transition region emission lines Si IV 1393 Ang and C II 1334.5 Ang. Loop's inclinations, are calculated using their 2D shape on the image, and the Doppler shifts measured along their length. We managed to select 5 loops where we measured Ξ^2 angles of 30 to 54 degrees. The loop maximum altitude range is from 2500 to 7000 km while their velocities are from 25 to 50 km/s. Proper motions and Doppler velocities indicate that the plasma flow is time dependent during the observation.

Rotational state of the most ancient asteroids as an observational constraint for asteroid family membership

Athanasopoulos Dimitrios, University of Athens Gazeas Kosmas (University of Athens), Delbo Marco (Nice Observatory), Avdellidou Chrysa (Nice Observatory), Rivet Jean-Piere (Nice Observatory)

Abstract

Asteroids, the building blocks of planets, during the history of the solar system have collided resulting in the formation of the families of asteroid fragments. The identification of the oldest asteroid families can help us to trace our Solar System back its first stages and reconstruct the original state of the asteroid belt. Classical identification methods, like Hierarchical Clustering Methods (HCM), are unable to recognize very old families because the family members are dispersed over time due to the effect of the non-gravitational forces (Yarkovski). The group of Delbo et al. (Nice Observatory) established another family identification technique that takes advantage of the "V-shape" that the asteroid family members form when are plotted in the (semimajor axis vs. 1/Diameter) space. The method has already successfully identified one ancient and two primordial families, with the latter two estimated to be as old as our Solar System. To better identify the borders of the families we perform a complementary and independent study, where we determine the spin direction of asteroids in the two sides of the "V-shape" through photometric observations. For this purpose, an international observational campaign called "Ancient Asteroids" was initiated at the University of Athens, involving professional and amateur observers. Here we will present the first observations of the campaign and the preliminary results.

Investigation of the GIC development in Mediterranean countries during the strongest magnetic storms of solar cycle 24

Boutsi Adamantia-Zoe, IAASARS/NOA Balasis Georgios (National Observatory of Athens), Daglis Ioannis A. (National and Kapodistrian University of Athens), Tsinganos Kanaris (National and Kapodistrian University of Athens), Giannakis Omiros (National Observatory of Athens)

Abstract

Geomagnetically Induced Currents (GIC) constitute an integral part of the space weather research and a subject of ever-growing attention for countries located in the low and middle latitudes. A series of recent studies highlights the importance of considering GIC risks for the Mediterranean region. Here, we exploit data from the HellENIc GeoMagnetic Array (ENIGMA), which is located in Greece, complemented by magnetic observatories in the Mediterranean region (France, Italy, Spain, Turkey and Algeria), to calculate corresponding values of the GIC index, i.e., a proxy of the geoelectric field calculated entirely from geomagnetic field variations. We perform our analysis for the most intense magnetic storms (Dst < -150 nT) of solar cycle 24. Our results show a good correlation between the storm sudden commencement (SSC) and an increase of the GIC index value. These investigations indicate that despite the elevated amplitude of the GIC index the associated risk remains at low level for all magnetic observatories / stations under study during the considered storm events.

A Mechanism Driving Recurrent Eruptive Activity on the Sun

Chintzoglou Georgios, Lockheed Martin Solar & Astrophysics Lab

Abstract

In Chintzoglou et al (2019) it was demonstrated that collision and shearing between opposite non-conjugated polarities (from bipoles emerging near each other within the same active region) produce "collisional polarity inversion lines" (cPILs) and drives rapid photospheric cancellation of magnetic flux. This mechanism of coupled magnetic cancellation and shearing is called "collisional shearing" and it is different than the standard magnetic cancellation, which occurs in the internal PIL of a single (usually decaying) bipole. In the same paper, it was demonstrated that collisional shearing occurred in two emerging flare- and CME-productive ARs (NOAA AR11158 and AR12017) by measuring significant amounts of magnetic flux canceling at the cPIL. This finding supported the formation and energization of magnetic flux ropes before their eruption as CMEs and the associated flare activity. Here, we provide spectropolarimetric evidence from HINODE observations that confirm the occurrence of strong magnetic cancellation (by submergence of Ω-loops) at the cPIL of these ARs. In addition, we provide theoretical support from data-driven 3D modeling of the coronal magnetic field, capturing the recurrent formation and eruption of energized structures during the collisional shearing process. We discuss our results in relation to extreme flare and eruptive activity.

On the origin of magnetospheric Ultra-Low Frequency (ULF) waves in sudden and gradual variations of solar wind dynamic pressure

Georgiou Marina, University of Athens

Abstract

Several observational studies have shown that external (i.e. solar wind and magnetosheath) dynamic pressure variations can drive quasi-periodic perturbations of the geomagnetic field. In this study, we utilise multi-spacecraft (ARTEMIS, GOES and THEMIS) measurements and investigate solar wind dynamic pressure increases that occur over different timescales as the source of geomagnetic pulsations with frequencies between ~0.5 and 25 mHz. During intervals of slow solar wind and low geomagnetic activity β€" to exclude waves generated by velocity shear at the magnetopause and substorm contributions - common periodicities in magnetic field oscillations at geosynchronous orbit and dynamic pressure variations in the upstream solar wind are detected. The selected variations in the solar wind dynamic pressure - associated with different solar wind features which can perturb the magnetopause - are found to excite Pc4-5 waves with specific frequencies (up to 20 mHz) in the magnetosphere. Furthermore, both an amplitude and frequency dependence is revealed, suggesting slightly different magnetopause response and subsequent effects in the magnetosphere from step-like, sudden and gradual variations in the solar wind dynamic pressure.

This research is co-finance by Greece and the European Union (European Social Fund β€" ESF) through the Operational Programme "Human Resources Development, Education and Lifelong Learning 2014-2020" in the context of the project ULFpulse (MIS: 5048130).

Mars upper atmosphere with the NASA Ames General Circulation Model.

Gkouvelis Leonardos, NASA / Ames Research Center

Abstract

The NASA Mars General Circulation Model (MGCM) is a 3D atmospheric model that simulates successfully the climate of Mars. In this work we will present the extension of the model to the mesosphere and upper atmosphere where the Martian atmosphere is interacting with the space environment and the high energetic part of the solar spectrum is being absorbed. We are evaluating our model with remote sensing observations and present results of the annual, diurnal variations. Furthermore, we will study the effect of the September 2017 solar flare that impacted Mars and was captured from NASA's MAVEN spacecraft which is orbiting the planet since late 2014.

Studying the temporal evolution of a solar flare observed with IRIS in the UV

Gontikakis Costis, Academy of Athens, RCAAM Stamatakis Orfeas (University of Athens)

Abstract

Study of EUV spectral lines, emitted from a solar flare that took place in active region NOAA 12297. The flare was observed with IRIS spectrograph on 2015 Mars 12. We study the temporal evolution of the EUV spectrum and analyze the plasma dynamics in spectral lines of the chromosphere, the transition region and the corona.

The ARTEMIS "Jean Louis Steinberg (ARTEMIS-IV) Multichannel Radiospectrograph On Line Database for Free Data Access

Hillaris Alexander, University of Athens

Abstract

The ARTEMIS-JLS (IV) Website http://artemis-iv.phys.uoa.gr provides free access to the ARTEMIS database (ARTDB), spectral data recorded by ARTEMIS "Jean Louis Steinberg (ARTEMIS-IV) Multichannel Radiospectrograph of the University of ATHENS located at Thermopylae, Greece (Lat: 38o 49'N, Lon: 22o 41'E) since 1996. The daily observations cover the time interval 05:30 - 15:00 UT. The instrument frequency range was 110-687 MHz in the 1996-2002 period, extended hence to 20-650 MHz with the addition of a low frequency antenna. Two receivers operate in parallel: (1) The Global Spectral Analyser (ASG), which covers the full frequency band with 10 samples/s time resolution. (2) The Acousto-Optic Spectrograph (SAO), in the 265-450 MHz range, with high frequency and time resolution (1.4 MHz and 100 samples/s). The total data volume is ~1.5 GBytes/Day.

The ARTDB spectral data comprise of Flexible Image Transport System (FITS) files each containing the daily recordings of the ASG and the SAO receivers. These are accompanied by daily overviews (Quick Looks) in the form of bitmap images of intensity and differential spectra. A gallery of select radio burst dynamic spectra, links to publications based, totally or in part, to ARTEMIS-IVJLS data and some educational links are also included.

Future plans include expansion of the data listings of solar radio events and the development of an automatic data processing pipeline (calibration and corrections of the raw data).

This project is co-financed by the Onassis Foundation Grant 15153 and the University of Athens Research Committee Grant, 15018.

Complex Solar Events Observed with the ARTEMIS-IV/JLS Radio-Spectrograph in the 14 - 20 January 2005 Period

Kapetanakis Konstantinos, University of Athens

Abstract

We present a multi-frequency and multi-instrument study of two out of five events observed in the period January 14 - 20 with the radio-spectrograph ARTEMIS-IV/JLS. We focus mainly on the complex radio signatures and their association with the active phenomena taking place: flares, CMEs, particle acceleration. The dynamic spectra of ARTEMIS-IV/JLS " Wind/Waves with 650 MHz - 20 kHz combined frequency coverage, were used to track the evolution of the event from the low corona to the interplanetary space; these were supplemented with GOES SXR and SOHO/LASCO for the associated flare and CME activity. The radio bursts positional data were obtained by the Nancay Radio-Heliograph.

Dependence of the evolution of auroral displays on geomagnetic activity

Kotsiourou Varvara, University of Athens Daglis A. Ioannis (University of Athens, Department of Physics)

Abstract

Auroral displays are the only optical manifestation of space weather in geospace. The spatiotemporal evolution of Aurora Borealis exhibits a bewildering, but repeatable variety of complex structures and dynamics, which is correlated with solar activity and could become an essential part in space weather prediction models.

In our work we have investigated the extent of the auroral oval as a function of geomagnetic activity, through the use of the OVATION Prime model, which was developed at the Johns Hopkins Applied Physics Laboratory by Patrick Newell and co-workers and is provided through NASA's Community Coordinated Modeling Center (CCMC). OVATION Prime uses energetic particle measurements from Low-Earth Orbit polar orbiting satellites of the Defense Meteorological Satellite Program (DMSP), considering discrete electron aurorae (monoenergetic and broadband), diffuse electron aurorae (electron and ion) and providing statistical distribution of auroral precipitation in the ionosphere [Newell et al.,2010].

Have examined the distribution of auroral precipitation for three intense geomagnetic storms' one caused by an SI and two caused by CMEs. We present and discuss our results.

The role of ionospheric oxygen ions in ring current dynamics

Moutsiana Georgia, University of Athens Daglis Ioannis (Department of Physics, National and Kapodistrian University of Athens, Athens, Greece), Gkioulidou Matina (Applied Physics Laboratory, Johns Hopkins University, Laurel, Maryland, USA), Papadimitriou Constantinos (Department of Physics, Nat

Abstract

The contribution of ionospheric oxygen ions in terrestrial ring current dynamics is considered of great importance. In the present study we investigate protons and oxygen ion injection events in the inner magnetosphere, as well as their decay characteristics in comparison with geomagnetic activity variations through the entire year 2015, using omnidirectional and integral flux data of protons and O-ions from the RBPSICE instrument onboard the Van Allen Probes. We note that the energy range of measured particles is ~ 45 keV - ~ 600 keV for protons and ~ 142 keV - ~ 1127 keV for O - ions, which means that only higher energy O - ions are taken into consideration. Our results show that during the storm main phase, the flux of O-ions in the ring current increases faster than the flux of protons, while during storm recovery the O-ion flux decreases faster than the proton flux. Moreover, enhancements of the O-ion/proton flux ratio correspond to oxygen injection events in the inner magnetosphere and correlate well with geomagnetic activity, while more intense geomagnetic storms are associated with enhancements of the above ratio in lower L-shells. Magnetospheric substorms that occur independently of geomagnetic storms seem to lead to enhancements of the O-ion/proton ratio confined in higher L-shells. On the other hand, substorms that occur during geomagnetic storms seem to contribute both in the further enhancement of O-ions in the inner magnetosphere and the displacement of injections in lower L-shells. Finally, we comment on the decay rate of O-ions in comparison with geomagnetic activity variations as well as the minor contribution of O-ions with energies above 600 keV.

Semi-automatic CME fitting tool and uncertainty analysis of its geometric parameters based on the GCS model.

Nikou Eleni, George Mason University Zhang Jie (George Mason University), Dupertuis Matthew (George Mason University), Dhakal Suman (George Mason University)

Abstract

Coronal mass ejections (CMEs) are large-scale 3-dimensional structures in the interplanetary space carrying plasma and magnetic field from the Sun’s corona. It is generally believed that an erupted CME is a curved magnetic flux rope with magnetic field lines wrapping around a central axis while remaining rooted on the surface of the Sun at the two legs. The 3-D morphology of a CME can be approximated by a graduated cylindrical model (GCS model). Based on this model, we can reconstruct the flux rope of a CME using six free parameters. These parameters are longitude,latitude, tilt angle, aspect ratio, half angle and leading height and can describe the morphology of the CME in 3-D along its radial, toroidal and poloidal dimension. Although studies that focus on the radial and toroidal dimension of the CMEs can be found in the literature, there is not much information on their poloidal dimension, which leaves room for misunderstandings and not accurate interpretation of the size of a flux rope. In this study we introduce a semi-automatic fitting tool that uses the MPFIT minimization IDL routine and combines multi-viewpoint white light observations from space instruments, (the twin STEREO and SOHO spacecraft) and the GCS point cloud in order to give us the best values of the geometric parameters along with their uncertainties. This tool only needs two input parameters, a set of observations from the instruments of interest and a set of initial parameters in order to minimize the chi-square between the observations and the model which accelerates the fitting process. Having a robust and fast way to estimate the CME geometric parameters along with their uncertainties will help the prediction of space weather.

Forecasting the Time-of-Arrival and the magnetic field of the Interplanetary Coronal Mass Ejections at 1 AU

Paouris Evangelos, National Observatory of Athens/IAASARS Vourlidas Angelos (The Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, USA), Papaioannou Athanasios (IAASARS-NOA), Anastasiadis Anastasios (IAASARS-NOA)

Abstract

The Time-of-Arrival (ToA) and the estimation of the magnetic field of Interplanetary Coronal Mass Ejections (ICMEs) at 1 AU are open issues in the field of forecast and propagation of CMEs in the interplanetary space. We present our improved version of the Effective Acceleration Model (EAM) which predicts the ToA of the CME driven shock and our statistical model for the estimation of the magnetic field of the CME at Earth. Our approach utilizes the initial CME speed and the halo/non halo categorization and provides the total strength (B) and the southern component (Bz) of the magnetic field for two regions: inside the sheath as well as inside the main part of the ICME. Preliminary results of a new methodology which takes into account magnetograms for the calculation of the magnetic field parameters (e.g. magnetic helicity) of the active region and then the estimation of the magnetic field of the associated CME at 1 AU are also presented.

This research is co-financed by Greece and the European Union (European Social Fund-ESF) through the Operational Programme B«Human Resources Development, Education and Lifelong LearningB» in the context of the project β€Reinforcement of Postdoctoral Researchers - 2nd Cycle (MIS-5033021), implemented by the State Scholarships Foundation (IKY).

Forbush Decreases driven by Interplanetary Coronal Mass Ejections

Papaioannou Athanasios, National Observatory of Athens/IAASARS Belov Anatoly (Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation by N.V. Pushkov RAS (IZMIRAN), Moscow Troitsk, Russia), Abunina Maria (Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation by N.V. Pushkov RAS (IZ

Abstract

Interplanetary coronal mass ejections (ICMEs) and their corresponding shocks can sweep out galactic cosmic rays (GCRs) and thus modulate their intensity, resulting in Forbush decreases (FDs). In this work, we selected all FDs that were associated with a sudden storm commencement (SSC) at Earth, and a solar driver (e.g., CME) was clearly identified as the ICMEβ€™s source. We introduce and employ the tH parameter, which is the time delay (in hours) of the maximum strength of the interplanetary magnetic field from the FD onset (as this is marked via the SSC), and consequently derive three groups of FD events (i.e., the early, medium, and late ones). For each of these we examine the mean characteristics of the FDs and the associated IP variations per group, as well as, the resulting correlations. In addition, we demonstrate the outputs of a superposed epoch analysis, which led to an average time profile of the resulting FDs and the corresponding interplanetary variations, per group. Finally, we interpret our results based on the theoretical expectations for the FD phenomenon. We find that both the shock sheath and the ejecta are necessary for deep GCR depressions and that the FD amplitude (A0) is larger for faster-propagating ICMEs. Additionally, we note the importance of the turbulent shock-sheath region across all groups. Finally, we present empirical relations connecting A0 to solar wind properties.

A study on the scattering of ultraviolet radiation in a solar active region

Pastras Stavros, University of Athens Gontikakis Costis (Academy of Athens, RCAAM)

Abstract

The transition region of the solar atmosphere emits ultraviolet radiation that consists of emission spectral lines. Usually the radiation emission happens due to thermal collisions between free electrons and ions. In the active regions, however, where the radiation levels are higher, the emission may happen due to radiation scattering as well. In this study, we analysed the radiation scattering phenomenon using spectral lines of ionised silicon. Specifically, we analysed observational data of a solar active region that have been collected by the IRIS spectrograph in the spectral lines of Si IV 1393Å 1402 Å This analysis was carried out using the software package for solar telescopes called solarsoft. In addition, our study included a method of correlating the spectral data of IRIS with corresponding observational data by the AIA telescopes aboard SDO. The study focused on the understanding of the physical conditions of the transition region that lead to instances of radiation scattering.

Using synthetic PSP/WISRP J-maps to infer the variable nature of the slow solar wind

Patsourakos Spiros, University of Ioannina Nindos Alexander (University of Ioannina), Vourlidas Angelos (JHU/APL)

Abstract

The nature of the slow solar wind, continuous or intermittent flow, is still debated. Coronagraphs and heliospheric imagers regularly observe a spectrum of transient slow wind flows e.g. instance blobs, jets. etc. A standard tool for the study of such flows, is the display of intensity as a function of time and elongation along a given direction, which is called a J-map. The launch of the Parker Solar Probe (PSP) mission in 2018, and the availability of high-quality up-close images of the corona by its Wide-Field Imager (WISPR) opened new exciting observational capabilities in solar wind research.

Here, we report on simple simulations of synthetic WISPR J-maps constructed for various scenaria of transient solar wind release in terms of blobs. The methodology is based on Monte-Carlo simulations of blobs with varying numbers, release frequencies, speeds, and launch longitudes. We compare our synthetic J-maps with an observed WISPR J-map taken during the fourth solar encounter of PSP and use the observed daily count of tracks in this J-map in conjunction with our synthetic J-maps in order to place constraints on the variability of the solar wind flow properties of slow solar wind transient release in terms of blobs.

Magnetic Erosion and kinematics of Coronal Mass Ejections

Stamkos Sotiris, University of Ioannina Patsourakos Spiros (University of Ioannina), Daglis Ioannis (National and Kapodistrian University of Athens), Vourlidas Angelos (Johns Hopkins University - Applied Physics Laboratory)

Abstract

To better understand the solar wind dynamic interactions with Coronal Mass Ejections (CMEs), we examine the effect of magnetic erosion on to the well-known aerodynamic drag force acting on CMEs. In particular, we consider the interplay between reconnection with the ambient solar wind and the virtual mass component of the drag equation. We quantify the effect of magnetic reconnection, which erodes part of the CME mass and magnetic flux, on the drag acting on CMEs and, eventually, we determine its impact on the time and speed of arrival of CMEs at 1 AU.

Correlation of seed & source electron flux with magnetic substorm activity.

Thimianos Aristotelis, University of Athens

Abstract

For decades, geomagnetic indices have been used extensively to parameterize space weather events, as input to various models and as space weather specifications. Satelaits, space instuments and the space station must be protected from violent phenomena such as magnetic storms and high energy particles that can damage their interior and put in danger human lifes. In order to understand the phenomena that occur in the geospace we study the correlation of the magnetic indeces with the electron fluxes that are added after an event, so that we can predict space weather and be prepaired for uncomfortable situations.

We studied the corellation of the seed and source electron flux that happend after a substorm activity for more than 200 magnetic substorms during the years 2016 - 2018. By using the SME electrojet index of the SuperMAG network of more than 100 ground based magnetometers and their continiously increasing number of magnetometer stations we provide the best spatial resolution of

the magnetic index and so we provide the most complety list of substorm activity for our study. For the electron flux we use the RBSP Mission data from the MagEIS

instrument, while the spacecrafts were located in the outer VanAllen Belts (L* > 3) and at the same time in the nightside zone of the magnetosphere(0 < MLT < 6). By thus, we were able to detect every flux of electrons at the most efficient way, in the most suitable location, because of the westward drift of the negative charged particles that penetrates our magnetosphere. In general by using the SME index for the subtorm event identification and the MagEIS data for the elctron flux in specific areas, we were able to correlate the flux of both seed and source electrons with the size of each substorm.
The outcome of our study is that the High energetic electrons (>0.5 MeV) are not presenting any corellation between the event size (SME index) and the particle flux ratio before and after the event, as we expected, but for the seed and source electrons we observe an uptrend in the flux. More specific, we saw that for both source and seed poppulations the flux ratio before and after a substorm event is increased up to one order of magnitude and it has nothing to do with the size of the event (SME index). The best correlation appears in the seed electrons around 200 - 250 keV and in the source electrons around 60-75 keV and the percentage of the increasing flux ratio events is yet to be determined.

Session 2: Extragalactic Astronomy and Astrophysics

ORAL CONTRIBUTIONS

Impact of Kink Instability on the Emission Signatures of AGN Jets

Acharya Sriyasriti, Indian Institue of Technology Indore

Abstract

Relativistic AGN jets exhibit multi-timescale variability and a broadband non-thermal spectrum extending from radio to gamma-rays. Relativistically beamed jets pointing towards our line of sight make them an ideal laboratory to study the impact of physical processes in the jet on the above emission signatures. These jets are prone to undergo several Magneto-hydrodynamic (MHD) instabilities during their propagation in space and could trigger jet radiation and particle acceleration. This work aims to study the implications of relativistic kink mode instability on the observed long-term variability in the context of the twisting inhomogeneous jet model. To achieve this, we investigate the physical configurations preferable for forming kink mode instability by performing high-resolution 3D RMHD simulations of the plasma columns using PLUTO code. Our simulation focuses on a particular section of an AGN jet that is highly magnetized and under-dense compared to its external medium. From our parameter study, we find that the configurations with high magnetization values are prone to undergo kink instability. The presence of axial wavenumber affects the dynamics of the plasma column and the growth of the instability. In this work, we also attempt to couple the dynamics of the plasma column with its emission features. We find a correlated trend between the growth rate of kink mode instability and the flux variability obtained from the simulated light curve. In addition, we discuss the effects of shocks on the multi-wavelength emission, and we perform a correlation/anti-correlation study using the hybrid macro-particle based framework in PLUTO code.

Evolution of the UV upturn: Helium enhanced stellar populations in early-type galaxies

Ali Sadman, Subaru Telescope Chung Chul (Yonsei University), De Propris Roberto (University of Turku), Bremer Malcolm (University of Bristol), Phillipps Steven (University of Bristol)

Abstract

Early-type galaxies exhibit a rise in their UV spectra shortward of 3000 Å despite little to no signs of star-formation activity, a phenomenon dubbed the "UV Upturn". It is now widely accepted that the upturn is driven by hot horizontal branch (HB) stars at late stages of stellar evolution. While several mechanisms have been proposed to explain how HB stars can reach high enough temperatures to become UV-bright, observations of such stars in the multiple stellar populations of Milky Way globular clusters and subsequent spectroscopic confirmation indicate that the most likely mechanism is through He-enhancement.

In this talk I will discuss how recent studies of cluster galaxies at a range of redshifts demonstrate that the upturn is consistently observed in early-type galaxies between $z = 0 \sim 0.6$ (albeit with a degree of stochasticity), with its strength and incidence steadily

declining thereafter, until it mostly disappears at z ~ 0.9. The upturn is also found to be ubiquitous in most low redshift galaxies irrespective of environment. This evolutionary pattern is best replicated using models of He-enhancement where a minority stellar population with non-cosmological helium abundances (up to around Y=0.45) drives the UV output. These findings might suggest that early-type galaxies assembled most of their stellar mass at z>3, with a chemical/stellar feedback history similar to metal-rich globular/open clusters.

Exploring the impact of the Star Formation in the Mass-Metallicity relation at global scales

Alvarez-Hurtado Paola, Institute of Astronomy, UNAM

Abstract

We explore the Mass-Metallicity relation (MZR) for ~1000 nearby galaxies (0.005<z<0.08) using integrated properties from the extended version of the CALIFA integral field spectroscopy data. We focused on exploring the best mathematical form that describes the observed MZR through different functional forms as well as different statistical environments. To test the goodness of the fit of the MZR, we identify the function that yields the smallest scatter in its residuals. We use this residual to explore possible secondary relations of the MZR with other observables (e.g., SFR, Gas mass, gas fraction, and morphology). Among other results, we note a significant lack of an anti-correlation between these residuals and the SFR, in contrast to previous studies. Our results suggest that the functional form and the presence of secondary relations may depend on statistical treatment.

Molecular Gas Content in the CO ALMA Radio-source Catalogue

Audibert Anelise, National Observatory of Athens/IAASARS Dasyra Kalliopi (University of Athens), Papachristou Michalis (University of Athens), Fernandez-Ontiveros Juan (Istituto di Astrofisica e Planetologia Spaziali- INAF), Ruffa Ilaria (Cardiff University), Gkogkou Anastasia (Laboratoire d'Astrophysique de Ma

Abstract

Relativistic radio jets interact with the ISM in ways that can initiate massive molecular and atomic gas outflows, as in the case of the radio bright Seyfert IC 5063. Previously unknown radio jets were even revealed by collimated molecular outflows detected in CO with ALMA (e.g. in NGC 1377 and ESO 420-G13). It is, therefore, important to check how frequently this phenomenon happens and whether the host galaxies of the radio jets contain massive enough gas reservoirs for their fates to change when radio jets propagate through them. For this purpose, we carried out an ALMA archival survey of CO in radio galaxies in the redshift range 0<z<3. Starting from the ALMA Radio-source Catalogue (ARC) that comprises ALMA calibrators, we built a radio-galaxy sample of ~60 sources with spectral window tunings around CO (1-0), (2-1), (3-2), or (4-3) and we complemented it with 60 more radio galaxies with CO data from the literature. In radio wavelengths, the CO-ARC (initial and extended) sample is representative of the NVSS catalog, when flux-limited at 0.4 Jy. Preliminary results from this meticulously-selected sample are as follows: CO detections revealed the presence of gas reservoirs of ~10^7 <Mmol < 10^11 Msun in ~1/4 of the sample. About 3% of the sources have outflows. The gas content of the radio galaxies increases faster with redshift compared to the most massive normal star-forming galaxies predicted in simulations. The construction of gaseous and stellar mass functions, for comparison with those of normal galaxies at all redshifts, is under way.

The EDGE-CALIFA survey: self-regulation of star formation at kpc scales

Barrera Ballesteros Jorge K., Institute of Astronomy, UNAM

Abstract

The processes that regulate star formation are essential to understand how galaxies evolve. We present the relation between star formation rate density, Sigma_SFR, and hydrostatic mid-plane pressure, Ph, for 4260 star-forming regions of kpc size located in 96 galaxies included in the EDGE-CALIFA survey covering a wide range of stellar masses and morphologies. We find that these two parameters are tightly correlated, showing a smaller scatter in comparison to other star-forming relations. A power law, with a slightly sublinear index, is a good representation of this relation. Its residuals show a significant anticorrelation with both stellar age and metallicity whereas the total stellar mass may also play a secondary role in shaping the Sigma_SFR-Ph relation. For actively star-forming regions, we find that the effective feedback momentum per unit stellar mass (p*/m*), measured from the Ph/Sigma_SFR ratio increases with Ph.The median value of this ratio for all the sampled regions is larger than the expected momentum just from supernovae explosions. Morphology of the galaxies, including bars, does not seem to have a significant impact in the Sigma_SFR-Ph relation. Our analysis indicates that local Sigma_SFR self-regulation comes mainly from momentum injection to the interstellar medium from supernovae explosions. However, other mechanisms in disc galaxies may also play a significant role in shaping the Sigma_SFR at kpc scales. Our results also suggest that Ph is the main parameter that modulates star formation at kpc scales, rather than individual components of the baryonic mass.

[CII] synthetic observations of dwarf galaxy mergers

Bisbas Thomas, University of Cologne

Abstract

The star-formation rate (SFR) is of fundamental importance for understanding the cyclic process of global star formation in galaxies across the epochs. Measuring it can reveal the properties and the evolutionary stages of the observed interstellar medium (ISM). The [CII] far-IR fine-structure transition at a rest frame frequency of 158um is widely used as a promising diagnostic of SFR, all the more since ALMA is able to provide unprecedented resolution of high-redshift observations of this line, opening an entirely new window in the study of the Early Universe ISM. In this talk, I will present [CII] synthetic observations of smoothed particle hydrodynamical simulations of dwarf galaxy mergers, in the merging process of which there is a large population of star clusters formed varying the SFR to more than three orders of magnitude. The resulting [CII]-SFR relation shows an approximately linear correlation, agreeing very well with observations particularly those from the Dwarf Galaxy Survey. I will also discuss the origin of [CII] emission in which the ionized and the warm neutral medium play the dominant source of that emission, depending on the evolutionary stage of the merger. Finally, I will talk about the origin of [CII]-deficit which, in these simulations, is related with the increase of the FUV photoelectric heating as a result of the feedback from the massive star cluster formation.

Evolution of the Chemical Enrichment and Mass Metallicity Relation for local galaxies

Camps FariΓ±a Artemi, Institute of Astronomy, UNAM

Abstract

We present the results of a fossil record technique study using MaNGA and CALIFA galaxies showing the chemical enrichment history (ChEH) as well as how the mass-metallicity relation (MZR) has changed.

In order to analyze how the evolution of these relations correlates with the properties of the galaxy we separate the sample into mass, morphology and star-forming status bins, finding a strong dependence on the mass and the morphology, and dependence on the star-forming status that is more subtle after accounting for the correlation between morphology and star-forming status. We also measure the ChEH and MZR at different galactocentric radii, finding the effects of local downsizing as well as an inversion of the metallicity gradient for low mass galaxies.

SMILE: Search for MIlli-LEnses

Casadio Carolina, Institute of Astrophysics - FORTH

Abstract

Projects aimed at characterising dark matter properties make use of very different approaches. One such approach is to look for strong gravitational lens systems. Gravitational lensed images with angular separation on milliarcsecond scales probe gravitational lens systems where the lens is a compact object with mass in the range 10^6 – 10^9 M_sun. This mass range is particularly critical for the widely accepted cosmological model, which predicts many more DM sub-halos, i.e., DM halos on sub-galactic scales (masses below $\sim 10^{11}$ M_sun), than currently observed. With the aim of finding compact objects in the mass range 10^6 – 10^9 M_sun, we search for strong gravitational lenses on milliarcsecond scales (< 150 mas). The most direct way to explore these small angular scales is through the high-resolution of radio Very Long Baseline Interferometry (VLBI). We perform a pilot search, using the Astrogeo VLBI FITS image database - the largest publicly available database which contained multi-frequency VLBI data of 13828 individual sources. We identified 40 new gravitational lens candidates, which are currently followed up with multi-frequency European VLBI Network (EVN) observations.

A detailed spectroscopic study of Tidal Disruption Events

Charalampopoulos Panos, DTU Space

Abstract

Tidal disruption events (TDEs) provide a unique tool for studying accretion physics onto supermassive black holes. However, crucial details such as the geometry and the emission mechanism are not fully understood, which has driven the development of many theoretical scenarios.

TDEs show big spectroscopic diversity (presence or absence of Hydrogen, Helium or Bowen lines like Nitrogen and Oxygen), so that detailed spectroscopic studies are necessary in order to constrain the theoretical models. After carefully and consistently performing a series of data reduction tasks, we present the first detailed, spectroscopic population study of 16 TDEs.

We find that there is a time lag between the optical light-curves and the luminosity of HΞ± for the majority of the TDEs in our sample which spans from 10 to 40 days. Furthermore we discover a linear relationship between the HΞ± luminosity and the blackbody radius for each event. Finally we see that Bowen TDEs have a lower HΞ± FWHM than the rest of the TDEs in our sample. This study will help the community to better understand the physical conditions governing these violent events.

Kinematical signatures of interactions between Fornax cluster galaxies

Chaturvedi Avinash, European Southern Observatory

Abstract

The Fornax galaxy cluster provides an unparalleled opportunity of investigating galaxy formation and evolution in a dense environment in great detail. Although the Fornax cluster seems relaxed, various studies have shown that the Fornax cluster still is accreting various sub-groups. Previous photometric studies of the central massive galaxy NGC1399 revealed an excess of globular clusters (GCs), suggesting accretion of GCs from nearby, interacting major galaxies like NGC 1404. Moreover, recent deep imaging surveys like the Fornax Deep Survey (FDS) with the VLT survey telescope have detected intra-cluster light, connecting several central cluster galaxies.

To kinematically characterize the Fornax cluster's intra-cluster population and understand the assembly of the outer halos of cluster galaxies, we have analyzed the VLT/VIMOS spectroscopic survey of the Fornax cluster covering half of the cluster virial radius (~300 kpc). Combined with previous spectroscopic measurements, this leads to the most extensive catalog of radial velocity measurements with a total of 2341 confirmed GCs in Fornax. We found that metal-rich GCs are concentrated around the major galaxies, while metal-poor GCs are kinematically irregular and extensively spread throughout the cluster's core region.

Our first analysis of this unprecedented dataset provides the kinematical characterization of the Fornax cluster's intra-cluster component. About 50% of the GCs contribute to the intra-cluster population. With the final goal to understand the mass assembly of the Fornax cluster and its member galaxies, in this talk, I will present the kinematics of GCs in the core of the cluster, discussing possible kinematical interaction signatures between NGC1399 and the major galaxies of the Fornax cluster.

How the passage of a radio jet changes the pressure, mass, and other properties of dense gas clouds: the case for shocks vs. cosmic rays

Dasyra Kalliopi, National and Kapodistrian University of Athens Paraschos George (Max Planck Institute for Radioastronomy), Bisbas Thomas (University of Cologne), Combes Francoise (Observatoire de Paris)

Abstract

The existence of outflows that displace millions or billions of solar masses of molecular gas and that can be linked to a change in the star formation rate of galaxies is proposed to be related to the rarefaction and acceleration of dense clouds by the passage of a tenuous medium. We will present observationally-derived pressure maps of dense and tenuous gas phases in the nearby galaxy IC5063 that show how the pressure in the interior and exterior of molecular clouds changed before and after the passage of radio

jets. The pressure maps are derived from a collection of data from large facilities and instruments (ALMA, VLT MUSE and SINFONI) and they inform us of the cloud stability and the wind mass loading. As the density and temperature measurements, which go into the pressure computation, are found with the aid of an astrochemical, radiative transfer code that uses various gas heating sources, we evaluate the role of mechanical heating vs. cosmic rays in altering the gas properties.

Hot Dust Obscured Galaxies and the Most Luminous Galaxy Known as seen by ALMA

Diaz-Santos Tanio, Institute of Astrophysics - FORTH

Abstract

In this talk I will provide a brief introduction to high-redshift, hyper-luminous, dust-obscured quasars and their importance in the galaxy evolution puzzle, reporting on the results from an ALMA pilot survey of a sample of 7 Hot, Dust-Obscured Galaxies (Hot DOGs) at z ~3 to 4.6. Observations of the fine-structure [CII] emission line at 158um have revealed a diversity of morphologies and complex kinematic structures, likely reflecting the disturbed dynamical state of these outstanding systems, which are thought to be at a key stage of their evolution. ALMA has also provided us with a close look to WISE 2246-0526 at z=4.6, the most luminous galaxy known, where deep observations of its far-infrared dust continuum emission have revealed, for the first time at such high redshifts, multiple galaxy companions and resolved filamentary structures connecting the neighbors to the central quasar host.

Properties of Active Galactic Nuclei in galaxy clusters

Drigga Eleftheria, University of Thessaloniki

Abstract

There is compelling evidence that the presence of AGN is closely linked to the large-scale environment, and that galaxy mergers and interactions play an important role in AGN triggering and evolution. As the most massive self-gravitating entities of the universe, clusters are ideal laboratories to investigate the impact of dense environments on AGN demographics. Previous studies have shown that AGN in clusters are strongly affected by their environment, but in a complicated way. The AGN fraction was found to depend on the distance from the cluster centre, the mass of the cluster and the redshift. Interestingly, in contrast to the lack of AGN in the centres of massive clusters, a number of studies have found an excess of X-ray AGNs in the cluster outskirts, supporting the presence of an in-falling population triggered by galaxy mergers. I will present our recent results that showed a significant excess of merging/interacting AGN in the center and in the outskirts of clusters compared to the background. Additionally we observe a higher frequency of spiral and irregular AGN host galaxies within r500 and 2r500 radius. We conclude that merging/interaction within galaxy clusters is a significant factor in the triggering of AGNs that can also affect their morphology. These results provide observational evidence of the physical mechanisms that drive AGN and galaxy evolution within clusters.

An expanding hadronic supercritical model for gamma-ray burst emission

Florou Ioulia, University of Athens Mastichiadis Apostolos (National & Kapodistrian University of Athens), Petropoulou Maria (National & Kapodistrian University of Athens)

Abstract

Relativistic hadronic plasmas have an intriguing property, coined hadronic supercriticality, according to which they can abruptly and efficiently release the energy stored in protons through photon outbursts. These photon flares may have a direct analogy to those observed from compact astrophysical objects, such as Gamma Ray Bursts (GRBs). Here, we investigate for the first time the manifistation and properties of hadronic supercriticality in adiabatically expanding sources. We consider the injection of relativistic protons in an expanding spherical volume with a radially decaying magnetic field and seek the parameters (e.g., expansion velocity) that lead the system to supercriticality. We then perform a Monte Carlo simulation of expanding blobs with randomly selected physical parameters that ensure the onset supercriticality, while computing the time-dependent electromagnetic signal from each blob. We compute gamma-ray light curves and broadband photon spectra from the superposition of blobs, and present

a physical picture of a typical GRB prompt emission. We also provide the all-flavour neutrino fluxes expected under the assumptions of these project and compare them with the standard models derived for GRBs.

Cold clouds in a very high resolution simulated dwarf starburst

Fotopoulou Constantina, Max Planck Institute for Astrophysics Naab Thorsten (Max Planck Institute for Astrophysics - MPA), LahΓ©n Natalia (Max Planck Institute for Astrophysics - MPA), Cernetic Miha (Max Planck Institute for Astrophysics - MPA), Steinwandel Ulrich (Max Planck Institute for Astrophysics - MPA), Hislo

Abstract

We present the results of the analysis of the cold gas in a hydrodynamical simulation of a gas-rich dwarf galaxy merger resolved with individual massive stars at sub-parsec spatial resolution and solar-mass mass resolution. The simulation is part of the griffin (Galaxy Realizations Including Feedback From INdividual massive stars) project. Our analysis reveals that the cold star-forming gas is structured in compact clumps and filaments. To identify the cold clouds we use the friends-of-friends (FoF) algorithm. We identify hundreds of cold clouds in each snapshot of the simulation with the typical irregular structure, masses and sizes of molecular clouds. The clouds have volume density profiles with a power law distribution and a slope of -2 (isothermal density distribution). The simulated cold cloud mass function (CMF) slope is well in agreement with observations. The slope of the CMF remains constant throughout the time of the simulation and is roughly the same for different gas particle density thresholds indicating self-similar structure. The simulated cold cloud properties follow the Larson relations.

Forward Modelling the Ensemble Variability of AGN populations

Georgakakis Antonis, National Observatory of Athens/IAASARS

Abstract

I will present a modeling methodology for the interpretation of the variability properties of AGN populations detected in extragalactic survey fields. The model is built upon empirical relations and is designed to account for the selection effects and biases

that affect observational measurements. I will demonstrate the predictive power of the model by comparing in a forward manner with observational measurements of the ensemble excess variance of AGN in the Chandra Deep Field South. I will show that the proposed modeling approach has the potential to jointly constrain both models of the stochastic flux variations of AGN and the underlying Black-hole mass vs stellar mass relation of the population. Future prospects will also be discussed.

Host galaxy and orientation differences between different AGN types

Gkini Anamaria, Univ. of Athens & National Observatory of Athens

Abstract

The main purpose of this study is to investigate aspects regarding the validity of the active galactic nucleus (AGN) unification paradigm (UP). In particular, we focus on the AGN host galaxies, which according to the UP should show no systematic differences depending on the AGN classification.

For the purpose of this study, we used (a) the spectroscopic Sloan Digital Sky Survey (SDSS) Data Release (DR) 14 catalogue, in order to select and classify AGNs using emission line diagnostics, up to a redshift of z = 0.2, and (b) the Galaxy Zoo Project catalogue, which classifies SDSS galaxies in two broad Hubble types: spirals and ellipticals. We find that the fraction of type 1 Seyfert nuclei (Sy1) hosted in elliptical galaxies is significantly larger than the corresponding fraction of any other AGN type, while there is a gradient of increasing spiral-hosts from Sy1 to LINER, type 2 Seyferts (Sy2) and composite nuclei. These findings cannot be interpreted within the simple unified model, but possibly by a co-evolution scheme for supermassive black holes (SMBH) and galactic bulges.

Furthermore, for the case of spiral host galaxies we find the Sy1 population to be strongly skewed towards face-on configurations, while the corresponding Sy2 population range in all host galaxy orientation configurations has a similar, but not identical, orientation distribution to star-forming (SF) galaxies. These results also cannot be interpreted by the standard unification paradigm, but point towards a significant contribution of the galactic disc to the obscuration of the nuclear region. This is also consistent with the observed preference of Sy1 nuclei to be hosted by ellipticals, that is, the dusty disc of spiral hosts contributes to the obscuration of the broad-line region (BLR), and thus relatively more ellipticals are expected to appear hosting Sy1 nuclei.

The building blocks of the spiral arms in galaxies

Harsoula Mirella, Academy of Athens, RCAAM

Abstract

Spiral galaxies make up a very large proportion of all the galaxies in the Universe. Morphologically, about two-thirds of spiral galaxies present a bar in their center and are called barred spiral galaxies. The rest of the spiral galaxies have no bar and either they present well defined spiral arms (called "grand design galaxies" which usually have two well defined spiral arms), or they present multi-arm and flocculent spirals which have subtler structural features.

We investigate the types of the orbits of the stars that form the building blocks of the spiral arms in the case of the "grand design" galaxies as well as in the case of the barred spiral galaxies (like the Milky Way). In the case of the grand design galaxies with no bar, organised elliptical orbits can create a density wave in a spiral form. We give such an example of an analytical galactic model and we investigate the dependence of this spiral density wave on the amplitude of the pertubation of the model, the pattern speed and the pitch angle of the spirals.

On the other hand, in the case of spiral galaxies with bar, the density perturbation due to the bar, is so large, in relation with the axisymmetric backgroud that there exist no more organised orbits that can support the spiral arms. For this type of galaxies the dominant theory for the formation of the spiral structure, nowadays, is the "manifold theory" introduced in 2006 according to which chaotic orbits with initial conditions along the unstable manifolds of unstable periodic orbits in the vicinity of the corotation, as well as sticky chaotic orbits close to the previous ones can support the spiral structure of the galaxy for long enough times before they go too far. We give such an example of a Milky-Way like barred spiral galaxy and we reconstruct the spiral structure using the chaotic orbits described above. Finally, we investigate the case where the bar and the spirals have different pattern speeds.

Towards an Atacama Large Aperture Submillimeter Array (AtLAST)

Hatziminaoglou Evanthia, ESO - Garching

Abstract

Astrophysical observations at (sub-)mm wavelengths (from ~300 micron to ~3mm) allow us to study the cold and dense material in the Universe, hence probing the formation of stars and planets, and the interstellar and circumgalactic medium within galaxies across cosmic time. The current generation of 10m-class single dish telescopes has delivered some of the first surveys at (sub-)mm wavelengths, allowing us to go far beyond the previously optical-biased view of the Universe. Follow-up observations with interferometers then revealed in exquisite detail the morphology and kinematics of such (sub-)mm sources, enabling tests and revisions of theoretical models for the formation and evolution of planets, stars, and galaxies. However, it is now clear that without a transformative change in the capabilities of single-dish facilities in the 2030s, interferometers (like the ALMA observatory) will soon become source-starved. The current generation of 10m-class single dish telescopes, with their limited fields of view, spatial resolutions, and sensitivities, can only reveal the β€tip of the icebergβ€™ of the (sub-)mm source population, both for Galactic and extragalactic studies. These limitations cannot be fully mitigated by interferometers, which are all intrinsically affected by a low mapping speed and by the loss of diffuse extended signals.

The Atacama Large Aperture Submillimeter telescope (AtLAST) project is a concept for a 50m diameter single dish observatory to be built near the ALMA site. With its extremely large field of view (the goal is ~2 degrees), spatial resolution (up to ~1.'' at 350 micron) and sensitivity to both point sources and large-scale structures, AtLAST will be transformational for all fields of Astronomy in the 2030s. In this talk I will describe the recently approved EU Horizon2020 project to deliver a comprehensive design study for such a next-generation single-single dish facility.

Black-hole X-ray binaries in the new era of X-ray astronomy

Kantzas Dimitrios, University of Amsterdam

Abstract

Since their discovery, cosmic rays (CRs) remain among the most mysterious phenomena of modern physics. The dominant sources, as well as the exact acceleration mechanisms, remain unknown. The CRs up to the knee, are considered to originate in the shock waves of supernova remnants, however, due to the lack of a “smoking-gun” TeV counterpart in many cases, this scenario has been recently questioned. In this talk, I will motivate how the small-scale analogues of active galactic nuclei (AGN), namely black-hole X-ray binaries (BHXBs), can potentially contribute to the Galactic CR spectrum. To investigate this idea, I developed a new, multi-zone, lepto-hadronic jet model to take advantage of the entire broadband multiwavelength spectra observed by BHXBs. I

applied this model to the first-ever simultaneous radio-to-X-ray spectrum of Galactic BHXB Cygnus X-1 obtained in 2016 (via the CHOCBOX program), and to a quasi-simultaneous dataset of another Galactic BHXB, GX339-4, during a bright outburst in 2010. In this talk, I will discuss how the different assumptions on proton acceleration affect both the jet properties and the observed spectrum. In particular, I will focus on the GeV-to-TeV regime and discuss its strong dependence on the rest of the multiwavelength spectrum. Finally, I will discuss the implication of my results for the next-generation gamma-ray facilities, such as the Cherenkov Telescope Array (CTA), as well as next-generation neutrino detectors, such as KM3NeT, concluding how they can help to constrain the potential BHXB contribution to the Galactic CR spectrum.

Radiative signatures of adiabatically compressing plasmoids in relativistic reconnection

Karavola Despina, University of Athens Petropoulou Maria (University of Athens, Physics Department)

Abstract

Magnetic reconnection is an efficient and rapid process of tapping mangetic energy that takes place in a variety of astrophysical environments, ranging from our own Sun to the jets and disks of accreting black holes. Plasmoids -- magnetized quasi-circular structures formed in reconnecting current sheets -- were thought to be the graveyards of energetic particles. Large-scale two-dimensional particle-in-cell simulations have revealed a new energization process for charged particles trapped within plasmoids. As plasmoids grow in size, their interiors are being compressed and their magnetic fields amplified in strength. Pre-accelerated electrons and positrons entering these plasmoids are further accelerated as a result of magnetic moment conservation, while losing energy via synchrotron radiation in an amplifying magnetic field. In this study, we investigate the temporal evolution of the system's particle distribution function, f(E,t), when both acceleration and radiation processes are taken into account. Our aim is to extract the radiation spectrum from compressing plasmoids and identify potential spectral features that may be encountered in observed spectra of non-thermal emitting sources.

What we know and what we do not know for galaxy star formation rates

Katsianis Antonios, Shanghai Jiao Tong University

Abstract

The "observed" SFR-M* relation of galaxies and the cosmic star formation rate density represent both important canvases for our current knowledge of galaxy formation and are routinely used to constrain cosmological models/simulations. However, a rising number of authors report a severe tension between the SFRs published by different methodologies/groups. This challenges the legitimacy of our results since there are numerous contradictions and as a community we unfortunately lack the ability to decide which measurements represent better reality ("true galaxy SFRs") due to the challenging and unique nature of Astronomy. In this talk I present some disturbing limitations for both the simulated galaxy SFRs obtained from state-of-the-art cosmological simulations (EAGLE, Illustris, Simba, Katsianis et al. 2021a, 2021b) and observations (Katsianis et al 2020, 2021b). We employ the EAGLE simulations combined with the radiative transfer code SKIRT and demonstrate that 1) the adopted methodology to obtain galaxy SFRs heavily affects the results of observational studies which if they all used the same tracer/methodology/assumptions would be actually consistent with each other (Katsianis et al. 2020). 2) The tension between observed and simulated SFR-M* relations previously reported in the literature is mostly alleviated if we consider the systematic uncertainties from different SFR tracers which have different shortcomings. Besides observations, simulations are found to suffer from troubling limitations as well (Katsianis et al. 2021). Our findings reflect the need for the employed quenching schemes in state-of-the-art models to be reconsidered and involve feedback prescriptions that allow 'quenched galaxies' to retain a small level of SF activity in order to be consistent with measurements of the specific star formation rate function at z ~ 0. I also discuss briefly the limitations caused by resolution effects and their impact on comparisons with observational studies.

Exploring the millimetre emission in nearby galaxies

Katsioli Stavroula, IAASARS/NOA & University of Athens Xilouris Manolis (IAASARS, National Observatory of Athens), Madden Suzanne (AIM, CEA, CNRS, UniversitΓ© Paris-Saclay), Nersesian Angelos (Sterrenkundig Observatorium Universiteit Gent), Galliano FrΓ©dΓ©ric (AIM, CEA, CNRS, UniversitΓ© Paris-Saclay), Jones

Abstract

Emission of the nearby galaxies (distance < 30 Mpc) at millimetre wavelengths is a largely uncharted territory. This spectral region lies between the tail of the dust emission and the start of the radio emission (free-free and synchrotron radiation). Observing at these wavelengths is crucial to decompose the millimetre emission into the different emission mechanisms and to investigate if any excess emission, compared to realistic SED (Spectral Energy Distribution) models, exists. In this talk, we will present new observations at 1.15 and 2 mm using the IRAM 30-m telescope and the NIKA2 camera in the framework of the IMEGIN (Interpreting the Millimetre Emission of Galaxies with IRAM and NIKA2) Large Program. This is the first time that 22 nearby galaxies are being observed at high resolution (1.15 and 2mm beams are 11.1" and 17.6" respectively) at millimetre wavelengths. As a pilot study we present the observations of the edge-on galaxy NGC0891, and the spatially resolved SED analysis for the dust and radio emission. For the interpretation of the observations we make use of HerBIE (HiERarchical Bayesian Inference for dust Emission), a state-of-the-art SED fitting code which uses Hierarchical Bayesian statistics in order to eliminate the noise-induced correlations of the inferred parameters. Our analysis shows how the different emission components, at millimetre wavelengths, compare in different areas of the galaxy (disk, halo, star-forming sites) and how they correlate with the gas and dust mass.

Modeling of Polarized Synchrotron Radiation in GRBs

Kerasioti Stefania, University of Athens

Abstract

GRBs are one of the most luminous phenomena in the universe and yet many aspects are not clear about their origin and physical characteristics. A great effort has been made through polarization measurements to enlighten and constrain some physical parameters such as the magnetic field and jet structure, for both prompt emission and afterglow. We study the prompt and early afterglow polarized synchrotron radiation, where the resultant magnetic field can be taken as a mix of an ordered and a random component. To model the radiation we use a light tracing code that solves radiation transfer equations for all Stokes parameters. The produced resolved images are then integrated spatially and temporally in order to study the dependence of polarization parameters on different physical parameters. More specifically we examine the effect of

different field geometries and Lorentz factor profiles on intensity, electric vector position angle and linear and circular polarization degrees.

A glimpse on MeerKAT's first discoveries in clusters: Diffuse radio emission in MeerKAT Galaxy Cluster Legacy Survey (MGCLS)

Kolokythas Konstantinos, North-West University (NWU) Knowles Kenda (UKZN), Venturi Tiziana (University of Bologna), Rudnick Larry (Minnesota Institute for Astrophysics)

Abstract

Galaxy clusters are the largest gravitationally-bound structures in the Universe, with their baryonic mass being distributed between the constituent galaxies and the ionized plasma of their intracluster medium (ICM). As such, radio observations of galaxy clusters are powerful tools for the detection of diffuse cluster-scale synchrotron emission, which carries information about the cluster formation history.

Observations using Square Kilometre Array precursor and pathfinder instruments are nowadays opening up a new window on diffuse cluster sources and challenge our simple classification scheme (radio halos, mini-halos, and radio relics), making clear the need for an update of our current knowledge. Towards this direction, MeerKAT's L-band, with a primary beam of more than a square degree, was the first to be commissioned in 2018, and MeerKAT began a programme of long-track observations of galaxy clusters. This programme became MeerKAT's Galaxy Cluster Legacy Survey (MGCLS), consisting of ~1000 hours, observing 115 galaxy clusters at 1.28 GHz spread out over the Southern sky. In this talk, I will present an overview of the MGCLS and the various legacy products being made available to the astronomical community focusing on interesting first results from the diffuse emission detected in galaxy clusters by presenting a few significant examples to reveal both the much-improved images compared to previous observations, as well as new discoveries that open up new areas of investigation in cluster formation and evolution.

The X-CLASS survey: A catalogue of 1646 X-ray-selected galaxy clusters up to z~1.5

Koulouridis Elias, IAASARS/NOA

Abstract

Cosmological probes based on galaxy clusters rely on cluster number counts and large-scale structure information. X-ray cluster surveys are well suited for this purpose, since they are far less affected than optical surveys by projection effects, and cluster properties can be predicted with good accuracy. The XMM Cluster Archive Super Survey, X-CLASS, is a serendipitous search of X-ray-detected galaxy clusters in 4176 XMM-Newton archival observations until August 2015. All observations are clipped to exposure times of 10 and 20 ks to obtain uniformity and they span ~269 sq. deg. across the high-Galactic latitude sky. The main goal of the survey is the compilation of a well-selected cluster sample suitable for cosmological analyses. In this talk we will present the detection algorithm, the visual inspection, the verification process and the redshift validation of the cluster sample, as well as the cluster selection function computed by simulations. We will also describe the various metadata that are released with the catalogue. The new X-CLASS catalogue comprises 1646 well-selected X-ray-detected clusters that span a wide redshift range, from the local Universe up to z~1.5, with 982 spectroscopically confirmed clusters, and over 70 clusters above z=0.8. Because of its homogeneous selection and thorough verification, the cluster sample can be used for

cosmological analyses, but also as a test-bed for the upcoming eROSITA observations and other current and future large-area cluster surveys. It is the first time that such a catalogue is made available to the community via an interactive database which gives access to a wealth of supplementary information, images, and data.

The effect of extinction, stellar mass, metallicity, and AGN activity on star-formation rates based on H$alpha$ emission

Kouroumpatzakis Konstantinos, Institute of Astrophysics - FORTH

Abstract

We present H_alpha photometry for the Star-Formation Reference Survey (SFRS), a sample of star-forming galaxies representative of the variety of conditions where star formation appears in the local Universe. Benefiting from the panchromatic coverage of the SFRS, we provide calibrations of H_alpha-based star-formation rates (SFRs) accounting (or not) for the correction of the contribution of [N_II] emission and examine the effect of extinction corrections as inferred by the Balmer decrement, infrared excess (IRX), and spectral energy distribution (SED) fits. We compare SFR estimates from SED fits, polycyclic aromatic hydrocarbons, hybrid indicators like the 24μm + Hα, 8μm + Hα, FIR + FUV, and Hα emission for purely star-forming galaxies.

A new calibration for 1.4 GHz-based SFRs based on comparison with the Hα emission is provided, while we measure a dependence of the radio-to-Hα emission ratio as a function of galaxy stellar mass. We examine biases introduced by active galactic nuclei in calibrations of different SFR indicators, and show that they have only a minimal effect on the inferred SFR densities from galaxy surveys. Finally, we explore the relation between galaxy metallicity and extinction.

Clustering of X-ray selected AGN in the local universe

Koutoulidis Lazaros, National Observatory of Athens/IAASARS

Abstract

Recent observations with X-ray satellites show that Active Galactic Nuclei (AGNs) are distributed differently in space than normal galaxies, tracing denser regions of the Universe. The purpose of this study is to thoroughly analyze the clustering of Active X-ray Galactic Nuclei (AGN), in order to emerge its correlations with various physical parameters, and with the aim of a more complete understanding of the natural processes that determine both the appearance of AGN and the supply with material of Supermassive Black Hole. We present the most accurate estimate for data analysis methods using sources compiled from the ROSAT-2RXS survey in the soft band (0.1-2.4kev) with median redshift z~0.1, covers a different parameter space in terms of area and depth and it is also the largest X-ray point source spectroscopic catalogue to date. Specifically we explore the dependence or not of spatial clustering length of X-ray selected AGN, on X-ray luminosity, obscuration and stellar mass. These results are not only important for constraining the accretion history of the Universe but they may also hold the key for understanding how galaxies evolve.

Search for AGN counterparts of unidentified Fermi-LAT sources with optical polarimetry. Demonstration of the technique

Mandarakas Nikolaos, Univ. of Crete & IA-FORTH

Abstract

The third release of the Fermi-LAT catalog (3FGL) contained 3034 gamma-ray sources. Classification of these extremely energetic sources is important for studying high-energy astrophysical processes. After the fourth release, (4FGL) more than 1000 gamma-ray sources remain unassociated with a lower-energy counterpart. We introduce optical polarimetry as a practical tool in the hunt for optical counterparts of the unidentified gamma-ray sources (UGSs) and we demonstrate its advantages. Using data from the RoboPol project, we validated that a significant fraction of active galactic nuclei (AGN) associated with 3FGL sources can be identified due to their high optical polarization exceeding that of the field stars. We performed an optical polarimetric survey within the 3Of uncertainty of four unidentified 3FGL sources and discovered a previously unknown extragalactic object at a redshift of z = 0.0609 B± 0.0004. Using these measurements and archival data we demonstrate that this source is a candidate counterpart for the Fermi field 3FGL J0221.2+2518 and most probably is a hybrid star-forming - AGN galaxy. We conclude that polarimetry can provide powerful complementary information on the nature of sources detected in wide-field surveys. For the particular case of AGN counterparts for unassociated Fermi sources, future extensive polarimetric surveys (e.g., PASIPHAE) will allow the association of a significant fraction of currently unidentified Ξ^3-ray sources.

Linking characteristics of the Polycyclic Aromatic Hydrocarbon population with galaxy properties: A quantitative approach using the NASA Ames PAH IR Spectroscopic Database

Maragkoudakis Alexandros, NASA Ames Research Center

Abstract

Polycyclic Aromatic Hydrocarbons (PAH) are a family of organic molecules who's mid-Infrared (IR) spectral signatures have been detected in many astronomical environments, including (Proto-)Planetary Nebula, Reflection Nebula, star-forming regions, and the diffuse interstellar medium. In addition, those signatures are frequently detected in galaxies. While qualitative and empirical relations exist between PAHs and the galactic environment as a whole, to this day no comprehensive study has examined those relationships in a quantitative way and its connection with the intrinsic properties of the PAH population responsible.

Utilizing the data, software tools and analysis paradigms that comprise the NASA Ames PAH IR Spectroscopic Database (PAHdb), we decomposed the Spitzer spectra of a diverse sample of more than 900 galaxies. With PAHdb's more than 4000 laboratory measured and quantum chemically calculated PAH spectra we were able to quantify the PAH size distribution, ionization fraction, the relative spectral contribution of small and large PAHs for different galaxy classes, and examine the connection of the characteristics of the underlying PAH population to fundamental galaxy properties. Ultimately, we will deliver a library of mid-IR PAH template spectra parameterized on PAH size distribution and ionization fraction for each galaxy class, which can then be incorporated into spectral fitting codes.

Stellar populations in high-redshift galaxies and their role in the dust heating

Masoura Vasileia, National Observatory of Athens / IAASARS Masoura V.A. (IAASARS-NOA), Paspaliaris E.-D. (IAASARS-NOA & AUTH), Xilouris M. (IAASARS-NOA), Nersesian A. (Ghent University), Georgantopoulos I. (IAASARS-NOA), Georgakakis A. (IAASARS-NOA), Katsioli S. (IAASARS-NOA & University of Athens)

Abstract

The knowledge of how stellar populations change with redshift is important to put significant constraints on galaxy evolution. The way that dust is being heated from the radiation coming from the different stellar populations defines the energetics within galaxies. Recently, a pilot study (Nersesian et al. 2019) examined the stellar populations and their role in the dust heating in galaxies in the local universe, while the same analysis was applied to local (U)LIRGs (Paspaliaris et al. 2021). This analysis was based on decomposing the stellar emission into old and young stellar populations by using the CIGALE SED fitting tool. With our current study we have expanded this analysis for galaxies at higher redshifts using the GAMA ($z<0.1$) and COSMOS ($z<3$) surveys aiming at defining how the stellar populations and the dust content evolve with redshift. The morphological information provided in the GAMA survey allowed us to investigate how various physical parameters change for galaxies of different morphological types. It was found that pure elliptical galaxies can be divided into star-forming and quiescent with the star-forming ones forming a main sequence (on the SFR/stellar mass plane) which is very similar to the main sequence of the late-type galaxies. Finally, the X-ray information provided in the COSMOS survey allowed us to separate the galaxies that host an AGN and compare the stellar populations of their host galaxies with the control sample of star-forming galaxies.

An underlying universal magnetic field component in the halos of spiral galaxies

Myserlis Ioannis, IRAM

Abstract

Large-scale, coherent galactic magnetic fields play a fundamental role in star formation, cosmic ray propagation, and the dynamics of astrophysical accretion disks, as well as galactic and extragalactic jets. The distribution of large-scale magnetic fields along the line of sight can be directly probed by means of Faraday rotation using multi-wavelength radio polarization observations. However, the low surface brightness of the radio emission in galactic halos make such observations quite challenging. Using the radio polarization data obtained by the CHANG-ES collaboration, we created rotation measure (RM) maps for a sample of 35 spiral galaxies seen edge-on and stacked them with the aim of amplifying any underlying universal magnetic field pattern in their halos. We discovered a large-scale toroidal magnetic field in the central region of the stacked galaxy profile, which is attributable to an axial electric current that universally outflows from the center, both above and below the plane of the disk. A similar symmetry-breaking has also been observed in astrophysical jets, but never before in galaxy halos. Our results are naturally explained by the Cosmic Battery mechanism operating in the innermost accretion disk around the central supermassive black hole.

Modelling the cold dust in nearby spirals galaxies with radiative transfer

Nersesian Angelos, Ghent University

Abstract

Cosmic dust grains are one of the fundamental ingredients of the interstellar medium (ISM). Despite of their limited contribution to the total mass budget, dust grains play a significant role in the physical and chemical evolution of galaxies. Over the past decade, our knowledge on the cosmic dust in nearby galaxies has increased substantially thanks to the availability of observational data from UV to far-infrared wavelengths. However, one part of the spectrum, the mm range, has largely remained unexplored. We aim to take advantage of the new, high-resolution data in the mm range observed with the NIKA2 instrument. Combining these new observational data with our radiative transfer framework, would allow us to accurately model the interplay between starlight and dust in a sizeable sample of spatially-resolved nearby galaxies. I will present the methodology of our dust radiative transfer modelling and its application to a small group of face-on spiral galaxies. I will highlight which modelling steps need to be improved, and how the new NIKA2 data would allow us to firmly characterize the physical properties of the very cold dust (<15K), as well as to quantify the importance of different emission mechanisms in the mm.

CO kinematics unveil outflows likely driven by a young jet in the warped disk of NGC6328

Papachristou Michalis, Univ. of Athens & National Observatory of Athens Dasyra Kalliopi (National and Kapodistrian University of Athens), Audibert Anelise (National Observatory of Athens), Ruffa Ilaria (National Observatory of Athens & Cardiff University), Combes Francoise (Observatoire de Paris)

Abstract

We report the detection of outflowing molecular gas in the center of the nearby massive radio galaxy NGC6328. The radio core is identified as a Gigahertz Peak Spectrum source with a compact (2 pc) double radio lobe morphology tracing a young Jet. We used ALMA CO(2-1) and CO(3-2) observations of 100 pc resolution to study the kinematics of the emission up to 6 kpc from the galaxy center. The observed kinematics were fitted with a warped disk model. The results show that most of the molecular gas is settled in a highly warped disk that possibly originated from a recent merger event. In the inner 400 pc of the disk, we identified blueshifted and redshifted emission components along with the orientation of the radio jet that cannot be explained with any possible disk kinematic models. Given that no evidence for a bar is found in this galaxy, our results suggest the presence of a previously undetected molecular outflow of a few solar masses a year. The CO(3-2)/CO(2-1) ratio shows a higher excitation in these regions compared to the disk, as seen in other galaxies with molecular outflows. Our work adds-up to the increasing evidence that the interaction between the AGN and the ISM can play a major role in regulating the growth of galaxies.

Where is the black hole in 3C84 located?

Paraschos Georgios Filippos, Max Planck Institute for Radioastronomy Kim Jae-Young (KASI), Krichbaum Thomas (MPIfR), Zensus Anton (MPIfR)

Abstract

Jets which are powered by an AGN are a crucial element in the study of black holes (BH) and their immediate surroundings. The formation of such jets is the subject of intense research, mainly based on the dichotomy presented by the two main interpretations: the one from Blandford & Payne (1982), where the jet is powered by a magnetic field in which field lines are anchored in the accretion disk, and the one from Blandford & Znajek (1977), where the field lines are connected to the ergosphere of the spinning BH. 3C84, the compact radio source in NGC 1275 located in the Perseus super-cluster, is a prime laboratory for testing these models, as well as studying the innermost AGN structure and jet origin, paralleled only by M87. Two jets emanate north- and southwards, at a moderately large viewing angle to the observer, avoiding strong Doppler beaming effects. Thus, the absence of the counterpart of the southern sub- mas jet in the north is both surprising and intriguing.

Utilising quasi-simultaneous VLBI observation of 3C84 at 15, 43, and 86 GHz, we determined the apparent core shift, through 2D-cross correlation and fitting of the apparent core locations. We also draw conclusions about the magnetic field strength and configuration at the jet apex. In this talk I will summarise our very recent results and report on the true location of the SMBH of 3C84, which interprets the apparent absence of the northern sub-mas counter-jet.

The physical properties of (U)LIRGs and their place in the local Universe

Paspaliaris Evangelos-Dimitrios, IAASARS - NOA & AUTH Xilouris Manolis (IAASARS - NOA), Nersesian Angelos (Ghent University & IAASARS - NOA), Masoura Vasilia-Aspasia (IAASARS - NOA & AUTH), Plionis Manolis (IAASARS - NOA & AUTH), Georgantopoulos Ioannis (IAASARS - NOA), Bianchi Simone (Osservatorio Astrofisi

Abstract

We make use of multi-wavelength photometric data (from the UV to the sub-mm), culled from the literature, and the CIGALE SED fitting code, to extract the physical properties of 67 (ultra-) luminous infrared galaxies [(U)LIRGs]. In order to pinpoint their place in the local Universe, we compare their median SEDs as well as the derived properties, to those of the 268 early- (ETGs) and 542 late-type nearby galaxies (LTGs) from the DustPedia database. In addition to that, (U)LIRGs were divided into seven classes, according to the merging stage of each system, and the evolution of the derived parameters with the merging stages were investigated. The contribution of the two stellar populations (old and young) to the bolometric luminosity of these systems and their role in the dust heating are also explored. In contrast to the local ETGs and LTGs, where the old stars are the dominant source of the stellar emission (96% and 79% respectively), in (U)LIRGs the young stars dominate the stellar emission (64%). At the same time, the effects of dust to the stellar light are significantly higher in (U)LIRGs, with 78% of the stellar luminosity absorbed by the dust compared to 7% and 25% for ETGs and LTGs respectively. Finally, the dust heating in (U)LIRGs comes mainly from the young stars, with the old stars being the dominant dust-heating source in the ETGs and LTGs.

Orbital patterns supporting X-shaped galactic bulges

Patsis Panos, Academy of Athens, RCAAM

Abstract

We review the morphology of orbital patterns that are found to support X-shaped bulges in the central regions of disk galaxies, which are observed side-on. We investigate the origin of boxy bulges observed in N-body simulations and compare them with what is foreseen by analytic models. We discuss the differences that time-dependency may introduce in the orbital context of X-shaped bulges and show how autonomous models of rotating bars can be used as guiding tools for predicting the orbital evolution in time dependent models.

Vertical distribution of HMXBs in NGC 55: Constraining their centre of mass velocity

Politakis Charalampos, Univ. of Crete & IA-FORTH

Abstract

We analyse the vertical distribution of High Mass X-ray Binaries (HMXBs) in NGC 55, the nearest edge-on galaxy to the Milky Way, based on X-ray observations by Chandra. Adopting a statistical approach, we estimate the difference between the scale height of the vertical distribution of HMXBs and the vertical distribution of star-forming activity at 0.48 0.04 kpc. The spatial offsets can be explained by a momentum kick the X-ray binaries receive during the formation of the compact object after a supernova explosion of the primary star. Determining the vertical distribution of HMXBs in the Milky Way using Gaia DR2 astrometry, we find that the corresponding difference is considerably lower at 0.036 kpc, attributed to the greater gravitational potential of the Milky Way. We also calculate the centre-of-mass transverse velocities of HMXBs in NGC 55, using travel time information from binary population synthesis codes and for different star-formation histories (SFH). For a flat SFH model (typical of spiral galaxies like NGC 55), we fi nd HMXBs are moving with a typical transverse velocity of 48 km/s consistent with space velocities of Milky Way HMXBs. For an exponentially declining SFH model, HMXBs are moving at a velocity of 22 km/s consistent with the corresponding velocity of HMXBs in the Small Magellanic Cloud (SMC) and Large Magellanic Cloud (LMC). Finally, we estimate the formation e fficiency of HMXBs in NGC 55 at 277 (systems/Solar mass/yr), consistent within the errors with the Magellanic Clouds but signi ficantly higher than the Milky Way (MW), a difference that can be explained by the sub-solar metallicity of NGC 55.

Bayesian Mutli-wavelength Spectral Energy Distribution fitting with Monte Carlo Markov Chains

Polkas Markos, University of Athens

Abstract

We develop a new Bayesian Spectral Energy Distributions (SEDs) fitting tool that, in the framework of the Monte Carlo Markov Chain, can be adapted to any kind of galaxy assuming a prior knowledge of a desired galaxy mass function.

The code is developed as part of the project ARC, which is about the stellar and gaseous properties of radio galaxies, and thus their location in the main sequence and their ability to evolve compared to normal galaxies at low and high z.

The radio galaxies are selected to have archival ALMA CO data and to be representative of a flux-limited sub-catalog of the NVSS 1.4 GHz radio survey.

Compared to the existing algorithms on SED-fitting, our code allows the selection of priors and includes many user-friendly features. In our new tool, we self-consistently calculate the contribution of several components on the SED from UV to radio wavelengths: young and old stellar populations, dust clouds, an Active Galactic Nucleus (AGN) accretion disk, a dusty torus, and a jet. The code allows for the use of templates for any of the above components so that any kind of galaxy (such as a Seyfert, blazer, or starbursts) can be fit without further modification.
For galaxies in the ARC, desired properties include the stellar ages and masses, the dust (and thus gas) mass, and radio jet power that enables us to evaluate the plausibility of jets impacting the evolution of their host galaxies. Examples will be shown.

An updated catalogue of high-redshift (z>3.5) X-ray AGN in the XMM-XXL northern field: Constrains in the bright end of the logN-logS

Pouliasis Ektoras, IAASARS, National Observatory of Athens

Abstract

X-rays offer the most reliable method to identify Active Galactic Nuclei (AGN). However, in the high-redshift Universe the X-ray AGN remain elusive because of the small areas covered by the X-ray surveys. In addition to wide area X-ray surveys it is important to have deep optical data in order to locate the optical counterparts and determine their redshifts. In this work, we build a high redshift (z>3.5) X-ray selected AGN sample in the XMM-XXL northern field using the most updated X-ray observations along with a plethora of new spectroscopic and multi-wavelength catalogues including the deep optical Subaru Hyper-Supreme-Camera (HSC) data reaching magnitude limits r~27 mag. We select all the spectroscopically confirmed AGN and complement this sample with high redshift candidates that are HSC dropouts. We confirm these are AGN and we derive their photometric redshifts using Spectral Energy Distribution techniques. We end up with a sample of 78 high-z sources (36 with spec-z), the largest at this field so far (3 times larger than previous studies), and we estimate the possible contamination and completeness. We calculate the number counts (logN-logS) in different redshift bins comparing our results with previous studies and models. We provide the strongest constraints yet at bright fluxes (f[0.5-2keV]>1x10^(-15)ergcm^(-2)s^(-1)). The samples of z>3.5 and z>4 are in agreement with an exponential decline model similar to that witnessed at optical wavelengths. Our work emphasizes the importance of using wide area X-ray surveys with deep optical data to uncover high redshift AGN.

Examining the properties of the BNS Merger GW170817 and their implications on the maximum mass using a Bayesian MCMC approach.

Psomas Iason, University of Athens

Abstract

The Binary Neutron Star Merger associated with the gravitational wave signal GW170817 observed by LIGO and Virgo detectors, has been the first gravitational wave observation to be detected also by non-gravitational means, and remains the most extensive studied BNS merger event to date. On this study, we take motivation from a paper of A. Nathanail, E. R. Most, and L. Rezzolla (2021) and consider the implications of this event to the maximum possible mass for the non-rotating configuration for Neutron Stars, M_TOV . Following a classical Bayesian approach, we use the Markov Chain Monte Carlo (MCMC) EMCEE algorithm of Dan Foreman-Mackey and contributors to sample the multidimensional space of parameters spanned by gravitational-wave and astronomical observations associated with GW170817, and find the most probable

values for the M_TOV under a flat prior hypothesis, both in the low-spin case and in the high-spin case. Several other prior hypotheses have also been examined and will be discussed in this study.

The ISM properties of Ultraluminous IR galaxies through cosmic time

Rigopoulou Dimitra, University of Oxford

Abstract

With far-infrared luminosities in excess of 10E12 Lsun, Ultraluminous Infrared Galaxies (ULIRGs) are amongst the most intensely star-forming objects in the Universe. They have routinely been used as templates for high-z submm luminous galaxies. Yet, observational evidence supports the existence of strong evolution in the properties of the ISM of nearby and distant ULIRGs. I will review key results from observational efforts with ground and space based facilities to establish the properties of ULIRGs through cosmic time. In addition I will discuss how intermediate redshift ULIRGs play a key role in understanding the transition from Main Sequence to Starbursts.

[α/Fe] traced by H ii regions from the CALIFA survey: The connection between morphology and chemical abundance patterns

Sanchez Sanchez Sebastian Francisco, Institute of Astronomy, UNAM

Abstract

Differential enrichment between Ξ±- and Fe-peak elements is known to be strongly connected with the shape of the star-formation history (SFH), the star-formation efficiency (SFE), the inflow and outflow of material, and even the shape of the Initial Mass Function (IMF). However, beyond the Local Group detailed explorations are mostly limited to early-type galaxies due to the lack of a good proxy for [Ξ±/Fe] in late-type ones, limiting our understanding of the chemical enrichment process.

We intent to extend the explorations of [Ξ±/Fe] to late-type galaxies, in order to understand the details of the differential enrichment process. We compare the gas phase oxygen abundance with the luminosity weighted stellar metallicity in an extensive catalog of ~25,000 H ii regions extracted from the Calar Alto Legacy Integral Field Area (CALIFA) survey, an exploration using integral-field spectroscopy of ~900 galaxies, covering a wide range of masses and morphologies. This way we define [O/Fe] as the ratio between both parameters, proposing it as an indirect proxy of the [α/Fe] ratio.We illustrate how the [O/Fe] parameter describes the chemical enrichment process in spiral galaxies, finding that: (i) it follows the decreasing pattern with [Fe/H] reported for the [α/Fe] ratio and (ii) its absolute scale depends of the stellar mass and the morphology. We reproduce both patterns using two different chemical evolution models, considering that galaxies with different stellar mass and morphology present (i) different SFHs, SFEs and different inflow/outflow rates, or (ii) a different maximum stellar mass cut for the IMF. We will explore the differential chemical enrichment using this new proxy galaxy by galaxy and region by region in further studies.

FRBSTATS: A web-based platform for visualization of fast radio burst properties

Spanakis-Misirlis Apostolos, University of Piraeus

Abstract

Fast radio bursts (FRBs) are currently one of the most important topics in astronomy and astrophysics. With only a few hundred events observed to date any information derived from the few successful detections is of great value. FRBSTATS is a user-friendly web interface that includes an open-access catalogue of FRBs published up to date, along with a highly accurate statistical overview of the observed events. The platform supports the retrieval of fundamental FRB data either directly through the FRBSTATS API, or in the form of a CSV/JSON-parsed database, while enabling the plotting of parameter distributions for a variety of visualizations. These features allow researchers to conduct more thorough population studies, while narrowing down the list of astrophysical models describing the origins and emission mechanisms behind these sources. Lastly, the platform provides a visualization tool that illustrates associations between primary bursts and repeaters, complementing basic repeater information provided by the Transient Name Server.

Multimessenger emission from hadronic X-ray Blazar Flares

Stathopoulos Stamatios Ilias, University of Athens

Abstract

Blazars are a subclass of active galaxies with jets closely aligned to the observer's line of sight. In addition, they are the most powerful persistent sources across the electromagnetic spectrum in the universe. The detection of a high-energy neutrino from the flaring blazar TXS 0506+056 and the subsequent discovery of a neutrino excess from the same direction have naturally strengthened the hypothesis that blazars are cosmic neutrino sources. The lack, however, of gamma-ray flaring activity during the latter period challenges the standard scenario of correlated gamma-ray and high-energy neutrino emission in blazars. Motivated by a novel theoretical scenario where neutrinos are produced by energetic protons interacting with their own X-ray synchrotron photons, we make neutrino predictions for X-ray flaring blazars. Our sample consists of all blazars observed with the X-ray Telescope (XRT) on board Swift more than 50 times from November 2004 to November 2020. To statistically identify an X-ray flaring state we apply the Bayesian Block algorithm to the 1 keV XRT light curves of frequently observed blazars. Using X-ray spectral information during the flaring states, we compute for each flare the 1-10 keV energy fluence, which is a good proxy for the all-flavor neutrino fluence in the adopted theoretical scenario. We present the expected number of muon neutrino events with IceCube for each source as well as the stacked signal from all X-ray flares of the selected sample. We discuss the implications of our results for IceCube and IceCube Gen-2.

Identification of Star Clusters in the central region of the SMC

Strantzalis Achilles, University of Athens Lazarou Dimitris (University of Athens), Hatzidimitriou Despina (University of Athens), Zezas Andreas (University of Crete), Valia Antoniou (Harvard-Smithsonian Center for Astrophysics)

Abstract

Star clusters are often considered as the building blocks of galactic disks, as star formation is generally clustered. The identification of star clusters (mostly small clusters) in the Small Magellanic Cloud, a nearby dwarf star forming galaxy, is an ongoing endeavour. It is only relatively recently that machine learning and data mining methods and techniques have been employed to detect star clusters in the Magellanic Clouds. Using a combination of data from the 6.5m Magellan Telescope and from GAIA early Data Realease 3 (eDR3), there is a unique opportunity to investigate the validity of earlier identifications and classifications, given the superior spatial resolution to most data used to date to search for star clusters in these nearby galaxies. Applying criteria based on colour-magnitude diagrams corrected for the field contribution, on number density profiles and image inspection, we examined all known clusters and candidates in the central regions of the SMC. We could only confirm part of the objects classified as clusters in the most recent compilation of Bica et al. 2020. Most of the non-confirmed objects are artifacts, caused by the inferior spatial resolution of some of the older surveys. We also applied the well-known data clustering algorithm "Density-based Spatial Clustering of Applications with Noise" (DBSCAN), to the Gaia EDR3 data, to independently search for clusters in this homogeneous high quality sample. DBSCAN is a non-parametric algorithm based on density. The results from the application of DBSCAN rediscovered successfully most of the star clusters that were classified as highly probable clusters on the basis of the three criteria described above. The combined use of the two methods is a very useful tool for the discovery and verification of star clusters in resolved galaxies.

The effect of the large-scale environment to FR-type radio AGN in the COSMOS field

Vardoulaki Eleni, Thueringer Landessternwarte Tautenburg Vazza Francesco (INAF), Perucho Manel (Universitat de ValΓ¨ncia), JimΓ©nez-Andrade Eric F. (NRAO)

Abstract

The role of the large-scale environment in shaping the extended radio AGN has been long invoked in order to explain the plethora of different radio structures observed in surveys. We explore the radio structure of Fanaroff-Riley (FR) type radio sources in the VLA-COSMOS Large Project at 3 GHz. We cross-correlate the 130 sources in our FR sample to a wide range of environments (X-ray galaxy groups, density fields, and the cosmic web) in the COSMOS field, and study the relation of radio structure to the large-scale environment. We infer trends regarding the location/incidence of the radio sources within these environments, and investigate the degree of distortion/complexity (e.g. bent angle) in the observed radio structure to understand how the large-scale environment affects the radio structure of FR-type radio sources. Finally, we compare our observational data to simulations of classic FRI and FRII radio AGN.

Galactic activity diagnostics based on WISE photometry and machine learning methods

Zezas Andreas, University of Crete & FORTH

Abstract

We present new multidimensional diagnostics for the classification of galaxies as star-forming, hosts of active galactic nuclei (AGN), or passive galaxies. These diagnostics are based on the application of Random Forest and Support Vector Machine methods on multi-band photometry from the WISE All sky survey for the Heraklion Extragalactic Catalogue (HECATE) consisting of all known galaxies within a 200 Mpc radius. The training of the diagnostic is based on optical spectroscopy from the SDSS survey. We find that the three-dimensional diagnostics involving the absolute magnitudes from WISE Bands 2 or 3, and two WISE colours (e.g. Band1-Band2 and Band2-Band3) provide superior performance over the commonly used colour-colour WISE diagnostics. The proposed diagnostics reach a recall rate of over 85% for star-forming galaxies while it allows the characterization of passive galaxies with a recall rate of over 90%. We apply this method to the full HECATE sample allowing us to characterize the activity in the local galaxy population, and we discuss the efficiency of our method in identifying heavily obscured AGN through comparison with X-ray surveys.

Manifold spirals in an N-body model with two pattern speeds

Zouloumi Konstantina, Univ. of Athens & RCAAM, Academy of Athens

Abstract

We apply the manifold theory in an N-body simulation of a barred spiral galaxy, where the bar rotates with a different angular speed than the spiral arms. This is a way to test whether the manifold theory is compatible with the hypothesis of co-existence of multiple pattern speeds in this galaxy.

We use the method of the Numerical Analysis of the Fundamental Frequencies and we locate the two different pattern speeds on the galactic disc. We confirm that the spiral arms rotate with a slower pattern speed than the bar, as it has been indicated from observations in real galaxies and N-body simulations.

The manifold theory for the spiral structure of the galaxies has been tested in models of barred spiral galaxies with a single pattern speed. It has been proved that the invariant manifolds of the unstable Lagrangian equilibrium points on the galactic disc can support dynamically and morphologicaly the spiral arms and the outer shell of the bar.

The calculation of the manifolds and the unstable Lagrangian equilibrium points changes with the input of an extra pattern speed in our model. It has been proved analytically that the system becomes non-autonomous, the unstable Lagrangian equilibrium points turn into equilibrium periodic orbits and the manifolds become time-evolving. We discuss a method of calculation of these unstable periodic orbits and the manifolds emanating from them in our model and we observe that they support the spiral structure of the galaxy. We also compare the morphology of the manifolds with the structures of the N-body simulation

Poster Contributions

Characterizing the ISM of the most obscured quasar and its host

Fernandez Aranda Roman, Univ. of Crete & IA-FORTH

Abstract

W2246-0526 is the most IR-luminous galaxy known to date. Located at redshift z~4.6, it is part of a population of galaxies knowns as Hot Dust Obscured Galaxies (Hot DOGs), at redshifts above z~1, characterized by having IR luminosities above 10^13 Lsun. These galaxies are powered by obscured accretion onto a central supermassive black hole (SMBH). Such luminous active galactic nuclei (AGN) are likely to be at a key stage of their evolution: when feedback from the obscured AGN may have started quenching star formation, just about to become regular quasars and the hosts to decay into dead elliptical galaxies.

In order to study the interstellar medium (ISM) of W2246-0526, we use ALMA observations of the brightest far-IR fine-structure lines, which trace different phases of the ISM and therefore can be used to constrain the gas properties of the galaxy host and investigate the role played by the hyper-luminous, central AGN. Preliminary analysis of the available datasets, accounting for more than 20h of ALMA observations, yield detections of the [CII]151μm, [NII]122μm, [NII]205 μm, [OI]63 μm, [OI]145 μm and [CI]370 μm emission lines. I will present maps of the intensity, projected velocity and dispersion of the various emission lines, report on early results, and discuss about future spectral synthesis, multi-phase gas modeling.

Metallicity and X-ray luminosity variations in NGC 922

Kouroumpatzakis Konstantinos, Institute of Astrophysics - FORTH

Abstract

We present a study of the metallicity variations inside the collisional ring galaxy NGC 922 based on long-slit optical spectroscopic observations. There is a metallicity difference between star-forming regions in the bulge and the ring, with metallicities ranging from almost solar to significantly sub-solar ([12 + log(O/H)] ~= 8.2). The HeI emission found in both the bulge and the ring star-forming regions indicates ionization from massive stars associated with recent (<10 Myr) star-formation, a result that is in agreement with the presence of very young star-clusters in all studied regions. There is an anti-correlation between the X-ray luminosity and metallicity of the sub-galactic regions of NGC 922, driven mainly by metallicity rather than stellar population age variations. The X-ray emission of the different regions in NGC 922 depends on metallicity as in similar studies of the integrated X-ray output of galaxies as well as with predictions from X-ray binary population models.

pyHIIExplorerV2: a tool for detecting and extracting physical properties from HII regions.

Lugo Aranda Alejandra Zaavik, Institute of Astronomy, UNAM

Abstract

MUSE is the most modern instrument to obtain data with the integral-field spectroscopy technique in the optical range, its high spectral and spatial resolution allows to recover more information than any other IFS instruments. To explore and exploit the information that MUSE provides, we present the code pyHIIExplorerV2 to detect clumpy regions of Halpha maps (candidates to HII regions) and extract as much

spectroscopic information as possible (for both the underlying stellar populations and emission lines). Simultaneously during the detection and extraction of the clumpy regions, pyHIIExplorerV2 builds a diffuse ionized gas model (DIG). The construction of DIG will allow us to decontaminate the information of the HII regions candidates.

Session 3: Cosmology and Relativistic Astrophysics

ORAL CONTRIBUTIONS

Singular solutions to the Tolman-Oppenheimer-Volkoff equation:classification and properties

Anastopoulos Charis, University of Patras

Abstract

Most solutions to the Tolman-Oppenheimer-Volkoff (TOV) equation are singular. For thermodynamically consistent equations of state all singular solutions have the same structure. They contain a singularity at the center, which behaves like a point-like topological defect with negative active gravitational mass. This singularity turns out to create no causality and predictability problems. These singular solutions describe compact stars that are stabilized because the repulsion from the center balances the gravitational pull of collapsing matter.

These stars satisfy Einstein's equations with ordinary fermionic matter, they have masses higher than the Oppenheimer-Volkoff limit, and they interpolate in mass between neutron stars and black holes.

Revealing the mechanism behind optical polarization plane rotations in blazars

Blinov Dmitry, Institute of Astrophysics - FORTH

Abstract

The optical polarization plane of some blazars occasionally experiences smooth hundreds degrees long rotations. Multiple models have been proposed to explain the nature of such events. However, even the deterministic origin of these rotations is questioned. We aimed to find repeated patterns of flares in gamma-ray light curves of blazars accompanying optical polarization plane rotations. Such patterns have been predicted to occur by one of the models explaining this phenomenon. For the blazar 3C 279, where multiple polarization plane rotations have been reported in literature, we obtained the Fermi-LAT gamma-ray light curve and analyzed its intervals adjacent to polarization plane rotations. We found a complex characteristic pattern of flares in the gamma-ray light curve that is repeated during periods adjacent to three largest amplitude EVPA rotation events in 3C 279. Our finding strongly favors the hypothesis with emission features propagating in the jet as the reason of optical polarization plane rotations. Moreover, it is compatible with the hypothesis of a sheath in the jet made of separate slowly propagating emission features.

A two-zone emission model for Blazars and the role of Accretion Disk MHD winds

Boula Stella, University of Athens

Abstract

Blazars are a sub-category of radio-loud active galactic nuclei with relativistic jets pointing towards the observer. They exhibit non-thermal variable emission, which practically extends over the whole electromagnetic spectrum. Despite the plethora of multi-wavelength observations, the origin of the emission in blazar jets remains an open question. In this work, we construct a two-zone leptonic model: particles accelerate in a small region and lose energy through synchrotron radiation and inverse Compton Scattering. Consequently, the relativistic electrons escape to a larger area where the ambient photon field, which is related to Accretion Disk MHD Winds, could play a central role in the gamma-ray emission. This model explains the Blazar Sequence and the broader properties of blazars, as determined by Fermi observations, by varying only one parameter, the mass accretion rate, onto the central black hole. Flat Spectrum Radio Quasars have a strong ambient photon field and their gamma-ray emission is dominated by the more extensive zone, while in the case of BL Lac objects, the negligible ambient photons make the smaller (acceleration) zone dominant.

The current state of Pulsar Timing Array search for a Gravitational-wave Background

Caballero Nicolaos, KIAA-PKU

Abstract

Pulsar Timing Arrays (PTAs) were conceptualized as a tool to, among other applications, directly detect low-frequency gravitational (GWs) waves in the nHz regime. With the confirmation of the existence of GWs by terrestrial detectors, the focus of PTAs is to extend the GW observational window to low frequencies and infer cosmological and large-scale structure properties of the Universe. In this talk, I explain the current state of affairs in PTA research in the context of the stochastic GW background, with focus on the data and work by the European Pulsar Timing Array.I will discuss what sources of noise impose the strongest limitations in the data analysis, the methods to mitigate these effects, and immediate plans for upcoming analyses.

Supermassive black hole binaries--gravitational-wave limits and prospects for multi-messenger detections

Charisi Maria, Vanderbilt University

Abstract

Supermassive black hole binaries are the natural end-product of galaxy mergers. At the final stage of their evolution, they become the most promising sources of low-frequency gravitational waves, currently targeted by Pulsar Timing Arrays and in the future by the Laser Interferometer Space Antenna (LISA). I will describe recent limits on tentative supermassive black hole binaries in nearby galaxies derived from the North American Nanohertz Observatory for Gravitational waves (NANOGrav). I will also discuss prospects for future multi-messenger detections with electromagnetic and gravitational-wave data.

Radio emission from high-mass X-ray binaries with strongly magnetized neutron stars

Chatzis Margaritis, University of Crete Petropoulou Maria (National and Kapodistrian University of Athens), Vasilopoulos Georgios (Yale University), Kylafis Nikos (Univ. of Crete & IA-FORTH)

Abstract

Low-mass X-ray binaries hosting black holes are known to produce mildly relativistic jets. This is evident by the correlated radio vs. X-ray intensity observed during powerful outbursts (e.g. V404 Cyg). On the contrary radio emission from an accreting strongly magnetized (B>10^12 G) neutron star (NS) was only recently observed for the first time and remains poorly understood.Due to the high magnetic field of the NS, the accretion disk is truncated at a very large radius. It still remains unclear if jet formation is possible under these conditions, and how the jet properties compare to those in a BH analog. However, radio emission may be related to strong outflows that originate from the accretion disk and/or the NS magnetosphere. In contrast,pulsed X-rays are created by radiative processes at the NS surface and in the accretion column. Thus, making a connection between X-ray and radio emission is challenging. Motivated by recent detection in radio frequencies of 3 accreting magnetized NSs, including the first Galactic ultra-luminous X-ray pulsar (Swift J0243.6+6124), we investigate possible explanations for the radio production site. We adopt a scenario where radio emission is powered by the synchrotron radiation of relativistic electrons accelerated at a strong shock formed by the collision of the NS outflow and the stellar wind of the companion. Using a toy model of spherically symmetric outflows we compute the 6 GHz and 22 GHz synchrotron luminosities for a wide range of stellar wind parameters and accretions rates (i.e., X-ray luminosities), while accounting for synchrotron self-absorption and free-free absorption. We compare our findings to the multi-epoch observations of Swift J0243.6+6124 and discuss the plausibility of the proposed scenario for the origin of radio emission.

Using a Simulated Annealing algorithm to identify coherent cosmological structures.

Chira Maria, Univ. of Thessaloniki & National Observatory of Athens

Abstract

We develop an optimization algorithm, using simulated annealing for the quantification of patterns in astronomical data based on techniques developed for robotic vision applications. The methodology falls in the category of cost minimization algorithms and it is based on user-determined interaction among the pattern elements criteria that define the properties of the sought structures. We tested the algorithm on a large variety of mock images and applied it on N-body simulation dark-matter halo data to conclude that this versatile technique can reveal coherent the counterpart of cosmological structure.

Jets, disc-winds, and oscillations around Kerr black hole

Dihingia Indu Kalpa, IIT Indore

Abstract

Relativistic jets and disc-winds are typically observed in BH-XRBs and AGNs. However, many physical details of jet launching and the driving of disc winds from the underlying accretion disc (AD) are still not fully understood. This study will investigate the role of the magnetic field strength and structure in launching jets and driving disc-winds. We will also explore the connection between jet, wind, and the AD around the central black hole. We have performed axisymmetric GRMHD simulations of the accretion-ejection system using AMR. Essentially, our simulations were initiated with a thin AD in equilibrium. We will present results from our extensive parametric study with different combinations of initial magnetic field strength and inclination parameter (m). Our study has found relativistic jets and disc-wind driven by the Blandford & Znajek and Blandford & Payne mechanism, respectively. We have also found that plasmoids are formed due to the reconnection events, and these plasmoids advect with disc-winds. Consequently, the enhanced magnetic tension force results in disc truncation and oscillation in the inner part of the AD. The plasma-beta and m play crucial roles in the evolution of the accretion-ejection system, which we will present in detail. Further, we will also discuss possible applications of our models to understand spectral state transition phenomena in BH-XRBs.

Plastic Flows in Neutron Star Crusts

Gourgouliatos Konstantinos N., University of Patras & Samuel Lander

Abstract

The outer layer of a neutron star is the crust comprising a solid ion lattice. If the neutron star magnetic field reaches magnetar-level strengths (10^14-10^15 G), it is likely that it will exceed the maximum stress the crust can tolerate and the crust will fail. Should this happen, the assumption of a solid lattice does not hold any more, and the system cannot be described by the usual electron MHD. Here, we present simulations of the magnetic field evolution of a plastically failing crust, in a simplified geometry and we explore its impact to the local and global structure of the magnetic field. We find that plastic flow tends to annul the shearing resulting from the electron-MHD evolution, nevertheless, if the failure is local, affecting a small patch of the crust, rather than global, it is likely that the field becomes more tangled than before. We discuss the impact of such flows in the context of magnetar bursts and their overall impact to the magnetic field evolution of the crust.

Insights into binary neutron star merger remnants with equilibrium modelling

Iosif Panagiotis, University of Thessaloniki Stergioulas Nikolaos (Aristotle University of Thessaloniki)

Abstract

Binary neutron star (BNS) collisions can result in transient compact remnants briefly supported by differential rotation and thermal pressure. This post-merger phase is expected to yield crucial constraints for the equation of state of high density matter. The study of remnants as quasi-equilibrium models can find applications in interpreting the post-merger gravitational wave (GW) signal, inferring the threshold mass for prompt collapse to a black hole, constructing universal or empirical relations for remnant properties and modelling processes that are relevant for multi-messenger follow-up

studies of GW observations. Here, we will present recent results using equilibrium modelling to describe coalescence remnants. Adopting a realistic differential rotation law, allows construction of sequences of remnant-like models with rotational profiles resembling those of numerically simulated remnants. Employing specific equations of state we deduce the threshold mass for prompt collapse and reproduce key predictions of BNS merger simulations. A possible correlation is conjectured between the compactness of equilibrium models of remnants at the threshold mass and the compactness of maximum mass non-rotating models.

Clustering effects on GWs Dark Sirens determination of H_0

Kalomenopoulos Marios, University of Edinburgh

Abstract

Gravitational waves (GWs) can be used to measure the Hubble parameter. The optimal technique, a "Standard Siren", requires the identification of the electromagnetic (E/M) counterpart of the GW source. However, a significant fraction of GWs will not have E/M counterparts. Such "Dark Sirens" can still help constrain the Hubble parameter by statistical techniques. In this work we investigate the power of this method using high-resolution, cosmological simulations that include realistic clustering effects. In addition, we quantify the role of catalogue incompleteness, i.e. the lack of certain galaxies from our catalogues due to observational limitations, when applying this technique.

Rotations of the polarization angle in blazars

Kiehlmann Sebastian, Institute of Astrophysics - FORTH

Abstract

Rotations of the optical polarization angle observed in blazars allow us to study the magnetic field that plays a major role in the launching, acceleration and collimation, and the emission processes of relativistic jets. Furthermore, rotations are of interest as their occasional contemporaneity with gamma-ray flares may convey information about the gamma-ray emission process. One difficulty in the interpretation of polarization rotations is the inherent 180 degrees ambiguity in the measurements.

We apply a novel method to four years of monitoring data from the RoboPol program that allows us for the first time to estimate how strongly the data is affected by the ambiguity. We discuss the questions of (i) the upper limit of rotation speeds, (ii) the observation cadence required to detect such rotations, (iii) whether rapid rotations have been missed in studies thus far, (iv) what fraction of data is affected by the ambiguity, and (v) how likely detected rotations are affected by the ambiguity.

We discuss the consequences of those findings for the results previously presented in the literature and argue for a new blazar polarization monitoring program that will significantly reduce the effect of the ambiguity.

Turnaround radius of galaxy clusters in N-body simulations

Korkidis Giorgos, Univ. of Crete & IA-FORTH

Abstract

In this talk, through the use of N-body simulations we will examine whether a characteristic turnaround radius, as predicted from the spherical collapse model in a ΛCDM Universe, can be meaningfully identified for galaxy clusters in the presence of full three-dimensional effects. In particular we use The Dark Sky Simulations and Illustris-TNG dark-matter-only cosmological runs to calculate radial velocity profiles around collapsed structures, extending out to many times the virial radius R200. There, the

turnaround radius can be unambiguously identified as the largest nonexpanding scale around a center of gravity.
From this analysis we find that: (a) a single turnaround scale can meaningfully describe strongly nonspherical structures. (b) For halos of masses M > 10^13 Msun, the turnaround radius Rta scales with the enclosed mass M as M^1/3, as predicted by the spherical collapse model. (c) The deviation of Rta in simulated halos from the spherical collapse model prediction is relatively insensitive to halo asphericity. Rather, it is sensitive to the tidal forces due to massive neighbors when these are present. (d) Halos exhibit a characteristic average density within the turnaround scale. This characteristic density is dependent on cosmology and redshift. For the present cosmic epoch and for concordance cosmological parameters (Ωm ~0.3; ΩΛ~0.7) turnaround structures exhibit a density contrast with the matter density of the background Universe of δ~11. Thus, Rta is equivalent to R11 β€“ in a way that is analogous to defining the "virial" radius as R200 - with the advantage that R11 is shown in this work to correspond to a kinematically relevant scale in N-body simulations.

The "corona" in black-hole X-ray binaries: what is it?

Kylafis Nikos, Univ. of Crete & IA-FORTH

Abstract

It is generally accepted that the "corona" in black-hole X-ray binaries, which is thought to produce the power-law X-ray spectrum, is the hot inner flow around the black hole. This picture explains satisfactorily a) the power-law X-ray spectrum, b) the time lag of the hard photons with respect to the softer ones, and c) the correlation between time lag and Fourier frequency. However, it does not explain i) the correlation between the time lag and the spectral index Gamma of the power law in GX 339-4 and other sources, ii) the fact that this correlation depends on the inclination of the source, iii) the phase-lag cutoff-energy correlation observed in GX 339-4, iv) the narrowing of the auto-correlation function with increasing photon energy, and v) the correlation between the Lorentzian frequencies in the power spectrum and the spectral index Gamma in Cyg X-1. I will demonstrate that, by extending the "corona" to include not only the hot inner flow but also the jet, all the above observational facts can be explained quantitatively. Last, but not least, I will demonstrate that the jet is a natural series of continuum sources that illuminate the accretion disk and one does not need to invoke artificial and nonphysical "lampposts", which are invoked if the jet is ignored. The "lampposts" are used to explain the reflection features in the observed spectrum.

Origin of the optical emission in Tidal Disruption Events through polarization

Liodakis Ioannis, Finnish center for Astronomy with ESO

Abstract

Tidal disruption events are very interesting and rare events that can help us understand a lot about supermassive black holes, their environments, and the very early stages of accretion disk and jet formation. While only a few events were know until recently, the advent of large time-domain surveys in optical, like the Zwicky Transient Facility, have significantly increased the number of know events. The origin of the emission in the so called ``optical'' TDEs is a matter of cutting edge research and vivid debate. I will discuss our current efforts of understanding the early stages of accretion disk formation and origin of the optical emission through its vastly underexplored polarization signatures.

Gravitational wave frequency deviations in universal relations of isolated neutron stars and postmerger remnants

Lioutas Georgios, GSI Helmholtzzentrum fuer Schwerionenforschung

Abstract

Gravitational wave frequencies produced from fluid oscillations are particularly important for the study of neutron stars. In this talk we compare and relate the gravitational wave emission of two very different systems: isolated, cold, non-rotating neutron stars and binary neutron star merger remnants. Both the quadrupolar fluid mode of isolated neutron stars and the dominant fluid oscillation of binary neutron star merger remnants have been shown to correlate with stellar properties such as the radius and the tidal deformability. We discuss the accuracy of different fits proposed in the literature focusing on isolated neutron stars. We then examine how individual points scatter with respect to the corresponding fit. We identify a clear similarity between how individual models deviate from the respective fits of isolated neutron stars and of merger remnants. We link the frequency deviations to the tidal Love number, which highlights that these deviations contain additional information about the equation of state.

Is the local Universe anisotropic? Galaxy clusters seem to think so

Migkas Konstantinos, University of Bonn

Abstract

Most cosmological studies adopt the assumption that the expansion rate of the local Universe, H0, is isotropic (i.e. obeys the Cosmological Principle). This is a fundamental pillar of concordance cosmology. However, several studies have accumulated recently that seem to suggest that things might not be so simple. The importance of utilizing new, independent methods to scrutinize this hypothesis cannot be understated. Scaling relations of galaxy clusters can be effectively used for that. By measuring many different, multiwavelength cluster properties, several scaling relations with different sensitivities can be built, and nearly independent tests of cosmic isotropy are then feasible. In this talk, I will present the most recent and intriguing results up to now using this method. We make use of up to 570 clusters with measured properties at X-ray, microwave, and infrared wavelengths, to construct 10 different cluster scaling relations (five of them presented for the first time) and test the isotropy of the local Universe. We ensure that our analysis is not prone to any known systematic biases or undiscovered absorption issues. By combining all available cluster information, we detect an apparent 9% spatial variation in the local H0. Using Monte Carlo simulations, we assess the statistical significance of the observed anisotropy to be >5 sigma. This result could also be attributed to a 900 km/s bulk flow which seems to extend out to 500 Mpc. These two effects are indistinguishable until more high-z clusters are observed by future all-sky surveys, such as eROSITA. However, both of these scenarios strongly contradict LCDM. The exact origin of the anisotropies remains to be

Plasmoid formation in 3D GRMHD simulations

Mpisketzis Vassilis, University of Athens

Abstract

Observations of SgrA* by the GRAVITY have shown the astrometrical position of infrared flares at around 10 gravitation radii. The flares are accompanied by a strong polarization, indicating a non-thermal radiation. In accretion flows onto black holes, reconnection layers are expected to occur, resulting in production of "plasmoids" which are essential for particle acceleration and therefore non-thermal radiation. We aim to present results of 3D-GRMHD simulations of an accreting disk, studying the production and evolution of plasmoids, while also tracking their position to correlate it with an astronomical position.

Non-canonical Domain Wall as a Unified Model of Dark Energy and Dark Matter: I. Background Dynamics

Mulki Fargiza A. M., Bandung Institute of Technology

Abstract

In this work, a new model of dark energy inspired by the Grand Unified Theory (GUT) will be constructed. This proposed model is aimed to decipher the fundamental and classical problems of dark energy, namely the cosmological constant problems, which nowadays receives less attention since the cosmological tensions were considerably important. By employing the non-canonical formalism in field theory and topological defect soliton we construct a non-canonical domain wall model of dark energy to account for energy scale problems of dark energy and its physical interpretations. We investigate the dynamics of non-canonical domain wall and then discover that this model can possess either dark energy or dark matter behavior at different times. We found that the dark energy behavior of non-canonical domain wall is determined by its velocity v with respect to the observer frame in comoving spacetime, that is either ordinary field or phantom field, as well as that of as dark matter can be either hot or cold depends on v of domain wall measured by the observer. We also found a single solution of the dynamics in which for v = 0 or “freezing”, non-canonical domain wall can entering phantom zone without having to experience ghost field instability, i.e. it has w < 1 without have to possess negative kinetic energy. These domain walls can give rise to late time cosmic acceleration starting from z∼0.8 and produce w = ∼1.5 with effective w = ∼1.03 today. We also obtain that cosmological properties of non-canonical domain wall do not depend on the choice of potential similar to that of canonical domain wall. In other side, to account for energy scale problems of cosmological constant we investigate the O•^4 potential to seek its possibility in alleviating fine-tuning problem of cosmological constant, and then we found the combinations of model parameters that can meet observation of dark energy density. In addition, we also investigate the force exerted by domain wall and anti-domain wall interaction as a preliminary attempt to explain late-time cosmic acceleration and the nature of dark energy. This work is carried out analytically.

F-GAMMA / QUIVER : Full-Stokes, multi-frequency radio monitoring of Fermi blazars

Myserlis Ioannis, IRAM

Abstract

The Fermi-GST AGN Multi-frequency Monitoring Alliance (F-GAMMA) comprises the most comprehensive monitoring program of gamma-ray emitting AGNs in the radio bands in terms of: sample size (total of ~150 blazars), frequency coverage (2.6 - 345 GHz in 13 frequency steps), cadence (monthly), and duration (2007 - 2015). Here, we will present the complete dataset, focusing on the radio variability and spectral evolution, as well as selected highlights of our results, including the correlation of our multi-frequency radio light curves with Fermi data to estimate the location of gamma-ray emission in jets.

Within the F-GAMMA framework, we developed a novel data analysis methodology for high-precision linear and circular polarimetry. The application of this methodology has been extended to our follow-up monitoring program, QUIVER, which focuses on a sub-sample of highly polarized sources, monitored with bi-weekly cadence. To augment our full-Stokes datasets, we developed a polarized radiative transfer model that generates synthetic light curves and spectra, accommodating a number of propagation processes in astrophysical plasmas. The direct comparison of observed and synthetic data, done simultaneously in total flux, linear and circular polarization is used to put strict constraints on the physical conditions in AGN jets.

Estimating the Hubble constant with gravitational waves and afterglow observations from neutron star mergers

Nathanail Antonios, Academy of Athens & University of Athens

Abstract

A fundamental role in Cosmology is played by the Hubble constant, which measures the current expansion rate of the Universe. A discrepancy exists in the Hubble constant measurements, between the Planck results that use the Cosmic microwave background (CMB) and the supernovae distance ladder. Binary neutron star mergers are promising sources for gravitational waves (GW) accompanied by electromagnetic (EM) counterparts and offer a completely independent Hubble constant estimation. However GW measurements have a degeneracy in the viewing angle determination, which for GW170817 was ~ 60 degrees. GW170817 was the first ever detection of GW from a neutron star merger, and was followed by a well monitored electromagnetic afterglow, produced by a relativistic jet. The afterglow modeling can break the viewing angle degeneracy. We argue that the choice of modeling of the jet through hydrodynamic or magneto-hydrodynamic simulations can have a big impact of the Hubble constant estimation. We present a comprehensive analysis of the viewing angle from different assumptions on the jet model and present a way to distinguish between different jet models that can result to a better estimation of the Hubble constant.

Spinning Particles In McVitte Spce Time

Papadopoulos Demetrios, University of Thessaloniki

Abstract

The spin-curvature interaction can modify the motion of the test particles in black hole space times due to spin-spin or spin-orbit couplings, or make the motion chaotic thus modifying significantly the orbit of the test body leading to the emission of characteristic forms of gravitational waves.

In view of those interactions and their consequences we have considered Mathison-Papapetrou (MP) equations, solved them numerically in the post Newtonian limit of McVittie background (Schwarzschild metric embedded in an expanding background) and obtained the orbits of spinning particles close to a massive object. We examined the deformation of the orbits due to the background space time and discussed their consequences.

Evidence for line-of-sight frequency decorrelation of polarized dust emission in Planck data

Pelgrims Vincent, Institute of Astrophysics - FORTH

Abstract

If a single line of sight (LOS) intercepts multiple dust clouds of the interstellar medium with different spectral energy distributions and magnetic field orientations, then the frequency scaling of each of the Stokes Q and U parameters of the thermal dust emission may be different. This phenomenon, which we refer to as LOS frequency decorrelation, may complicate search for the B-mode signature from primordial gravitational waves in the polarization of the Cosmic Microwave Background radiation. In this talk, I will present our analysis that led to the first observational discovery of LOS frequency decorrelation of polarized thermal emission from Galactic dust for specific LOSs identified either with Robopol starlight polarization data or using independent measurements of neutral-hydrogen emission to probe the 3D structure of the magnetized interstellar medium

Gravitational-wave-driven tidal secular instability in neutron star binaries

Pnigouras Pantelis, Sapienza University of Rome

Abstract

We report the existence of a gravitational-wave-driven secular instability in neutron star binaries, acting on the equilibrium tide. During the orbital evolution of the binary system, the tide propagates around the star and emits gravitational waves, which dissipate energy unless the stellar spin exceeds the orbital frequency of the binary. In this case, gravitational-wave emission pumps more energy into the tide, thus leading to an instability, which is similar to the classic Chandrasekhar-Friedman-Schutz (CFS) instability of normal modes. For simple models, used to demonstrate the instability mechanism, we calculate the instability growth time scale, which can be as low as a few seconds at small orbital separations. The implications for the binary's orbital evolution are also explored, where it is found that the instability slows down the inspiral, as

opposed to tides in nonrotating (or slowly rotating) neutron stars, where the inspiral is accelerated.

What if new physics sets in above 50 TeV? Cosmic-ray air-shower simulations with increased cross-section and multiplicity

Romanopoulos Stelios, Univ. of Crete & IA-FORTH

Abstract

We have used COSIKA to study, through air-shower simulations, observational signatures of a possible increase in cross-section and multiplicity in collisions with center-of-mass energies exceeding ~50 TeV. We have simulated collisions for primaries with energies in the range 10^8 - 10^{12} GeV. We have used two different high energy models for the simulations, EPOS LHC and QGSJETII-04, with Fluka for low energy interactions on both. A smooth transition from galactic to extra-galactic cosmic rays was implemented, by fitting a Galactic component with an exponential suppression at ~10^9 GeV. The remaining flux in Auger data was interpreted as extra-galactic protons. Above 10^9 GeV, the proton-air cross-section and the multiplicity of secondary particles were altered, so as to bring the simulated $langle X_text{max}rangle$ in agreement with Auger data. The parameter space of the viable cross-section and multiplicity in the scenario where the composition of Auger cosmic rays at the highest energies remain unchanged and light places constraints on the phenomenology of any new physics affecting the interactions for high energy protons that may be probed by $sqrt{s}>50$ TeV collisions. The muonic production of the showers was also studied in this context.

Stability analysis of relativistic magnetized astrophysical jets

Sinnis Charalampos, University of Athens

Abstract

Astrophysical jets are observed as stable structures, extending in lengths several times their radii. The role of various instabilities and how they affect the observed jet properties has not been fully understood. Using the ideal relativistic MHD equations to describe jet dynamics we aim to study the stability properties through linear analysis. Our jets' physical quantities are defined by the acceleration and collimation processes near the central object that generates the outflow. So, the distribution of each quantity carries the signature of the processes taking place at the early stages of jet propagation. In order to find the growth rates for the instabilities we solve numerically the perturbed system. We find connections between growth rates and various characteristic parameters such as magnetization, as well as the underlying dominating physical mechanism that trigger the instabilities, whether it is a matter or magnetic field-dominated process. Especially, we focus on a new set of solutions which showcase really small instability growth timescales, giving them the trait of "hyper-unstable" modes. We have found strong correlation between these new modes and the ratio of jet over ambient medium's density values and also the existence of strong toroidal component of the magnetic field near outflow's boundary layer.

Semi-analytic model of the spectral properties of gravitational waves from neutron star merger remnants

Soultanis Theodoros, Heidelberg Institute for Theoretical Studies

Abstract

This talk addresses the spectral properties of gravitational wave (GW) emission from binary neutron star merger remnants. The dominant feature in the post-merger GW emission is attributed to the fundamental quadrupolar oscillation (f_{peak}) mode, while secondary frequency components are present too. For a selected equation of state (EoS), we perform fully relativistic hydrodynamics simulations and we investigate the detailed structure of the post-merger GW signal for instance by a quantitative analysis of the resulting spectrograms. Based on this analysis we introduce a semi-analytic model to describe the postmerger GW signal. This model may be employed in GW data analysis since it provides a very good match to the actual data. We evaluate the performance of the model by considering the fitting factor (FF). Finally, we utilize the semi-analytic model for the post-merger GW emission to assess the importance of individual frequency components in terms of future detections.

POSTER CONTRIBUTIONS

Numerical simulations of relativistic hydrodynamical and MHD jets: transition from jet break-out to self-similarity

Choraiti Sideri Eleanna, University of Patras, Gourgouliatos Konstantinos N. (University of Patras)

Abstract

Relativistic jets appear in a wide variety of astrophysical environments from gamma-ray bursts to active galactic nuclei. Motivated by these systems we study the role of the magnetic field and the Lorentz factor in the large-scale structure of relativistic jets via numerical simulations. We perform six sets of axisymmetric numerical simulations of hydrodynamical and MHD jets with injection Lorentz factors 2, 5, 10, using AMR-VAC. We follow the evolution of these jets within a medium of uniform density and pressure. We monitor the propagation velocity of the jet, pressure, density and the aspect ratio of the width of the jet over the length of the jet and we compare them against the analytical relation found by Kommisarov and Falle (1998) for self-similar jets. We observe the transition of the jet from the initial break-out to the self-similar phase and we confirm the validity of the analytical study. We find that the inclusion of the magnetic field changes the time and location where the jet transitions to the self-similar phase. Finally, we notice the formation of reconfinment shocks within the jet and we present the scaling relation of the location of the reconfinment shock with the Lorentz factor and the magnetic field.

On the Effects of Resistivity in Relativistic Magnetized Flows

Loules Argyrios, University of Athens, Vlahakis Nektarios (University of Athens)

Abstract

We present semianalytic solutions of the system of equations governing steady, axisymmetric, radially self-similar, relativistic, magnetized flows of finite resistivity. The effects of various resistivity profiles and values on the properties of these flows are studied, with particular focus placed on the geometric configuration of the velocity and electromagnetic field lines. The possibility of particle acceleration is also examined, by solving the equation of motion for a test particle moving under the influence of the electromagnetic fields of such flows.

Session 4: Stars, Planets and the Interstellar Medium

ORAL CONTRIBUTIONS

Evolution of helium stars at different metallicities: classification, populations, supernovae and compact remnants

Aguilera-Dena David R., Institute of Astrophysics - FORTH

Abstract

Massive stars become stripped of their hydrogen envelope as a consequence of binary interaction or due to single star mass loss. Massive stripped envelope stars are observed as classical Wolf-Rayet (WR) stars, and are potential progenitors to Type I core-collapse supernovae (SNe). Their compact remnants are also found in X-ray binaries and gravitational wave sources. We compute large grids of helium star models at different metallicities until core collapse, to predict the observable properties of such stars, and characterise the transients they produce, and their compact remnants.

WR stars are detected down to a minimum luminosity, which is lower for larger metallicity. We confirm this observation by considering the wind optical depth of our models, which we use in a simple criterion for identifying Wolf-Rayet stellar models. Our metal-rich models spend less time as nitrogen-rich (WN type) stars, and more as carbon-rich (WC type) WR stars. We find the minimum luminosities for each type to be strongly metallicity dependent, and predict the WN/WC number ratio as a function of metallicity. All our models which evolve to obtain a carbon rich surface compositions have strong enough mass loss to appear as WC stars.

Our more metal-rich helium stars produce less massive carbon-oxygen cores, and have lower carbon mass fractions at core helium exhaustion. This implies that, for a given initial mass, they are more likely to undergo a successful supernova explosion. We analyse their surface properties at the time of core collapse to determine the type of supernova they might produce, and derive the expected number ratio of Ic to Ib SNe as a function of metallicity. Using several methods to infer the explosion properties based on the pre-SN structure of our models, we find that not only the rates of different types of supernova vary with metallicity, but also their ejecta masses, and the corresponding neutron star (NS) and black hole (BH) mass distributions, These variations have strong consequences for our understanding of binary BH and NS systems, including double compact mergers.

Machine learning as a tool for discovering Symbiotic Stars

Akras Stavros, National Observatory of Athens/IAASARS

Abstract

Over the last 2 decades, data mining and machine learning algorithms (ML) have become increasingly popular in astronomy and are widely used for a variety of fields. The Sloan Digital Sky Survey (SDSS) was the first survey that provided a large amount of photometric measurements for more than 50 million sources (DR1, 2003). Since then, several more photometric sky-surveys have been conducted and even more are planned for the near future covering the entire spectral range from Ξ^3-rays to radio. To explore this amount of data is necessary to apply automatic techniques.

In this talk I will show how ML algorithms can lead to the development of new selection criteria for the identification of new member for different type of sources such as Symbiotic Stars and Planetary Nebulae in publicly available photometric surveys. The

combination of data from different spectral wavelengths is crucial to improve the efficiency of the ML models. Seven new Galactic Symbiotic Stars have been spectroscopically confirmed with a detection rate up to 75-80%, while the old selection criteria resulted in detection rate of only 25%.

X-ray spectral energy distributions and bolometric corrections of black hole and neutron star X-ray binaries

Anastasopoulou Konstantina, INAF Osservatorio astronomico di Brera

Abstract

We present a library of spectral energy distributions (SEDs) for Galactic black-hole and neutron- star X-ray binaries (XRBs) in different accretion states based on RXTE spectra. We discuss the evolution of the SED shape as a function of the Eddington ratio and the BH mass, or the type of compact object. These SEDs can be used in XRB population synthesis models to compute the emerging spectrum from an XRB population, or to predict the expected X-ray luminosity in a given energy band. Moreover we compute average bolometric corrections (BC=Lband/Lbol) corresponding to different Eddington accretion ratios. These can provide a picture of the energetics of the accretion flow for an X-ray binary based solely on its observed luminosity in a given band. Finally, using this spectral library, we calculate the X-ray to optical flux ratios for accretion flows in different Eddington ratios. These can be used to estimate the contribution of the disc to the optical emission of a binary system and to characterize its nature.

Very hot plasma in the central degrees of the Milky-Way? An XMM-Newton view

Anastasopoulou Konstantina, INAF Osservatorio astronomico di Brera

Abstract

Our understanding of the physics of galaxies and the interstellar medium has greatly advanced in the last few years. In our Galaxy, evidence for outflows that connect the activity in the center and the disc at sub-parcec scales with the larger scale structures (Fermi, eROSITA bubbles) are now more evident with systematic studies by XMM-Newton and the discovery of the chimneys, a channel hundreds of parsecs long of hot plasma which could be powered by supernovae or past AGN activity of the SgrA*. In this presentation I make use of older as well as very recent ("Multi-Year Heritage Programme"; 3.65 Ms spread over 3 years of observations, PI: Ponti) XMM-Newton observations of the Galactic center and disc. I examine whether a very hot plasma (~7 keV) component in the few central degrees of the Milky way, identified in previous studies with Suzaku observations, is present also in the XMM-Newton observations and at higher Galactic longitudes. I measure its possible geometry and physical properties (thermal energy, density, pressure etc.) and discuss whether its energetics could be powering the outflow we observe at hundred-parsec scales (i.e. chimneys) in the Galactic Center.

ODUSSEAS: a machine learning tool to derive effective temperature and metallicity for M dwarf stars

Antoniadis - Karnavas Alexandros, Instituto de Astrofisica e Ciencias do Espaco

Abstract

The derivation of spectroscopic parameters for M dwarf stars is very important in the fields of stellar and exoplanet characterization. We present our easy-to-use computational tool ODUSSEAS, which is based on the measurement of the pseudo equivalent widths for more than 4000 stellar absorption lines and on the use of the machine learning Python package "scikit-learn" for predicting the stellar parameters. It offers a quick automatic derivation of effective temperature and [Fe/H] for M dwarf stars using their 1D spectra and resolutions as input. The main advantage of this tool is that it can operate simultaneously in an automatic fashion for spectra of different resolutions and different wavelength ranges in the optical. ODUSSEAS is able to derive parameters accurately and with high precision, having precision errors of 30 K for Teff and 0.04 dex for [Fe/H]. The results are consistent for spectra with resolutions between 48000 and 115000 and S/N above 20.

Photodissociation region diagnostics across galactic environments

Bisbas Thomas, University of Cologne

Abstract

To determine the physical properties and evolution of the ISM, we need to model its chemical conditions as these set its heating and cooling rates and ionization state, which mediates coupling to magnetic fields. Calculating the intensity of various emission lines is important not only for estimating cooling rates, but also for predicting the diagnostic information they carry, so we can assess how well ISM conditions can be inferred from a given set of observables. To this end, many groups worldwide focus on algorithms constructing synthetic observations of various distributions under different ISM conditions. The general goal is to understand how these conditions affect the trends of emissivities of the different coolants. In this talk, I will present results from recent three-dimensional PDR simulations and synthetic observations of molecular clouds in various ISM environments and explore the behaviour of the most commonly used diagnostics. Two clouds are embedded in ISM environments with cosmic-ray ionization rates in the range of 1e-17 -- 1e-14 s-1, FUV intensities from 1-1000 G0, and metallicities from 0.1 -- 2 Zsun. The clouds probe a range of densities and levels of turbulence, including compression due to cloud-cloud collisions. I will show how the column densities of HI, H2, CII, CI, CO and OI change in each case, as well as the velocity integrated emission of the carbon cycle. I will conclude discussing how the CO-to-H2 and CI-to-H2 conversion factors change in each case. In the era of ALMA, SOFIA, and the forthcoming CCAT-prime telescope, it is crucial to understand the emission of lines in a wide range of galactic and extragalactic environments to study their ISM.

Type Ia supernovae from non-accreting progenitors

Chanlaridis Savvas, Univ. of Crete & IA-FORTH

Abstract

Type Ia supernovae (SNe Ia) signal the death of a star in a thermonuclear runaway. While most, if not all, are believed to result from the disruption of white dwarf stars, a subset of them may have a more exotic origin. In this talk I will discuss detailed

numerical models of single, non-rotating low-mass helium stars. These models show that stars with initial masses between 1.9 and 2.7 solar masses exhibit inflation leading to violent mass loss and the complete depletion of helium from their envelopes. At the same time, they develop a highly degenerate oxygen-neon core that grows to the Chandrasekhar mass limit via stable shell burning and subsequently ignites carbon and oxygen explosively at relatively low densities. I will argue that the resulting thermonuclear runaways are likely to prevent core collapse, leading to the complete disruption of the star in a SN Ia-like explosion.

On the Origin of Mixed Morphology Supernova Remnants

Chiotellis Alexandros, National Observatory of Athens / IAASARS Zapartas Emmanouil (Geneva Observatory, University of Geneva), Boumis Panos (IAASARS - National Observatory of Athens), Souropanis Dimitris (IAASARS - National Observatory of Athens)

Abstract

Mixed morphology or thermal composite supernova remnants (hereafter MMSNRs) consists a distinctive and peculiar class of evolved supernova remnants (SNRs), characterised by the co-existence of a shell-like radio morphology and centrally dominated, thermal X-ray emission. The properties of MMSNRs cannot be explained by the canonical SNR evolution models, as evolved SNRs are expected to contain cold and low density gas in their interior. In order to explain the central X-ray emission, several suggested models involve the formation of a reflected shock triggered by the collision of the remnant's blast wave with the density walls that have been shaped by the mass outflows of the progenitor star. However, previous attempts failed to reproduce the MMSNRs properties within the framework of the reflected shock model.

In this work we revisit the reflected shock model taking into consideration the overall expected mass outflows of potential MMSNR progenitors. We do so by coupling hydrodynamic simulations with detailed stellar evolution models of massive stars. This way we more accurately model the formed circumstellar medium as shaped by the evolution of the parent star from its zero-age-main-sequence till its final explosion. Our hydrodynamic results show that the previous difficulties can been raised under such an approach, achieving to reproduce the overall morphological and emission properties of the MMSNRs. We discuss the interpretation of our results in the overall understanding of this peculiar class of SNRs.

Spectral analysis of evolved massive stars in the SMC and LMC

De Wit Stephan, National Observatory of Athens / IAASARS

Abstract

Stephan De Wit, Alceste Bonanos, Frank Tramper, Ming Yang, Grigoris Maravelias, Konstantina Boutsia

The ASSESS project aims to tackle the role of episodic mass loss for evolved massive stars. In this framework, we present a spectral analysis of a small sample of dusty evolved massive stars in the Magellanic Clouds. We use Near Infrared (NIR) criteria (M[3.6]< -8 mag and J-[3.6]>1 mag) to select bright dusty sources. The final sample comprised of 11 sources without a previously documented spectral type. The sources were observed with the MagE spectrograph (6.5m Baade telescope). We derive the stellar parameters by fitting existing MARCS models to the optical wavelength domain, with key diagnostics being the TiO bands and Ca II triplet. From the best fit model, we also derive the extinction and surface gravity for each star. In addition, we use 2MASS K-band magnitudes to determine a bolometric magnitude. Using the bolometric magnitude, we proceed to derive the radius, luminosity and initial mass, further mapping the global properties of these stars. We compare the best-fit effective temperature to the temperature found using classical color-temperature relations, to investigate the discrepancy between both methods. We also plan to include NIR spectra that we have obtained to allow for a second temperature estimate, to further investigate the temperature discrepancy. Furthermore, we aim to use the derived parameters for advanced SED modelling (DUSTY) to derive the mass-loss rates. Increased mass-loss rates, exceeding those provided by the classical channels, is a strong indication of the presence of episodic mass loss.

Revealing the complex 3D morphology of the Planetary Nebula NGC 2818

Derlopa Sophia, National Observatory of Athens / IAASARS Akras Stavros (National Observatory of Athens / IAASARS), Boumis Panos (National Observatory of Athens / IAASARS), Mendes de Oliveira Claudia (Departamento de Astronomia, Instituto de Astronomia, Brazil), Amram Philippe (Aix Marseille Univ, CNRS, CNES, LA

Abstract

The transition of spherically symmetric AGB envelopes to axis-symmetric planetary nebulae (PNe) is a long-standing problem in the evolution of low/intermediate mass stars. The presence of a binary system has been suggested to explain the formation of aspherical PNe through the common-envelope phase. Detailed morphokinematic analysis of aspherical PNe provide further insight into their formation and evolution. The planetary nebula NGC 2818 is ideal for such a study due to its multi-polar morphology and the presence of a bulk of cometary knots and filaments. In this talk, I present the preliminary results of the 3D Morpho-kinematic (MK) modelling of NGC 2818. The "Shape" software is used to reconstruct the morphology and reproduce the kinematic properties of the nebula, employing long-slit echelle spectra and Fabry-Perot imaging spectroscopy for the first time.

Novel Evolutionary Model for the Early stages of Stars with Intelligent Systems (NEMESIS)

Dionatos Odysseas, University of Vienna

Abstract

We aim to advertise our recently funded H2020/SPACE project NEMESIS that has the ambition to reshape our understanding on the formation of stars by employing artificial intelligence methods to interpret the largest, panchromatic data collection of young stellar objects. Recent evidence suggests that planets form synchronously rather than sequentially to their host stars, indicating a rapid early evolution of star-planet systems. To ascertain these timescales, it is necessary to first determine the characteristic transitions that describe each phase of star formation. The definition of classes for young stellar objects was made possible more than 30 years ago, due to the first space-based infrared sky surveys. Whilst successful in determining global properties, current classification is prone to large uncertainties, and therefore, timescales, which are based on population statistics among different classes in a steady-state evolution, remain dubious. NEMESIS aims to readjust the current classification scheme and its characteristic timescales so that it is concurrent with the most recent observational and theoretical constraints. To meet these goals NEMESIS will compile the largest, panchromatic dataset comprising of all young stellar objects in nearby star-forming regions, harnessing critical information that resides in data from space missions. It will reprocess and analyze this unique dataset with supervised and unsupervised machine

learning algorithms, deep learning neural networks for object detection, clustering and regression analysis of images in order to advance the analysis and interpretation beyond the current state-of- the-art. Ultimately, NEMESIS brings big data techniques and hybrid machine learning methods to systematically analyze and interpret large data volumes in order to answer some of the most persisting questions, paving the path toward data- intensive science applications in modern astrophysics.

Observing stars as the explode: new results and future prospects

Gal-Yam Avishay, Weizmann Institute

Abstract

Recent powerful wide-field sky surveys have substantially increased our ability to monitor the night sky in visible light, and detect variable, moving and transient sources. For example, the Zwicky Transient Facility (ZTF) now routinely detected cosmic explosions within one day of explosion, opening new windows to study the properties, progenitors, and physics of these events. I will present new results from the last year, include new measurements of sample of exploding massive stars detected in their infancy, revealing that most massive stars likely explode within compact distributions of circumstellar material; the discovery of new types of explosions; and the emerging characterization of rapidly evolving transients.

Contact Binaries Towards Merging - CoBiToM project

Gazeas Kosmas, University of Athens Gazeas Kosmas (University of Athens), Loukaidou Georgia (University of Athens), Niarchos Panagiotis (University of Athens), Palafouta Sofia (University of Athens), Athanasopoulos Dimitrios (University of Athens), Liakos Alexios (National Observatory of At

Abstract

Contact Binaries Towards Merging (CoBiToM) Project focuses on contact binaries and multiple stellar systems, as a key for understanding stellar nature. The goal is to investigate stellar coalescence and merging processes, as the final state of stellar evolution of low-mass contact binary systems. Observational data of approximately 100 eclipsing binaries and multiple systems and more than 400 archival systems will be obtained. Additional photometric, spectroscopic and astrometric information will be provided by Gaia mission, which run for a certain period of time or they are currently operational. The programme aspires to give insights for their physical and orbital parameters and their temporal variations, e.g. the orbital period modulation, spot activity etc. Gravitational phenomena in multiple-star environments will be linked with stellar evolution. Further investigation will be performed upon the possibility of contact binaries to host planets, as well as the link between inflated hot Jupiters and stellar mergers. CoBiToM Project is based on a multi-method approach and a detailed investigation, that will shed light for the first time on the origin of stellar mergers and rapidly rotating stars.

Dynamically Informed Habitable Zones in Circumbinary Planetary Systems

Georgakarakos Nikolaos, NYUAD Eggl Siegfried (University of Washington, USA), Dobbs-Dixon Ian (New York University Abu Dhabi, UAE)

Abstract

Determining habitable zones in stellar binaries can be a challenging task due to the combination of perturbed planetary orbits and varying stellar irradiation conditions. Nonetheless, the concept of β€dynamically informed habitable zones allows us to decide where to look for habitable worlds in such complex environments. In this work we apply that concept to potentially habitable worlds on circumbinary orbits. We provide analytical estimates for such systems, even when another giant planet is present in the system. By applying our methodology to Kepler-16, Kepler-34, Kepler-35, Kepler-38, Kepler-64, Kepler-413, Kepler-453, Kepler-1647 and Kepler-1661, we demonstrate that the presence of the known giant planets in the majority of those systems does not preclude the existence of potentially habitable worlds. Among the investigated systems Kepler-35, Kepler-38 and Kepler-64 currently seem to offer the most benign environment.

A Planet Nine Analog Gravitationally Sculpting the Outer Structure of the HD 106906 Planetary System

Kalas Paul, UC Berkeley

Abstract

One of the newest challenges to understanding the origin and evolution of our solar system is the discovery of detached Kuiper belt objects such as Sedna whose orbits lie significantly beyond Neptune and may be gravitationally influenced by a hypothetical Planet Nine. However, the origin of Planet Nine is also a mysteryβ€"did it originally form in a circumstellar disk along with the other solar system planets and later evolve into a distant orbit, or is the wide orbit primordial because it was captured by the Sun at early times in a denser star-forming environment? By studying analogs to our young solar system, we gain vital empirical information for these evolutionary pathways. Using four epochs of HST high-contrast imaging observations in combination with Gaia data, we measure the orbital motion of the gas giant exoplanet HD 106906 b. Like Sedna and Planet Nine, HD 106906 b is now found to have a large periastron distance and inclination relative to the inner planetary region. This 15 Myr old system also has an extended, highly distorted debris disk and our orbit constraints for the detached planet are consistent with simulations where it dynamically sculpts the disk. Thus, the HD 106906 planetary system represents a novel test case for Planet Nine analogs shaping the outer portions of planetary systems.

Computing 3D Periodic Orbits around an ellipsoid and any irregular-shaped asteroid

Karydis Dionysios, University of Thessaloniki

Abstract

Our work concerns the triaxial ellipsoid model. It was chosen among other models because it may serve as a very good approximation of many asteroids that have an elongated oval shape. Since all previous work mostly focused on studying planar periodic orbits (POs), we have extended the search on three dimensional (3D) ones. In addition, our approach of finding these orbits was not based on computational methods, but instead on studying the vertical stability index along a family of planar POs from

which bifurcations occur. These bifurcations arise at certain points of the family where the vertical stability index crosses the values of B±2. In this way, a numerous amount of 3D families emerged, not only of retrograde orbits but of prograde as well. The dynamic characteristics of all these families were studied so that future missions to asteroids of nearly this shape could benefit from this insight.
Another approach to finding families of 3D POs was using evolutionary algorithms. In fact, two different algorithms were used. More specifically, one was a genetic algorithm based on Darwin's evolutionary techniques. The second one was particle swarm optimization which mimics the way a flock of birds flies, or a school of fish swims in a collective movement. The outcome of these methods was most promising since the POs found were both great in numbers and in dynamic characteristics. These kinds of orbits would have probably never been found using the previously mentioned technique.
The third method of obtaining POs around the ellipsoid was using Poincare maps for many different levels of energy. By observing the invariant curves of the phase space of these sections, we can deduce where a PO might be situated on the map. This way we have managed to pinpoint the whereabouts of orbits that were eluding us when using the other two methods.
The aforementioned analysis was conducted in order to move on to the next step which is none other than to use and implement all the existing families of the ellipsoid to real asteroids such as Eros, Castalia, Golevka, Apophis etc. Bearing in mind that each celestial body has its own mass, rotation speed and shape, it is evident that different kinds of ellipsoid models would fit as a starting point for each asteroid. A method of finding the initial conditions of the desired POs of the asteroids, based on the knowledge already acquired from the ellipsoid, is our current main objective.
In fact, we have created a method of modelling any 3D object using mascons (point masses) which helps us simulate its gravitational field by simply adding the individual fields exerted by all the discrete masses. Another method of transforming an ellipsoid consisting of mascons into the shape of any desired asteroid is also implemented. That enables us to use a continuation process in order to start from a known orbit of a certain ellipsoid and end up with a new equivalent orbit of the asteroid. In that way, we have obtained many families of orbits of Eros asteroid, which was chosen among others, because it is a highly nonsymmetric and irregular object.

The ExoClock Project: an open integrated platform for maintaining the Ariel target ephemerides with contributions from the public

Kokori Anastasia, UCL- CSED

Abstract

The ExoClock Project (www.exoclock.space) is an open, integrated, and interactive platform, designed to maintain the ephemerides accuracy of the Ariel targets. Ariel is ESA's medium class space mission prepared for launch in 2028. The main aim of the mission is to characterise a large number of exoplanets to better understand their nature. ExoClock aims to provide transit mid-time predictions for Ariel by collecting all currently available data (literature observations, observations conducted for other purposes, both from ground and space) and by efficiently planning dedicated efforts to follow-up the riel targets. ExoClock is open to contributions from a variety of audiences professional, amateur and industry partners aiming to make the best use of all available resources towards delivering a verified list of ephemerides for the Ariel targets before the launch of the mission. In this presentation strategies, tools and the current status of the ExoClock project will be described in detail. In addition, the first results will be presented briefly.

Polarization power spectra and dust cloud morphology

Konstantinou Anna, Univ. of Crete & IA-FORTH

Abstract

In the context of Cosmic Microwave Backgrounds polarization studies and the characterization of its Galactic foregrounds, the power spectrum analysis of the thermal dust polarization sky has led to the intriguing evidence of an E/B asymmetry and a positive TE correlation. These observational facts were subject to theoretical and simulation-driven works that led to different interpretations. Relying on Virtual Reality simulation tools to generate dust clouds with realistic shapes and morphology we produced synthetic dust polarization maps and analyzed their power spectra. We unveiled several possible degeneracies that complicate the interpretation of polarization power spectra in terms of ISM physics.

I propose to discuss the main results of our analysis and their consequences for the interpretation of the power spectra deduced from Planck observations.

Authors: A. Konstantinou, V. Pelgrims, F. Fuchs, K. Tassis, 2021 in prep.

Multi-wavelength Study of Supernova Remnants

Kopsacheili Maria, Univ. of Crete & IA-FORTH Zezas Andreas (Univ. of Crete & IA-FORTH), Leonidaki Ioanna (Institute of Astrophysics - FORTH), Boumis Panos (National Observatory of Athens / IAASARS)

Abstract

Studies of supernova remnants (SNRs) in different galaxies provide a more representative picture of their populations and their dependence on their environment. This is particularly important for addressing the role of SNRs in feedback and metal enrichment in a wide variety of galactic environments. We present our results from a systematic study SNRs populations in a sample of nearby spiral galaxies (NGC 7793, NGC 55 ,NGC 45, NGC 1313). Based on deep narrow-band HΞ± and [S II] images, we find 97 candidate SNRs, 67 of which are new identifications. After accounting for incompleteness effects, we derive the HΞ± and the joint [S II]-HΞ± luminosity functions for the SNR populations in these galaxies. This selection-effect free method allows us to directly compare results between different galaxies. We also introduce the excitation function of SNRs, which describes the number density of objects as a function of their [S II]/HΞ± ratios. Prompted by the limitations of the standard [S II]/ HΞ± diagnostic tools we have developed new, 2D and 3D diagnostic tools for identifying SNRs based on combinations of optical emission-line ratios. Through the effective differentiation from H II regions, this diagnostic provides more complete samples of SNRs including those in later evolutionary phases with slower shocks which are not accounted for using the [SII]/HΞ± diagnostic. We also present theoretical models of populations of SNRs, setting a framework for a population synthesis model for SNRs, able to reproduce well the observed HΞ± and [S II]- HΞ± luminosity function. Such models will enable us to estimate the distribution of physical parameters of the SNR and link observations with feedback processes.

A new automated tool for the spectral classification of OB stars

Kyritsis Elias, Univ. of Crete & IA-FORTH

Abstract

As more and more large spectroscopic surveys become available, an automated approach in spectral classification becomes necessary. Due to the importance of the massive stars it is of paramount importance to identify their phenomenological parameters (e.g., the spectral type) which can be used as proxies to their physical parameters (e.g mass, temperature).

In this work, we use the Random Forest (RF) algorithm to develop a tool for the automated spectral classification of the OB-type stars according to their sub-types. We use the regular RF algorithm, the Probabilistic RF (PRF) which is an extension of RF that incorporates uncertainties, and we introduce the KDE - RF method which is a combination of the Kernel-Density Estimation and the RF algorithm. We train the algorithms on the Equivalent Width (EW) of characteristic absorption lines measured in the spectra from large Galactic (LAMOST, GOSSS) and extragalactic surveys (2dF, VFTS) with available spectral-type classification. By following an adaptive binning approach we group the labels of these data on 11 sub-types within the range O3-B9. We examined which of the characteristic spectral lines (features) are more important to use based on a number of feature selection methods and we searched for the optimal hyper-parameters of the classifiers, to achieve the best performance.

From the feature screening process we find 13 spectral lines as the optimal number of features. We find that the overall accuracy score is better than ~ 75 % with similar results across all approaches. We apply our model in other observational data sets providing examples of potential application of our classifier on real science cases. We find that it performs well for both single massive stars and for the companion massive stars in Be X-ray Binaries, especially for data with S/N in the range 50-300. Furthermore, we present an alternative model for lower quality data S/N < 25 based on a reduced feature-set classification scheme, including only the strongest spectral lines.

The similarity in the performances of our models indicates the robustness and the reliability of the RF algorithm when used for spectral classification of early-type stars. This is strengthened also by the fact that we are working with real-world data and not with simulations. In addition, the approach presented in this work, is very fast and applicable to products from different surveys in terms of quality (e.g different resolutions) and of different format (e.g., absolute or normalized flux).

Progenitors of Red novae

Lalounta Eleni, University of Patras Papageorgiou Athanasios (DepartmentΒ ofΒ Physics,Β UniversityΒ ofΒ Patras,Β Greece), Christopoulou Panagiota-Eleftheria (DepartmentΒ ofΒ Physics,Β UniversityΒ ofΒ Patras,Β Greece), Catelan MΓ΅rcio (Pontificia Universidad CatΓ³lica de Chile, Santiago, Chil

Abstract

Little is known about red novae but they are thought to be the result of the merger of overcontact binary systems with mass ratio q β‰¤ 0.25. Theoretical models predict that a contact binary system will merge around q ~ 0.07β€“0.09 or even 0.05. The case of Nova Sco 2008 is the observational evidence that confirms this theory where archival data revealed the precursor was the contact binary system V1309 Scorpii. It is clear that these Low Mass Ratio systems (LMR) could play an important role in our understanding of stellar evolution and help us not only to refine the current theoretical models but also to identify precursors of mergers (FK Com-type stars and blue stragglers). In this talk, I will present the results of the photometric analysis of 30 newly discovered totally eclipsed LMR (0.07β‰¤qβ‰¤0.22) overcontact binary systems from Catalina Sky Survey with PHOEBE-0.31a program and give out their absolute parameters based on their well established GAIA distance. In addition, I will discuss the concept of instability criteria and period variation that can be used to test the merging hypothesis. Finally, I will briefly present preliminary results of the survey of selected LMRs observed with Aristarchos 2.3 m telescope.

Investigating the evolutionary paths of Supernova Remnants through their multi-wavelength emission

Leonidaki Ioanna, Institute of Astrophysics - FORTH Zezas Andreas (IA/FORTH & University of Crete), Kopsacheili Maria (IA/FORTH & University of Crete), Anastasopoulou Konstantina (Observatorio Astronomico di Brera / INAF)

Abstract

According to baseline models, the evolution of a Supernova Remnant (SNR) assumes (spherical) propagation in a uniform Interstellar medium (ISM) and consists of four-stages: (1) free expansion, (2) adiabatic (Sedov-Taylor) phase, (3) radiative phase, and (4) dissipation. Each of these phases has its own signature at different wavebands: For example it is expected young SNRs to emit strongly in the X-rays with almost undetectable optical emission or more evolved SNRs to be strong optical emitters with faded out X-ray emission. In reality, SNR evolution is more complex than previously described since ISM not only is hardly uniform but it spans a wide range of conditions. Models predict strong dependence of the SNR properties (e.g. multi-Ξ» emission, luminosity, temperature) on the parameters (e.g. density) of their surrounding ISM.
In order to investigate the evolution of SNRs, their physical parameters and their interplay with the environment, we have embarked in a multi-wavelength study of SNRs in our Galaxy. The proximity of Galactic SNRs allows us to probe their structure, physical properties and interaction with their ambient medium in great detail. From the ~300 (radio) known Galactic SNRs, we initiated investigating all Northern, X-ray-emitting SNRs with angular diameter < 10' (~30 objects), comprising deep narrow band HΞ±, [S II], [OIII] and HΞ² images performed with the 1.3m telescope at Skinakas Observatory (Crete), and radio/X-ray archival data.
In this talk, I will present the striking results of this pilot study, addressing the following topics: 1) the correlation of multi-wavelength emission in SNRs, 2) the age dependence of SNRs on their multi-wavelength luminosities and, 3) their excitation parameters vs X-ray emission. Furthermore, these results are also compared with (the parameters of) SNRs in the Magellanic Clouds, two galaxies close enough to provide spatially resolved nebulae in different from our Milky Way environments.

The EngAstros project: Enhanced modelling and Asteroseismology of δ-Scuti stars in close binary systems

Liakos Alexios, National Observatory of Athens/IAASARS Niarchos Panagiotis (Section of AAM/UoA), Boumis Panayotis (IAASARS/NOA), Gazeas Kosmas (Section of AAM/UoA), Hatzidimitriou Despina (Section of AAM/UoA), Mkrtichian David (NARIT), Moriarty David J. W. (School of Mathematics and Physics, UQ), Ulas Burak

Abstract

This work concerns the early announcement of the international project entitled "EngAstros". The project focuses on pulsating stars of δ-Scuti type (Ξ´S), which are multi-periodic and short-period pulsators exhibiting both radial and non-radial

oscillation modes. Particularly, we aim to study the Ξ′S-members of close binary systems, in order to use the interaction between the components as the utmost tool for the accurate calculation of their physical parameters. The latter will further allow for an in depth study of the oscillation properties and the evolutionary stages of Ξ′S. A sample of this kind of systems will be gathered mostly using the online and publicly available photometric databases of space telescopes missions (Kepler, K2, TESS). For particular systems of interest, spectroscopic observations will be undertaken to determine spectral types and radial velocities of the components. Spectroscopy and photometry will provide the means for the determination of the physical parameters of the Ξ′S and their comparison with evolutionary models. Furthermore, Fourier analyses of light curves will provide information on the oscillation frequencies and modes of the pulsating components. All the aforementioned analyses, especially when combined with the eclipse timing variation analysis, provide a holistic view of the system and specifically of the mechanisms that affect the pulsation properties of Ξ′S (e.g. proximity, mass transfer). The final goal of this project concerns the combination of the selected systems with all the known similar cases and the establishment of the most complete and coherent catalogue, including the properties of the Ξ′S according to the proximity of their components.

Studying evolved massive stars in nearby galaxies using a photometric machine-learning classifier

Maravelias Grigoris, IAASARS-NOA & IA-FORTH Bonanos Alceste Z. (IAASARS-NOA), Tramper Frank (IAASARS-NOA), de Wit Stephan (IAASARS-NOA), Yang Ming (IAASARS-NOA), Bonfini Paolo (IA-FORTH, CSD-UoC)

Abstract

Massive stars have a key role in the evolution of their host galaxies. Through their mass loss they transfer energy and momentum to the interstellar medium, while they enhance the galactic environment with a series of elements produced both at their cores and during their supernova explosions. Although mass loss is so important, we still lack a deep understanding of its processes and impact in the evolution of the massive stars. Therefore, discrepancies between theory and observations still hold. One main manifestation of mass loss is through episodes of intense activity, in certain phases of evolved massive star phases. Currently, this type is not included in the models while its importance of its role in the evolution is undetermined. A major hindrance to determining the role of episodic mass loss is the lack of large samples of classified stars. Given the recent availability of extensive photometric catalogs from various surveys spanning a range of metallicity environments, we aim to remedy the situation by applying machine learning techniques to these catalogs. We compiled a large catalog of known massive stars in M31 and M33, using IR (Spitzer) and optical (Pan-STARRS) photometry, as well as Gaia astrometric information. We grouped them in 7 classes (Blue, Red, Yellow, B[e] supergiants, LuminousBlue Variables, Wolf-Rayet, and outliers, e.g. QSO's and background galaxies). Using this catalog as a training set, we built an ensemble classifier utilizing color indices as features. The probabilities from three machine-learning algorithms (Support Vector Classification, Random Forests, Neural Networks) are combined to obtain the final classifications. The overall performance of the classifier is ~86%. Highly populated (Red/Blue/Yellow Supergiants) and well-defined classes (B[e] Supergiants) have a high recovery rate between 73-98%. On the contrary, Wolf-Rayet sources are detected a ~20% while Luminous Blue Variables are

almost never recovered. This is mainly due to the small sample sizes of these classes. In addition, the mixing of spectral types, as there are no strict boundaries in the features space (color indeces) between those classes, complicates the classification. In an independent application of the classifier to other galaxies (IC 1613, WLM, Sextans A) we obtained an overall accuracy of ~74% despite the missing values on their features (which we replaced by averaging values from the training sample). This approach results only in a few percent difference, with the remaining discrepancy mainly attributed to the different metallicity and extinction effects of their host galaxies. Given these results we proceeded further to apply our classifier in a large catalogs of sources of nearby galaxies without prior spectral classification. We present our, preliminary, findings on the numbers of different massive star classes in the context of the different metallicity for those galaxies.

Compressibility of the Jovian magnetosphere

Millas Dimitrios, UCL

Abstract

The magnetospheres of giant planets, such as Jupiter and Saturn, are a unique type of space laboratories for magnetized plasma. Their rapid rotation, composition and size result in major differences compared to the terrestrial magnetosphere, the most prominent being the presence of a disc-type magnetic structure. Each magnetosphere responds to external or internal drivers; the most important external driver is the solar activity. The response of the magnetosphere is quantified by the compressibility index, calculated from the magnetopause radius as a function of the total pressure.

We present results of a numerical study of the compressibility of the Jovian magnetosphere, using first an numerical implementation of Caudal's iterative scheme to create an axisymmetric magnetodisc structure. A large ensemble of models is produced and treated as virtual observations (or "crossings"). The models are created using a different system size (parametrized by the magnetopause distance) and hot plasma content (parametrized by the hot plasma index) for each case. We evaluate methods of different order to obtain the compressibility index and discuss the effects of the system size. We compare the results with observations of the Jovian magnetosphere and with similar studies focused on the magnetosphere of Saturn.

A complementary step of our work is the implementation of an angular velocity correction algorithm (Pontius scheme), using the equatorial magnetodisc structure in a consistent way and examine the major differences with a simple dipole model.

Galactic spurs of synchrotron emission: new distance constraints

Panopoulou Georgia, Caltech

Abstract

Galactic synchrotron emission exhibits large-angular-scale features known as radio spurs.

Determining the physical size of these structures is important for modeling the Galactic magnetic field. However, the distance to most of these structures is either debated or entirely unknown. We revisit a classical method of finding the location of radio spurs by comparing optical polarization angles with those of synchrotron emission as a function of distance. We are able to constrain the estimates of the distance to two radio structures: Loops I and IV. We find that at high Galactic latitude, the polarized synchrotron emission of Loop I arises at 100 pc. This is consistent with the conclusions of earlier work based on stellar polarization and extinction, but in stark contrast with what has recently been claimed based on X-ray data from e-ROSITA. We provide the

first distance measurement towards Loop IV, at 400 pc, and find strong evidence that the synchrotron emission of Loop IV arises from chance alignment of structures located at different distances. Future optical polarization surveys will allow to expand this analysis to other radio spurs.

Mineralogy of interstellar dust: What can we learn from the X-rays?

Psaradaki Ioanna, University of Michigan

Abstract

Understanding the chemistry of the interstellar medium (ISM) is fundamental for the comprehension of the Galaxy evolution. Some of the refractory interstellar elements, such as Si, Mg and Fe, are known to be locked up into dust grains. Iron is known to be highly depleted from the gas phase into solids, but the exact composition of the iron-bearing grains is not yet well understood. Oxygen is one of the most abundant elements in the Galaxy and important for life on Earth. Nevertheless, the exact reservoirs of oxygen in different interstellar environments still remain an open question.

The X-ray energy band includes a plethora of transitions from atomic and solid species of elements from carbon to nickel. X-ray radiation from astronomical X-ray sources can be absorbed by atoms and solids in the ISM, producing distinct absorption features. In particular, the so-called X-ray absorption fine structures (XAFS) are features of dust observed near the corresponding photoelectric absorption edges. By studying these features, we can investigate the dust chemical composition, crystallinity and grain size in different density environments of the ISM.

To study the XAFS we need up-to-date dust models. In this talk, I will discuss our group effort to build a global X-ray dust extinction model based on laboratory experiments. Here, I will focus on the atomic and solid phase features of the ISM observed near the photoelectric edges of oxygen and iron. I will present recent results on dust mineralogy using our new calculated dust models and their application to the high-resolution X-ray absorption spectra of bright background sources. In this study we use the XMM-Newton and Chandra satellites but I will also discuss the prospects of studying the dust with future X-ray missions, such as Athena and XRISM.

The growth of super-Earths: the importance of a self-consistent treatment of disc structures and pebble accretion

Savvidou Sofia, MPIA, Heidelberg Bitsch Bertram (MPIA, Heidelberg)

Abstract

The conditions in the protoplanetary disc are determinant for the various planet formation mechanisms. We present a framework which combines self-consistent disc structures with the calculations of the growth rates of planetary embryos via pebble accretion, in order to study the formation of Super-Earths. We first perform 2D hydrodynamical simulations of the inner discs, considering a grain size distribution with multiple chemical species and their corresponding size and composition dependent opacities. The resulting aspect ratios are almost constant with orbital distance, resulting in radially constant pebble isolation masses, the mass where pebble accretion stops. This supports the "peas-in-a-pod" constraint from the Kepler observations. The derived pebble sizes are used to calculate the growth rates of planetary embryos via pebble accretion. Discs with low levels of turbulence (expressed through the Ξ±-viscosity) and/or high dust fragmentation velocities allow larger particles, hence lead to smaller pebble isolation masses, and the contrary. At the same time, small pebble sizes lead to low accretion rates. We find that there is a trade-off

between the pebble isolation mass and the growth timescale with the best set of parameters being an α-viscosity of 10^{-3} and a dust fragmentation velocity of 10 m/s, mainly for an initial gas surface density (at 1 AU) greater than 1000 g/cm^2. A self-consistent treatment between the disc structures and the pebble sizes is thus of crucial importance for planet formation simulations.

High-accuracy estimation of magnetic field strength in the interstellar medium from dust polarization

Skalidis Raphael, Univ. of Crete & IA-FORTH

Abstract

Dust polarization is used to probe the magnetic field properties in the interstellar medium (ISM), but it does not provide a direct measurement of its strength. Various methods have been developed employing dust polarization and spectroscopic data in order to infer the magnetic field strength. All of these methods rely on the assumption that the observed linewidths of the emission spectra and the spread in the distribution of the polarization angle is due to the propagation of Alfven waves. Observations, however, indicate that non- Alfvenic (compressible) waves may be important in the ISM kinematics. With simple energetics arguments we developed a new method which takes into account the compressible modes. We created synthetic observations from 3D MHD turbulent simulations in order to assess the accuracy of our method. For comparison, we applied two of the most widely accepted past methods, which are solely based on Alfvenic modes. The omission of compressible modes highly affects these methods, which in some cases produced estimates which deviated more than a factor of two from the true magnetic field strength. In contrast our proposed method produced estimates with a mean relative deviation from the true value equal to 17%. Our method achieved a uniformly low error in the estimation of the magnetic field strength independently of the turbulent properties of the medium.

Linking the properties of accreting white dwarfs with the ionization state of their ambient medium

Souropanis Dimitris, Univ. of Athens & National Observatory of Athens Chiotellis Alexandros (IAASARS, National Observatory of Athens, 15236 Penteli, Greece), Boumis Panos (IAASARS, National Observatory of Athens, 15236 Penteli, Greece), Akras Stavros (IAASARS, National Observatory of Athens, 15236 Penteli, Greece), Chatziko

Abstract

Steadily nuclear burning white dwarfs, members of interacting binaries, have been associated with several astrophysical objects and phenomena such as the Supersoft X-ray sources (SSSs) and the Type Ia Supernovae (SNe Ia). If accreting WDs are embedded in adequately dense ambient medium, extended and luminous nebulae will be formed by the WDs ionizing activity. These nebulae should persist long after the SNe Ia explosion. Nevertheless, searches for relic ionized nebulae around nearby SSSs, SNe Ia and supernova remnants (SNRs Ia) resulted to no detection, except for one case, this of the SSS CAL 83. In this study, we model the ionization and emission properties of the ambient medium around accreting WDs by coupling known WD hydrogen and helium accretion models of the literature with radiation transfer numerical techniques. We investigate the ionization structure of these nebulae, as well as the expected optical line luminosities and surface brightness profiles as a function of the WD mass and the accretion rate covering the whole parametric space of hydrogen and helium steadily nuclear burning accreting WDs. Subsequently, we compare our results with relevant

constrains on the accreting WD's ionizing flux imposed by the observations of several SSSs and SNRs Ia. The severe discrepancies extracted by this comparison rule out any steadily accreting WD model as a potential progenitor of these remnants and in addition requires the ambient medium around the SSSs to be tenuous and lower than 0.2 cm^{-3}. Finally, we discuss possible alternatives that could raise the irreconcilability between the theoretical expectations and the relevant observables we receive from accreting WDs and related systems.

Discovery of an optical cocoon tail behind the post-AGB HD 185806

Spetsieri Zoi-Tzogia, IAASARS, National Observatory of Athens Spetsieri Zoi Tzogia (IAASARS, National Observatory of Athens, Greece), Boumis Panayiotis (IAASARS, National Observatory of Athens, Greece), Chiotellis Alexandros (IAASARS, National Observatory of Athens, Greece), Akras Stavros (IAASARS, National Observat

Abstract

Bow shaped circumstellar structures are formed around supersonically moving stars through the interaction between the stellar wind and the surrounding ambient medium. The formed bow shocks consist excellent celestial labs as they provide crucial information relevant to properties of the local interstellar medium and the mass loss history of the parent stellar system. Bow shocks surrounding AGB stars and red supergiants are mainly identified in the infrared and rarely in the optical wavelengths. In this work, we present the first optical identification of a shell-like bow shock with a cocoon surrounding the source HD 185806 in the optical wavelengths. The same shell structure also appears in WISE images, especially at 22Ξ'Om. Our goals were to study the morpho-kinematic properties of the shock nebulae and explain its morphology providing insights for future studies. We performed photometric and spectroscopic analysis of observations in the optical filters HΞ±, HΞ±+[N II] and [O III], where the interaction of the stellar wind with the ISM is mostly evident. We also used Gaia DR2 to estimate the distance radial velocity and transverse velocity of the source. Furthermore, we used MESA evolutionary tracks and models to estimate the age, mass, and the stellar wind properties of the star. We additionally used the software SHAPE to produce a 3D model of the bow shock nebulae surrounding the source. Through the employment of these tools, we link the current properties of the bow shaped circumstellar structure to the nature and evolution of its parent star.

Population Studies of exoplanets in the 2020s: Building on the legacy of HST

Tsiaras Angelos, UCL - CSED

Abstract

With the number of exoplanets increasing daily and with new facilities being built this decade, the field of exoplanets will be entering the era of atmospheric characterisation. In this effort, atmospheric population studies are the way forward in constraining which are the current conditions on these planets, how did they form, and how did they evolve. One of the most successful instruments for observing exoplanetary atmospheres is the Wide Field Camera 3 (WFC3) on-board the Hubble Space Telescope. In particular, the use of the spatial scanning technique has given the opportunity for even more efficient observations of the brightest targets, achieving the necessary precision of 10 to 100 ppm to the flux of the star.

Hubble has given us few of the most incredible results in the field so far, like the detection of water vapour in the atmosphere of the temperate planet K2-18b. However, the most impactful results from Hubble concern the largest population studies of exoplanetary atmosphere to date. In this presentation, I will discuss the key elements

that made the above-mentioned studies possible and how these elements need to be expanded in the era of JWST and Ariel. Moreover, I will discuss the capabilities of these new facilities and the how observations from them will answer some of the most important questions regarding the nature of exoplanets.

Magnetic field tomography in the interstellar medium using advanced statistical tools

Tsouros Alexandros, Univ. of Crete & IA-FORTH

Abstract

Polarization of starlight is caused by dichroic absorption from dust grains aligned with the magnetic field, and consequently it probes the magnetic field of the intervening clouds. Ξʻ single line of sight (LOS) generally penetrates multiple dust clouds each containing different magnetic field orientations, and so these dust clouds effectively act as polarizing screens for the observed starlight. Measurements of the Stokes Q and U parameters for stars that lie along a single LOS therefore contain essential information with regard to the number and location of those screens along that LOS, and so provides a promising method for probing the 3D structure of the magnetized interstellar medium (ISM). With the upcoming advent of the PASIPHAE stellar optopolarimetric survey, as well as the existence of stellar distance data from the Gaia mission, the question of how one can infer the number and positions of dust clouds along a single LOS by combining polarization and star position data becomes highly relevant. However, the problem of extracting this information is nontrivial, owing to the existence of observational noise which significantly reduces our ability to segment the data space, and hence extract the desired locations of the screens. For this reason, advanced statistical inference tools and methodologies are required. In this talk, we will present a variety of strategies that aim at addressing this inference problem, all revolving around the use of the Bayesian Blocks algorithm; a statistical tool that performs optimal segmentation analysis on sequential data.

To beam or not to beam? ULX pulsars hold the answer.

Vasilopoulos Georgios, Yale University

Abstract

A large number of X-ray binaries with luminosities that exceed 10B³β⍰'H erg/s have been discovered in nearby star-forming galaxies, these are referred to as ultraluminous X-ray sources (ULXs). The discovery of pulsations from ULXs demonstrated that stable accretion onto NSs at super-Eddington rate is possible. Following this discovery, it has been speculated that extreme radiation could cause most of the material to be expelled by outflows from the accretion disk, causing a narrow funnel that results in very strong beaming factors, thus making ULXPs visible only to observers that look down the barrel of the gun. Alternatively, it has been proposed that beaming is not really that high (i.e. less than factor of 2 enhancement), and that super-Eddington accretion rates onto the NS are a result of non-isotropic accretion and large magnetic fields.

We report on the temporal properties of the ULX pulsar M51 ULX-7 inferred from the analysis of the 2018-2020 Swift/XRT monitoring data and archival Chandra data obtained over a period of 33 days in 2012. We find an extended low flux state, which might be indicative of propeller transition, lending further support to the interpretation that the NS is rotating near equilibrium. Alternatively, this off state could be related to a variable super-orbital period.

Moreover, we report the discovery of periodic dips in the X-ray light curve that are associated with the binary orbital period. These characteristics are similar to those seen in prototypical X-ray pulsars like Her X-1 and SMC X-1 or other ULX pulsars. The presence of the dips implies a configuration where the orbital plane of the binary is closer to an edge on orientation, and thus demonstrates that favorable geometries are not necessary in order to observe ULX pulsars. A major consequence of this discovery is that the relation between mass accretion rate and beaming factor that is typically used for ULXPs based on non pulsating ULXs would need to be revisited in the context of pulsating sources.

The entry geometry and velocity of planetary debris into the Roche sphere of a white dwarf

Veras Dimitri, University of Warwick Georgakarakos Nikolaos (New York University Abu Dhabi), Mustill Alexander (Lund Observatory), Malamud Uri (Technion Haifa), Cunningham Tim (Warwick University), Dobbs-Dixon Ian (New York University Abu Dhabi)

Abstract

Our knowledge of white dwarf planetary systems predominately arises from the region within a few Solar radii of the white dwarfs, where minor planets break up, form rings and discs, and accrete onto the star. The entry location, angle and speed into this Roche sphere has rarely been explored but crucially determines the initial geometry of the debris, accretion rates onto the photosphere, and ultimately the composition of the minor planet. Here we evolve a total of over 100,000 asteroids with single-planet N-body simulations across the giant branch and white dwarf stellar evolution phases to quantify the geometry of asteroid injection into the white dwarf Roche sphere as a function of planetary mass and eccentricity. We find that lower planetary masses increase the extent of anisotropic injection and decrease the probability of head-on (normal to the Roche sphere) encounters. Our results suggest that one can use dynamical activity within the Roche sphere to make inferences about the hidden architectures of these planetary systems.

Evolved Massive Stars in the Magellanic Clouds

Yang Ming, National Observatory of Athens/IAASARS

Abstract

We present two multiwavelength source catalogs for the Large and Small Magellanic Clouds (LMC and SMC), respectively. The catalogs were built by crossmatching and deblending between the SEIP source list and Gaia DR2. Under strict constraints on the Gaia astrometric solution, which resulted in about 99.5% of the targets estimated to be genuine members of the MCs. The catalogs contain 197,004 and 45,466 targets in over 50 bands (ranging from UV to IR) for the LMC and SMC, respectively. Additional information about radial velocities and classifications were collected from the literature. Using the MIST models, J-Ks color cuts, and empirical cuts, we identified and ranked more than 4300 RSG, 700 YSG, and 6100 BSG candidates in the MCs. The comparison of the CMDs between LMC and SMC indicates that the most distinct difference appears at the bright red end of the optical and NIR CMDs. A further quantitative comparison of colors of massive star candidates indicates that there is essentially no difference for the BSG candidates, but a large discrepancy for the RSG candidates, which may be due to the combined effect of metallicity on both spectral type and mass-loss rate (MLR) as well as the SFH and age. Moreover, a comparison between the models and data shows that the lower limit of initial mass for the RSG population

may be as low as 7 or even 6 M_sun. After removing the foreground contamination, the RSG population is well separated from the AGB population even at faint magnitude.

By using a most comprehensive RSG sample (1,239 secure RSG candidates) for the SMC up to now, we estimate that there are in total ~1800 or more RSGs in the SMC. The investigation of color-color diagrams shows that there are fewer RSGs candidates (~4%) showing PAH emission features compared to the Milky Way and LMC (~15%). The degeneracy of MLR, variability, and luminosity of the RSG sample is discussed, indicating that most of the targets with high variability are also the bright ones with high MLR. Some targets show excessive dust emission, which may be related to previous episodic mass loss events. The total dust budget produced by entire RSG population is estimated as ~1.9×10^{-6} M_sun/yr in the most conservative case, based on the MLR derived from IRAC1-IRAC4 color. The Geneva evolutionary model is compared with our RSG sample at SMC metallicity, showing a good agreement.

Binary population synthesis with POSYDON: a next-generation code that employs detailed stellar structure and binary evolution calculations

Zapartas Manos, University of Geneva

Abstract

It is now established that most massive stars are members of a binary or a higher-order stellar systems, and more often than not, the presence of a binary companion decisively alters their evolution via binary interaction processes such as tides, mass-transfer, and stellar mergers. Interacting binaries are arguably the most important astrophysical laboratories available for the study of compact objects. Accretion of matter from a binary companion gives rise to X-ray emission, while gravitational waves emitted from coalescing binary compact objects allow us to witness the last few seconds of their lives. While some aspects of the astrophysics of these binaries can be obtained from observations and modeling of present-day properties of individual, well-studied systems, more comprehensive insight requires understanding their astrophysical origin, population properties, evolutionary links to other stellar systems, and interplay with their environments. In this direction, binary population synthesis modeling has been shown to be a valuable tool.

In this talk, I will present POSYDON, a next-generation binary population synthesis code incorporating full stellar structure and binary evolution modeling, using the MESA code, throughout the whole evolution of binaries. This allows POSYDON to employ self-consistent treatments of physical processes in stellar and binary evolution, including: (i) realistic mass-transfer calculations and physical assessment of stability, (ii) internal angular momentum transport and spin-orbit coupling for asynchronous binaries due to tides and mass-transfer, (iii) core sizes and central and surface abundances that are calculated taking into account the effects of binary interactions (iv) compact object masses and spins that are based on the structure of stellar models that are products of self-consistent binary evolution modelling.

With POSYDON we aim at addressing many of the limitations of traditional, parametric binary population synthesis codes, while at the same time maintaining much of their flexibility and making transparent to the user the complexity and computational cost of detailed stellar structure and binary evolution calculations. To achieve this, POSYDON (i) includes a structural “flow” to quickly evolve individual binaries using precalculated grids for some evolutionary phases and on-the-fly calculations for others, (ii) generates

synthetic binaries from birth which are then evolved through the "flow" to produce a target population, (iii) employs machine learning methods to interpolate between precalculated models, (iv) provides an easy-to-use infrastructure to run large grids of MESA binary models on HPC resources.

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POSTER CONTRIBUTIONS

Application of an Upwind Integration Method to Plane Parallel Hall-MHD

Chouliaras Georgios, University of St Andrews

Abstract

Observations of strongly magnetized neutron stars indicate that they host violent phenomena such as outbursts and flares. These violent phenomena are directly related to the evolution of the magnetic field in the crust driven by the Hall effect and Ohmic dissipation. The former leads to the development of non-linear shock waves. We study the impact of an Upwind scheme on the numerical convergence of simulations of the Hall and Ohmic effect in neutron stars crusts. We discretise the induction equation using a finite difference scheme and for the integration of the advective terms on the induction equation we use two different schemes a Forward Time and Central in Space (FTCS) and an Upwind scheme and we compare them in terms of accuracy and performance. We explore the impact of the Upwind method on convergence according to the ratio of planar to vertical field and the Hall parameter. In the limit of a low strength planar field the implementation of an Upwind scheme provides a vast improvement leading to the convergence of simulations where the Hall parameter is 2 orders of magnitude higher than that of the FTCS. Upwind is still better if the planar field is stronger, yet, the difference of the maximum value of the Hall parameter reached is within a factor of 10 or a few. We conclude that the implementation of Upwind scheme indeed enhances the efficiency of the simulations by achieving numerical convergence on higher Hall parameter values. Therefore, it provides us with the opportunity to explore enviroments with higher electrical conductivity getting us closer than before to realistic environmental conditions of magnetars.

White dwarfs in galactic open clusters: a test bed for mass loss in low mass stars

Christodoulou Evangelia, University of Athens

Abstract

Co-Authors
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White dwarfs (WDs) are the final stage of stellar evolution of low mass stars. The final masses of stars when they become WDs depend on details of stellar evolution and mass loss. They can also be affected by mass transfer in close binary systems.
Mass loss and its dependence on initial mass and metal abundance remains a significant uncertain parameter in our understanding of low mass stellar evolution.
The recent (December 2020) Gaia data release EDR3, provides a unique opportunity to set some observational constraints to mass loss recipes currently used in the most advanced stellar evolutionary models.
To this purpose we have identified WDs that are members of open clusters in the Galaxy, by applying criteria based on five parameters (coordinates, proper motions and parallax). We used the WD catalog of Gentile Fusillo et al. (2019) and the open cluster catalogue of Cantat-Gaudin et al. (2018a).
For each star cluster we constructed the corresponding colour-magnitude diagram of stellar members and WD members and overlayed the stellar isochrone best fitting the stars (we used the most recent PARSEC evolutionary tracks) and the H- and He- WD

cooling sequences from http://www.astro.umontreal.ca/~bergeron/CoolingModels (reference papers: Holberg & Bergeron (2006); Kowalski & Saumon (2006); Tremblay, Bergeron, & Gianninas (2011); Bergeron et al. (2011); Blouin et al. (2018); Bédard et al. (2020)). Knowing the age of the cluster and the time a WD has spent on the cooling sequence, as well as the terminal masses provided by the stellar evolutionary models and the masses derived from the WD cooling sequences, we can inspect the validity of the mass loss recipes, over a range of masses (the clusters used have ages ranging from a few tens to a few hundreds of million years) and a range of metal abundances (Z=0.009 to 0.05). We present here preliminary results from this study.

Starquakes on the red dwarf UV Ceti

Contadakis Michael, University of Thessaloniki Avgolpoupis Stavros, J (2Session of Astronomy, Astrophysics and Mechanics, Department of Physics, Scool of Sciences, Aristotle University of Thessaloniki, GR-54124, Thessaloniki Greece), +Seiradakis2 John-Hugh (2Session of Astronomy, Astrophysics and Mech

Abstract

In this paper we present some evidence concerning the observation of star quakes on UV Ceti.UV Ceti has been subjected of extending research for many decades at the Stefanion Observatory. Apart of the spectacular flaring phenomena, the results of the analysis of the one colour (B) observations of the Stefanion Observatory at any stage of their activity (quiescence, weak flares, strong flares),indicate that: (1) Transient high frequency oscillations occur during the flare event and during the quiet-star phase as well; (2) The Observed frequencies range between 0.0005Hz (period 33min) and 0.3 Hz (period 3s) not rigorously bounded. It is interesting that transient oscillations appear also far apart from the observed flares, during the quiet state of the stars, as a result of the general magnetic activity of the star. The power spectrum of these oscillations resemples that of the solar like oscillation spectra i.e the sunquake spectra. In particular the starquake spectra of UV Cet resemples that of a red subgiant.
Keywords: Flare stars-Discrete Fourier Transform an alysis -Brownian Walk noise

Testing model predictions for the occurrence of carbon stars, as a function of age and metallicity, using Gaia EDR3 data

Hatzidimitriou Despina, National and Kapodistrian University of Athens

Abstract

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Carbon Stars (CS) are asymptotic giants with atmospheric C/O ratios larger than 1 , believed to emerge during the β€third dredge upβ€. CS are considered to belong to a rather broadly defined intermediate age population and are often used as tracers of such populations in nearby galaxies. Theoretical models have predicted the ratio of to stars (for the latter,), in simple populations, as a function of age and metallicity. The

Milky Way star cluster population offers a unique opportunity to validate these models over a significant part of the parameter space.
The aim of the present project is to construct as complete a catalogue as possible of carbon stars with known ages and metallicities in the Milky Way. This can be achieved by identifying carbon stars that belong to open clusters, for which we know these parameters. We have used the most complete catalogues of carbon stars and open clusters available to date and have identified star clusters that possess carbon stars, by demanding that there is an undeniable spatial (in coordinates and parallaxes) and kinematic (proper motions) correlation between the carbon star and the star cluster members. In addition, the carbon star needs to lie on the Asymptotic Giant Branch of the host cluster. The significant improvement of proper motions and parallaxes in Gaia EDR3 has a significant impact on cluster membership determination and improves the validity of the association of a CS with a star cluster. We found about 15 clusters with at least one CS member. Although the sample is small, it is important that several CS seem to have ages and metallicities in regions of the theoretical log(age) versus metallicity diagram where the predicted C/M ratio is rather low.

Optical investigation of the Supernova Remnants IC 443 and G 65.3+5.7

Koukouli Ismini, NTUA/SAMP & NOA/IAASARS Boumis Panos (National Observatory of Athens, IAASARS), Derlopa Sophia (National Observatory of Athens, IAASARS, NKUA/Dept. Physics), Chiotellis Alexandros (National Observatory of Athens, IAASARS), Akras Stavros (National Observatory of Athens, IAASARS)

Abstract

Supernova remnants (SNRs) are objects created after the supernova explosion of massive stars (M > 8 Mβ¨€), as well as, in close binary systems with one or two white dwarfs, and they are of high importance since through this mechanism a major amount of energy is provided to the interstellar medium (ISM). In this work, we present a sample of high-resolution images from the evolved SNRs IC 443 and G 65.3+5.7, taken with the 2.3m Aristarchos telescope. Both SNRs present complex filamentary structures in the light of HΞ±+[N II] and [O III], which coincide with emission in other wavelengths. Taking into account our results, we investigate the SNRs physical properties and their interplay with their environment.

Modelling the gamma-ray periodic emission related to SS 433

Koutsoumpou Evgenia, University of Athens Mastichiadis Apostolos (University of Athens)

Abstract

A periodic emission of gamma rays has been recently observed by the Fermi Telescope from SS 433. This is the archetypal micro-quasar, i.e. a peculiar X-ray binary system consisting of an A-type star, a compact object (black hole or neutron star) and precessing relativistic jets, all embedded in the supernova remnant W50. The gamma-ray periodic signal, however, does not come from the central compact object or from the jets but coincides spatially with the cloud Fermi J1913+0515 which is at a distance of ~36pc from the center. Interestingly enough, the period of the gamma-ray emission is ~160d while the precession period of the jets is ~162.5d, opening up the possibility that the two phenomena are interconnected. In the present work we study such a scenario: We assume that relativistic particles are emitted from the central region with a period of ~162.5d and study the diffusion-advection equation in order to determine those parameters which allow particles to retain their initial periodicity when they

reach the emission site. Furthermore, we examine the possible physical mechanisms responsible for producing the observed GeV radiation.

Bouncing against the Yellow Void - the case of rho Cas

Maravelias Grigoris, IAASARS-NOA & IA-FORTH

Abstract

Massive stars are rare but of paramount importance for the formation and the element enhancement of their immediate environment and host galaxies. They lose mass from their birth through strong stellar winds up to their spectacular end of their lives as supernovae. This continuous mass loss changes as they evolve and in some phases it becomes episodic or displays outburst activity. One such phase is the Yellow hypergiants. Due to their pulsations and atmosphere instabilities when approaching a specific region in the Hertzsprung-Russel Diagram (11000- 7000 K, the Yellow Void) they experience outbursts. These are depicted in photometry as a decrease in their apparent magnitude. The latest most pronounced such event for Rho- Cassiopeia (Cas) was recorded in 2013. Rho-Cas is a very bright (V~4.6 mag) and well known star, for which an extremely large database of photometric observations exists. Using data acquired from the American Association of Variable Stars Observers and the British Astronomical Association we studied the 2013 outburst through visual estimates and digital observations. Their individual light curves are almost identical that highlights the accuracy of visual observations, making them valuable even today. The 2013 outburst was shallower and shorter than the previous outburst in 2000. This motivated us to further investigate other events as recorded through visual estimates, since they have proven to be consistent with digital observations and they offer the most homogeneous dataset. By fitting the profiles of all outbursts we noticed a decreasing trend in their duration and periodicity. This is a possible indication that Rho- Cas is bouncing against the Yellow Void and preparing to pass to the next evolutionary phase.

Title: Deciphering the large cometary structure around the Planetary Nebula A66 6

Nikopoulos Giorgos Panagiotis, NTUA & National Observatory of Athens Dr. Boumis Panos (National Observatory of Athens / IAASARS), Dr. Chiotellis Alexandros (National Observatory of Athens / IAASARS), Dr. Akras Stavros (National Observatory of Athens / IAASARS)

Abstract

Planetary Nebulae (PNe) are formed when low/intermediate mass stars (M=1-8Msun) can no longer sustain themselves through nuclear fusion reactions in their core. During the asymptotic giant branch (AGB) phase, they eject most of their exteriors in the form of a strong stellar wind. The following contraction of the AGB core toward the formation of a White Dwarf, triggers a fast stellar wind that sweeps the previously ejected, slower moving and denser material, shaping the final morphology of PNe. A number of PNe reveal the morphology of a bow-shaped halo, formed due to the systemic motion of their progenitor star. In this study, we observe and analyze the bow-shaped shell and the long collimated tail of the PN A66 6, using deep, high resolution narrow band HΞ±+[N II] and [O III] images taken from the 2.3m Aristarchos telescope. We also discuss possible evolutionary paths that led to the current morphology and properties of A66-6.

Force-free axisymmetric twisted magnetar magnetospheres

Ntotsikas Dimitrios, University of Patras Kampylis Georgios (University of Patras), Gourgouliatos Konstantinos-Nektarios (Assistant Professor, Department of Physics / University of Patras)

Abstract

Magnetar magnetospheres are believed to be strongly twisted due to shearing of the stellar crust by internal magnetic stresses. For a twisted magnetic field, lines tend to inflate in the radial direction.We study the problem of a force-free, twisted, relativistic magnetosphere, following the same procedure as in force-free axisymmetric pulsars, using the method of simultaneous relaxation for the magnetic field inside and outside the light-cylinder. We allow only the field lines within the closed region to be twisted, as the ones crossing the light-cylinder extend to infinity. Applying linear and non-linear solutions we notice that by increasing the twist a larger fraction of the magnetic field lines tend to cross the light cylinder resulting in them becoming open,thus reinforcing the issue of large polar caps, which may correspond to the hot spot during outburst. Finally, based on the above we are able to make calculations for the angular shear for a variety of linear and non-linear solutions and by using the spin-down formula of Contopoulos and Spitkovsky (2006) we evaluate the loss of electromagnetic energy and the resulting spin-down rate of an aligned rotator in force-free conditions.

A large scale survey for exoplanets with TTVs

Poultourtzidis Efthymios, University of Thessaloniki

Abstract

ExolClock (exoclock.space) is a project to observe transiting exoplanets, to keep their ephemerides updated. The last ExoClock publication includes more than 1600 observations of 180 planets. The database includes also 2500 mid-time points from the literature. These data points in combination with the ExoClock observations compose a large dataset of individual transits. Searching for transit time variations (TTVs) in individual planets is more common but searching for TTVs in large datasets can provide us with a better understanding of the nature of the planets. Studies of TTVs can give us more detailed and consistent explanations on how they occur. Furthermore, they can help us finding out more information about their corresponding planets and stellar systems in order to better characterize them. We run a new analysis in this dataset, to search for TTVs in individual planets to verify the already known ones. In conclusion, we look for patterns in ttvs and in the O-C diagram with respect to other properties of the planets, like distance from the parent star, period, stellar coordinates and proper motion. In this study, we present a list of more than 10 candidate planets with TTVs. We plan to continue monitoring these through the ExoClock project to better understand their nature.

High energy particle emission from twin relativistic jets

Smponias Theodoros, Mazarakis High School

Abstract

High energy particle emission from twin relativistic jets.

A pair of relativistic jets is simulated using the PLUTO hydrocode, and the results are saved to disk. Using this data, in-house software calculates directional emission of high energy particles, at each point. The angle between the local velocity and the line of sight is employed in the above calculation. Furthermore, with another program, a synthetic image is formed, with the option of employing time-delayed signal travel. Finally, the results are compared to observations.

Ages of Supernova Remnants and the Associated Pulsars

Tsichli Savina, University of Patras Achilleopoulos Georgios (undergraduate student), Konstantinou Lydia (undergraduate student), Gourgouliatos Konstantinos N. (Assistant Professor)

Abstract

Pulsar observations across different wavelenths have revealed a growing diversity of the properties of neutron stars, such as their magnetic field, spin-down ages and braking indices. The magneto-dipole model of neutron stars (NSs) postulates a braking index of n=3, and predicts ages that differ substantially from the ages evaluated with other methods. Here, we study the ages of a sample of 68 supenova remnants and we compare them against the spin-down ages of the associated neutron stars. We find that these ages are not in agreement and we explore the possible resolutions to this issue caused by changes in the strength of the magnetic field, the moment of inertia or an initial period of a few milliseconds.