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Plenary Talks

Public Outreach Talk

The first human journey to the Galaxy: the Odyssey of Voyager 1 and 2

Stamatios Krimigis
Academy of Athens

The first systematic step of mankind over the Earth's surface started with Wright brothers' flight in N. Carolina in 1903, which reached a few meters height. Fifty-four years later the first satellite, Sputnik, were launched outside the Earth's atmosphere, reaching a height of 946 km. Nowadays, we observed the transition of the first spacecraft beyond the solar atmosphere, on 25 August 2012, when Voyager 1 crossed the Milky Way boundary, at a distance of 18.2 km billions. In less than 110 years we have passed from a height of almost zero to a distance 122 times greater than the Earth-Sun distance. The speaker is the principal investigator at one of the 4 instruments on Voyager since the beginning of the mission; he will describe the epic journey of the spacecraft to the far edge of our Solar system.

Το πρώτο ανθρώπινο ταξίδι στον Γαλαξία: Η Οδύσσεια των διαστημοπλοίων Voyager 1 και 2

Σταμάτιος Κριμιζής
Ακαδημία Αθηνών

Το πρώτο συστηματικό βήμα της ανθρωπότητας πάνω από την επιφάνεια της Γής άρχισε με την πτήση των αδελφών Wright στην Β. Καρολίνα το 1903, και έφτασε σε ύψος λίγων μέτρων. Πενήντα-τέσσερα χρόνια αργότερα εκτοξεύθηκε ο πρώτος δορυφόρος, ο Σπούτνικ, έξω από την ατμόσφαιρα της Γής σε ύψος 946 χλμ. Στις ημέρες μας είδαμε το πέρασμα του πρώτου διαστημόπλοιου πέρα από τα όρια της Ηλιακής ατμόσφαιρας στις 25 Αυγούστου 2012, όταν το Voyager 1 ξεπέρασε το σύνορο με τον Γαλαξία σε απόσταση 18,2 δισεκατομμύρια χλμ. Δηλαδή σε λιγότερα από 110 χρόνια φτάσαμε από ύψος σχεδόν μηδέν σε μια απόσταση 122 φορές μεγαλύτερη από αυτήν μεταξύ του Ήλιου και της Γής. Ο ομιλητής είναι επικεφαλής ερευνητής ενός από τα 4 όργανα στο Voyager από την έναρξη της αποστολής και θα περιγράψει το επικό ταξίδι των διαστημοπλοίων στα άκρα του ηλιακού μας συστήματος.

"Best PhD Prize" Talk

Exploring the properties of leptohadronic plasmas: from theory to observations

Petropoulou Maria
Purdue University

Leptohadronic plasmas, i.e. magnetized plasmas consisting of relativistic electrons and protons/neutrons, are ubiquitous among non-thermal astrophysical sources, such as Active Galactic Nuclei (AGN) and Gamma Ray Bursts (GRBs) and they are certainly of relevance to the sites of the (unknown yet) sources of Ultra High Energy Cosmic Rays. The spectral and temporal behaviour of such plasmas can be quite complex due to the many different physical processes that couple protons, electrons and photons, making their study challenging. In fact, we discovered that leptohadronic plasmas may become very efficient photon and neutrino emitters, due to a nest of non-linear processes.
Based on the principles of this so-called "hadronic supercriticality"', we proposed a new mechanism for the prompt GRB emission, which accounts for several of the observed spectral and temporal features. Although the physical conditions in AGN jets do not favour the growth of this supercriticality, we showed that the presence of relativistic protons there has strong implications for the neutrino emission from these objects; these can now be tested against the recent neutrino observations of IceCube.

Highlight Talk by a Young Astronomer

Large jets from small-scale magnetic fields

Giannios Dimitrios
Purdue University

The recent observations of powerful, minute-timescale TeV flares from several blazars pose serious challenges to theoretical models for the blazar emission. In this talk, I will discuss the magnetic reconnection model for the blazar flaring. I argue that radiation emitted from the reconnection layers can account for the observed “envelope” of ~day-long blazar activity as well as the fastest observed flares. Moreover, I will show that the reconnection model predicts that the emission regions are characterized by rough equipartition between radiating particles and magnetic fields; in agreement with observations.
The magnetic reconnection in the jet may be result of small-scale magnetic fields imprinted to the jet flow from the central engine. I will present force-free simulations that demonstrate that large-scale jets can be produced by small-scale fields originating from the accretion disk. Accretion of the magnetized loops to the black hole can lead to strongly intermittent and powerful jets.

Plenary Talk 1

Rosetta: to catch a comet!

Mark J. McCaughrean
ESA

The European Space Agency's mission Rosetta captured the imagination of the world in 2014, as it rendezvoused with Comet 67P/Churyumov-Gerasimenko and deployed a lander, Philae, to its surface. In this talk I'll give a behind-the-scenes view of the mission, its history, its 10-year journey to reach the comet, and the exciting events that have been taking place there. I'll present some of the early results as scientists unlock this treasure chest of information about the formation of our solar system and the origins of water and perhaps even life on Earth. And finally, a look forward to the rest of the mission: the best is yet to come!

Plenary Talk 2

Cosmic galaxy evolution: strengths and weaknesses of an emerging new paradigm

Elbaz David
CEA Saclay

In recent years, exciting results have emerged on the formation history of galaxies. Deep extragalactic surveys, from Herschel in particular, have provided a clearer view on the growth of galaxies with cosmic time. A puzzling universality of galaxy evolution has emerged, despite the wide variety of morphologies, environments and merger histories of individual galaxies. At the same time, numerical simulations of galaxy formation have reached a new consensus on the role of diffuse gas accretion that seem qualitatively consistent with the universal evolution of galaxies. A new paradigm has emerged on the evolution of galaxies that are paradoxically the result of their large-scale environment and at the same time presenting little variation with environment (except in the extreme case of galaxy clusters). Quantitatively however, both observations and theory have become well enough constrained to present a tension that suggests that this emerging picture is missing a key ingredient: internal self-regulation of star-formation as well as external regulation processes seem to play a key role but remain elusive. I will present the current stare-of-the-art on how galaxies evolved through cosmic history and discuss the emerging tension between observations and theory, as well as possible solutions. I will focus in particular on the existence and interpretation of the so-called "star-formation main sequence" of galaxies that plays a central role in this new paradigm.

Plenary Talk 3

Formation and evolution of planetary systems: what is generic and what is special in the history of our Solar System?

Morbidelli Alessandro
CNRS/OCA

The observations of extrasolar planetary systems have shown that our Solar System is not typical. Most solar-type stars have one or more super-Earth planets on orbits with period shorter than a few hundred days. These kind of planets don't exist in the Solar System. Only ~ 15% of the stars have giant planets, and in most known cases the extrasolar giant planets have much shorter periods and more eccentric orbits that Jupiter and Saturn. How can we explain the difference between the Solar System and the other systems and the diversity among planetary systems in general? To answer this question we need to study the processes of planet formation and dynamical evolution as well as their complex interplay. Some aspects appear generic, other stochastic or even singular. I will review both, trying to outline a general picture of formation and evolution of planetary systems, with its possible numerous bifurcations. The Solar System appears to be a low-probability end-state of this general picture.

Plenary Talk 4

Ex Imago Mundi: The current scientific revolution from imaging exoplanets.

Kalas Paul
University of California, Berkeley

Direct imaging has now arrived as an effective observational method for discovering and characterizing extrasolar giant planets. A new generation of ground-based, high-performance adaptive optics systems has been successfully commissioned over the last year, and imaging surveys of hundreds of young, nearby stars are now underway. I will review the scientific questions that motivate direct imaging surveys, and describe some of the details concerning the Gemini Planet Imager. Our GPI survey of 600 nearby stars will last three years and has already yielded several new discoveries, some of which invoke new questions concerning the dynamical co-evolution of exoplanets and dusty debris disks.

Plenary Talk 5

Stellar structures in Extended Gravity

Salvatore Capozziello
Dipartimento di Fisica, Universita' di Napoli "Federico II"

We investigate the hydrostatic equilibrium of stellar structure by taking into account the modified Lane'-Emden equation coming out from Extended Theories of Gravity. Such an equation is obtained in metric approach by considering the Newtonian limit of f(R)-gravity, which gives rise to a modified Poisson equation, and then introducing a relation between pressure and density with polytropic index n. The modified equation results an integro-differential equation, which, in the limit of General Relativity becomes the standard Lane'-Emden equation. We find the radial profiles of gravitational potential by solving for some values of n. The comparison of solutions with those coming from General Relativity shows that they are compatible and physically relevant. This analysis gives rise to unstable modes not present in the standard Jeans analysis (derived assuming Newtonian gravity as weak filed limit of f(R)=R). In this perspective, we discuss several self-gravitating astrophysical systems whose dynamics could be fully addressed in the framework of f(R)-gravity.

Session 1: Heliophysics and the Solar System

Oral Presentations

Modeling populations of energetic particles in the radiation belts through data assimilation models using novel estimates of the radial diffusion coefficients

Th. Sarris
Democritus University of Thrace

In order to accurately approximate radial diffusion processes of relativistic electrons in the radiation belts, it is essential to obtain the Power Spectral Density (PSD) of Ultra-Low Frequency (ULF) waves as a function of L, and in particular the distribution of the PSD in the various azimuthal modes of the waves. These estimates can then be used to estimate the radial diffusion coefficients and to model the radiation belts more accurately through assimilative models. Using simultaneous measurements from GOES geosynchronous satellites, the THEMIS constellation of spacecraft and the Van Allen probes, we calculate the PSD of ULF pulsations at different L, through which we provide estimates of the diffusion coefficient due to compressional magnetic perturbations as a function of m, L and Kp. These results can have significant implications in better defining the regions where radial diffusion can be effective vs. the regions where it cannot account for the observed changes in the phase space density of relativistic electrons. Results for various storms and case studies are presented.

Modeling of plasma dynamics in the inner geospace during enhanced magnetospheric activity

Tsironis Christos
IAASARS, National Observatory of Athens
Anastasiadis Anastasios (IAASARS/NOA), Katsavrias Christos (University of Athens), Daglis Ioannis A. (University of Athens)

We investigate the effect of substorms on the ring current buildup and its interaction with the other current systems in the inner geospace, by means of numerical simulations of plasma ion dynamics during enhanced magnetospheric activity. A particle tracing model, developed for this purpose, solves for the ion motion in a dynamic, solar wind-driven geomagnetic field, and the electric field due to convection, corotation and Faraday induction. The kinematic data from the test-particle simulations is used for analyzing the dependence of the system on the initial conditions, as well as for a mapping of the different ion species to the storm-time magnetospheric currents. Furthermore, an estimation of the Dst index is given in terms of the ensemble-averaged ring and tail currents. The presented tool serves as the final link in a Sun-to-Earth modeling chain of major solar eruptions, providing an estimation of the inner geospace response.

Combined Effects of Concurrent Pc5 and Chorus Waves on Relativistic Electron Dynamics

Katsavrias Christos
University of Athens
Daglis Ioannis A. (UofA), Li Wen (Dept. of Atmospheric and Oceanic Sciences, UCLA), Dimitrakoudis Stavros (National Observatory of Athens), Georgiou Marina (UoA), Turner Drew L. (The Aerospace Corporation, El Segundo, California, USA), Papadimitriou Constantinos (National Observatory of Athens)

We present multi--point electron phase space density (PSD) observations as well as concurrent Pc5 and Chorus wave activity during two severe geomagnetic storms caused by Interplanetary Coronal Mass Ejections (ICMEs) and resulted in contradicting net effect. We show that -- during the March 17, 2013 storm -- the pronounced chorus wave activity is responsible for the enhancement of the electron population in the outer radiation belt. On the other hand, the significant depletion of electrons -- during the September 12, 2014 storm -- is the result of long--lasting outward diffusion driven by the continuous enhanced Pc5 activity. This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Thales. Investing in knowledge society through the European Social Fund.

ULF wave radial diffusion in the radiation belts as determined through a multi-parameter study

Dimitrakoudis Stavros

IAASARS, National Observatory of Athens

Mann Ian (University of Alberta), Balasis Georgios (IAASARS/NOA), Papadimitriou Constantinos (IAASARS/NOA), Anastasiadis Anastasios (IAASARS/NOA), Daglis Ioannis A. (University of Athens)

Radial diffusion, generated by ultra-low frequency (ULF) waves, is thought to play an important role in the transport of electrons in the outer radiation belt. In situ measurements of those waves' power spectral densities would require a large number of satellites operating in different orbits, which is currently prohibitively expensive. As a more practical alternative, measurements from ground-based magnetometers can be continuously taken and then mapped to their equivalent L-shells in the equatorial plane. Here we have used 11 years of dayside ground magnetometer measurements from multiple IMAGE stations to derive the electric field diffusion coefficient from L=3.34 to 6.46. We have processed the measurements with four binning methods, as functions of Kp, Dst, solar wind speed and solar wind pressure. Upper and lower quartiles were calculated for all initial values and derived diffusion coefficients, and the PSDs were analyzed by deciles, in which case Kp was found to be the best single parameter for predicting the effect of ULF wave power in radial diffusion. Binning by Dst, however, reveals a remarkable high energy tail in the ULF wave power distribution. This is more pronounced for lower L stations than for higher L ones, which lends further credence to observations that ULF wave power penetration to low L is connected with decreases in Dst.

Anatomy of the Pulsating Double Layer Source in the Earth's Magnetotail

Sarafopoulos Dimitrios

Democritus University of Thrace

This investigation is composed of an observational part, plus a new theoretical model interpreting the related exhibited satellite datasets through an entirely new approach concerning the substorm's ultimate excitation mechanism. First, we present a few representative case studies showing the Bz component of the magnetic field to develop quasi-periodic negative deflections with periodicities ranging from T=15 to 60 s in the central plasma sheet (CPS) with persistent tailward plasma flows. The wave activity of Bz is much lower outside the CPS, while occasionally almost a monochromatic response is identified. In certain cases, a profound change of frequency is evident and happens most probably due to the Doppler-effect; there is a relation between the plasma velocity enhancement and the increase of frequency. When comparing the amplitude of Bz deflections to the lobe magnetic field, one plausibly may infer that the deflections reflect the very dynamics of the source itself. Therefore, we put forward the concept about "a pulsating source", and more specifically, we adopt the pulsating "twin Double Layer (DL) structure" as the ultimate mechanism converting magnetic energy to kinetic. The DL acts either as a resistor or a capacitor and the twin-DL structure approximately behaves in a way similar to the cardiac cycle with repeated, rhythmic contractions and expansions. The contraction phase represents the abrupt local thinning of the plasma sheet (PS) that terminates explosively, heating the plasma and accelerating energetic particles. The expansion phase corresponds to a local distention of the source, which also terminates explosively. The DLs are oppositely polarized depending on the range of Rc whether it fulfills the condition rgi < Rc < 9 rgi or rge < Rc < rgi, where rgi (rge) and Rc are the ion (electron) gyro-radius and the curvature radius of the local magnetic field, respectively. In more detail, the "akis structure", as it was earlier introduced by Sarafopoulos [2008, 2012] and further elaborated in this work, repetitively forms DLs that undergo a transition from depolarization to re-polarization in each of the consecutive cycles. The collapse of the dissipation region (leading to local dipolarization) seems to occur when rge < Rc < 9rge. Large scale Boström's type II field aligned currents (FACs) flow and neutralize the net charges produced by "charge separation processes" within the twin-DL structure; thus the whole structure principally operates (under favorable conditions) like a huge resonant RLC-type circuit. Actually the pulsating source is an integral part of that huge (resonating) circuit, wherein even the ionosphere obviously plays its vital role imposing a positive feedback. The author of this study believes that Faraday's law can be experimentally validated with his suggested model more reliably than with the alternative X-type magnetic reconnection model incorporating the concept of "magnetic diffusion". The presently proposed "akis structure" embedded in the whole magnetotail's current system is presumably a precious structure with novel features. The source will probably be triggered at that place in which the condition for resonance is satisfied, while the resonance dramatically increases the rate of energy conversion, that is the efficiency of the source.

The AIDA mission to the binary asteroid Didymos

K. Tsiganis

Aristotle University of Thessaloniki

The AIDA (Asteroid Impact and Deflection Assessment) mission is a joint ESA/NASA technology demonstration mission, currently under Phase A/B1 study. The target (binary asteroid "Didymos") consists of a primary (with Diameter of order

800 m) and a secondary (called 'Didymoon', about 150 m across) on a rouhgly circular orbit of only 1.1 km separation. The purpose of the mission is twofold: study a prototype binary near-Earth asteroid, by performing in situ observations (and possibly a lander) and (b) perform an impact experiment and measure the resulting deflection of the moon's orbit. The mission concept consists of launching two separate spacecrafts, AIM (ESA) and DART (NASA), at two different epochs (CubeSat payloads are also predicted). AIM will rendezvous with Didymos and perform the main observations, while DART (launched later) will impact Didymoon at a prescribed location and velocity. In this talk we are going to focus on the currently accepted model for the orbital and rotational motion of the Didymos system, as deduced from observations and dynamical modeling. We present the derivation of an accurate dynamical model and discuss its implications for the mission.

On the origin of the 5-55 keV Heliosphere ENAs using Cassini/INCA measurements

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Academy of Athens
Krimigis Stamatios (APL), Mitchell Donald (APL), Decker Robert (APL), Roelof Edmond (APL)

The survey of the two Voyagers through the Heliosphere during the past decades has inspired numerous models and theories concerning its shape, size and interactions with the Local Interstellar Medium (LISM). However, remote sensing using Energetic Neutral Atom (ENA) detectors (e.g. INCA and *IBEX*), not only has led to a number of unexpected signatures, such as the Belt (Krimigis et al. 2009) and the Ribbon (McComas et al, 2009), that no theory had predicted to date, but the combination of these long distance communicators (ENAs) with the *in-situ* ion measurements from the Voyagers, can in fact provide the ground truth concerning the physics of the Heliosphere.

Recent results from the Cassini/INCA H_{ENA} measurements have shown the existence of a N-S asymmetric Heliosheath (Roelof et al. 2012), that does not include an effective “magnetosphere-like” tail and acts as a diamagnetic bubble (Krimigis, et al. 2009), which hosts a “reservoir” of particles that are constantly replenished by the solar wind ions (Dialynas et al. 2013), with partial pressure gradients that are possibly not consistent with a tail magnetic field configuration that is similar to the measured magnetic fields by the Voyagers in the nose hemisphere (Dialynas et al. 2015), capable of confronting a stronger interstellar magnetic field (IMF) than assumed in the past (Krimigis et al. 2010). However, the aforementioned results depend on the reasonable assumption that the ENAs that INCA detects are sourced from the Heliosheath.

Here we produce all-sky, H_{ENA} maps of the heliosphere from the year 2003 to 2014, in four discrete energy passbands within the energy range of 5.2-55 keV to explore the time evolution of the Heliosphere during the declining phase of SC23 and the onset of SC24 and the source of the observed Hydrogen ENAs. Our results can be summarized as follows: a) the declining phase of SC23 is closely correlated with an ENA intensity decrease towards the heliospheric tail, i.e. the beginning of SC23 (year 2003), where solar activity is high, is associated with high ENA intensities (e.g. ~5-8 in the 5.2-13 keV) that reach a minimum (by a factor of ~2 lower in all TOF channels) by the end of year 2011, ~1 year after the observed minimum in the solar activity; b) the ENA decrease in the 5.2-55 keV heliotail ENAs during the 2009 to 2011 time span is consistent with the intensity decrease of the >40 keV ion measurements (by a factor of 2-3) during the same time interval, as measured by VGR1 and VGR2 in the heliosheath (Decker et al. 2012); c) the observed minimum towards the nose direction in both the INCA ENA data and the VGR2 >40 keV ion data (Decker et al. 2015) occurs during the year 2013, while recover from 2014 to date (by a factor of ~2 in the >40 keV ion data and a factor of ~1.8 in the >35 keV ENA data) and d) the correlation between the decrease of both ENAs and ions in both the heliospheric nose and tail during the declining phase of SC23 and their recovery at the onset of SC24, combined with the ~130 AU distance between VGR1 and VGR2 (both sides of the ecliptic equator) provides further evidence of the global response of the ENA heliosphere in the solar wind changes through the solar cycle.

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Correlation between CME-related strong geomagnetic storms, SEP and Earth's surface temperature in north-east USA: 1997-2015

Anagnostopoulos Georgios
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In a recent study we presented, for the first time, a case study, the March 2012 events, with a strong evidence of a correlation between the arrival of a CME at Earth's environment, and variations in the magnetosphere, ionosphere, stratosphere and the troposphere (Anagnostopoulos et al., 2015). March 2012 has been most known in the scientific community as well as in the public for the historic heat wave in north-east USA (highest temperature of the last century); this heat wave was not anticipated by atmospheric models. Furthermore, we found that the superstorm of March 2012 was also followed by intense winds, rainfalls and fluctuating (>1500 V/m) geolectric fields in South East Europe (Greece) and various extreme weather events all over globe.

In this study we wanted to examine whether a correlation of big CMEs producing very strong (Dst < -150 nT) magnetic storms are often related with increased surface temperatures in north-east USA (Madison, Wisconcin). For this reason, we examined the period from the launch of ACE spacecraft (1997) up today and we found 25 very strong CME-related magnetic storms. The time series of ACE and NOAA satellites were compared with the values of Dst and the temperature in Madison (TM) and we found that the vast majority (>85%) of the storms examined are well related with increased values of TM (after the main phase of the storm). Moreover, we saw that the TM often starts increasing with the arrival of the high energy solar particles (before the CME). The Earth and space based observations analyzed in our study are consistent with a sequence of fast (probably non-linear) physical processes connecting the Magnetosphere with the Atmosphere, under the extreme conditions examined. The present statistical results provide a good basis to improve our understanding of the March 2012 heat wave in USA.

The CME-index for short-term estimation of Ap geomagnetic index based on the new ICME list

Paouris Evangelos
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Mavromichalaki Helen (UoA)

It is well known that the interplanetary coronal mass ejections (ICMEs) play the most important role on their interactions with the magnetosphere as they are the dominant drivers of intense geomagnetic storms. In this work 160 ICMEs associated with CMEs were spotted from SOHO-LASCO coronagraph and their characteristics were calculated by in situ observations from ACE data. The result of this analysis is a new ICME's list which contains all the available information for the background geomagnetic conditions before the arrival of the shock, the sheath between the shock and the main part of the ICME and the ICME itself, such as velocities, magnetic fields (Bsheath, BICME and Bz) and plasma characteristics (plasma beta, temperature and density) and the geomagnetic conditions, such as the Dst index minimum and the Ap maximum values. This new ICME list has been used for the formation of the CME-index (Pi) taking into account for the first time the magnetic field of these ICMEs and other characteristics as well, such as their angular width and their velocity. These ICMEs characteristics show a very high correlation between the examined variables, such as the magnetic field z component (Bz) and the Dst minimum value, during the geomagnetic storm or the mean magnetic field of the sheath and the transit velocity of the ICME, revealing important results. At this point a model based on the CME-index created from this list is proposed in order to predict geomagnetic conditions and especially the Ap index and it is tested in some case studies with very good results.

Preliminary Measurements of Schumann's Resonances (SR) in the Greek Area.

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Academy of Athens & Mariolopoulos-Kanaginis Fdn
Repapis, C (Mariolopoulos-Kanaginis Fdn), Kostarakis, P., Tatsis, G., Votis,K., Christofilakis,V (Physics Dept. Electronics-Telecommunications and Applications Lab., University of Ioannina)

Schumann's Resonance (SR) measurements have been collected in the greater areas of Ioannina and Athens by an equipment, designed and built in the laboratory of electronics and telecommunication of the University of Ioannina. Remarkable differences among measurements received in various places and epochs have been detected. At first, SR intensities taken around the Summer solstice are weaker than those taken around the Winter solstice, on the average. Another obvious remark is an inverse correlation between the SR intensity and the geomagnetic index Dst. High values of this index, which imply a disturb geomagnetic environment, correlate better with low SR intensity values. In the opposite,

low Dst values correspond to higher SR intensities. In general, the relative position of the Sun in relation to the earth as well as the solar/geomagnetic activity seems to affects the SR signal profile.
Key words: Schumann resonance, Dst index, geomagnetic activity.

Nanoflares, avalanches and heating of the solar corona.

Archontis Vasilis
University of St. Andrews

A long-standing puzzle in solar physics is that the outer atmosphere of the Sun (corona) is millions of degrees hotter than its surface. Nano/micro-flares have been invoked as possible sources of heating the solar corona but their nature is largely unexplained. We performed three-dimensional realistic simulations of flux emergence to reveal that clusters of eruptive nano/micro-flares are formed spontaneously by magnetic reconnection at current layers between interacting magnetic bipoles. Each nano/micro-flare can restructure the magnetic field so that another small or bigger flare (avalanche) is triggered nearby. This 'sympathetic' flaring activity involves the recurrent eruption of plasmoids and the emission of several x-ray jets from each current layer. Thus, we find that nano/micro-flares can provide a sufficient amount of energy to both, heat (1-6 MK) and accelerate (100-400 km/s) the plasma. This indicates that these small flares may be important in heating the solar corona and driving the solar wind.

Coronal heating from explosive events: A kinetic approach

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Coronal heating from explosive release of magnetic energy remains an open problem in solar physics. Several one-dimensional hydrodynamical models have been developed over the last decade, using simple approaches for the way energy is deposited in the coronal plasma, namely by inserting "nanoflares" at random sites and times.
In this work, we use a different approach: with the help of nonlinear force-free extrapolation techniques we reconstruct the magnetic field of an Active Region using an observed photospheric vector magnetogram of the Region as boundary condition. We then determine the location, the energetics, and the volume of the unstable regions (i.e., regions prone to releasing energy) inside the reconstructed magnetic field. The statistical distributions of these unstable volumes, their fractal structure and corresponding fractal dimension, and the electric current distribution in space are estimated, using established clustering techniques. Based on these results, and assuming a simple model for the resistivity, we estimate key characteristics of the fractally distributed electric fields inside solar active regions. Using the analysis of Isliker and Vlahos (Phys. Review E, 67, 026413, 2003), we first estimate the mean free path of electrons traveling between different unstable volumes by means of the fractal dimension of these volumes' distribution. We then follow thousands of particles, obeying an initial Maxwellian distribution with temperature 10 eV, and monitor their energization along their trajectories as they encounter the electric fields inside unstable volumes. After 50 seconds, the temperature of the plasma increases, approaching 200-300 eV, while a small population of particles is accelerated and reaches energies as high as 30-50 keV. Unlike the modeling of the plasma heated by small-scale local heat pulses, the kinetic aspect of our analysis allows the particles to visit many unstable sites, gradually gaining energy.Our model can be improved by taking into account that (1) the spatial resolution of our nonlinear force-free field reconstruction is relatively poor and we cannot resolve well the weekest explosive events (E<1024 ergs) and (2) the model for the resistivity is yet to be sufficiently understood, so resistivity remains a free parameter in our model.

Probing the quiet Sun structure and dynamics with ground and space based instruments

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We present a detailed study of a very quiet solar region at the solar disk center, using data from ground based and space born instruments. The region was observed by the Dutch Open Telescope, the XRT, SOT and EIS instruments onboard Hinode, TRACE and the MDI onboard SoHO. This combination of instruments offers a complete tomographic view of the atmospheric layers with plasma temperatures spanning from a few thousand to million Kelvin. Calculations of the current-free magnetic field vector up to the corona shows that the network structure persists up to coronal temperatures and consists of a multitude of flux tubes that connect to different network and internetwork areas and reach different

heights and temperatures. We use EIS rasters to deduce spectral characteristics of transition region lines and study their connection with the underlying chromosphere. Through time series of EIS intensigrams, we find that the variations of the EUV radiation of the transition region are mostly found around magnetic field concentrations at the network boundaries. At least some of the jet-like structures observed in the Hα line, around the network, have a counterpart in the overlying atmosphere. We study their evolution in the different atmospheric heights/temperatures. Also, the height of the magnetic canopy, the interface between the completely magnetized plasma of the chromosphere/transition region and the underlying photosphere is determined. Through a phase difference analysis between different heights at the internetwork and the magnetic canopy regions we infer the impact of the chromospheric magnetic field on wave propagation. The research was partly funded through the project "SOLAR-4068", which is implemented under the "ARISTEIA II" Action of the operational program "Education and Lifelong Learning" and is cofunded by the European Social Fund (ESF) and Greek national funds.

A granule seen in the far wings of the H-alpha line: exceptional darkening before fragmentation

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Based on high-quality H-alpha observations, we report, for the first time, the exceptional darkening of a quiet Sun granule as seen in the H-alpha far wings before its fragmentation. High-cadence time series of H-alpha imaging spectroscopy measurements obtained by SST/CRISP in a quiet Sun region are analyzed. From the observed H-alpha line profiles, we derive some physical parameters of the granule, such as the Doppler Signal and full-width at half-maximum, and investigate their temporal evolution. The granule first appears like a typical quiet Sun granule, but then it gets dark in both far blue and red wings of the H-alpha line. The darkening phase lasts for about 5 minutes, then the granule splits into several small granules. We find that during the darkening phase downflows are observed inside the granule together with an excessive broadening of the spectral line, which is attributed to a temperature increase. In addition, high-speed upflow features appear in the adjacent intergranular lane, as well as above the granule right before and during the darkening phase. We discuss some possible mechanisms for the darkening and evolution of the granule.

Carrington-L5: The UK/US Next Generation Space Weather Operational Mission

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Airbus Defence and Space

Airbus Defence and Space have carried out a study to investigate the possibilities for an operational L5 space weather mission, in collaboration with RAL, the UK Met Office, UCL and Imperial College London. The study looked at the user requirements for an operational mission, a model instrument payload, and a mission/spacecraft concept. A particular focus is cost effectiveness and timeliness of the data, suitable for operational forecasting needs. The study focussed on a mission at L5 assuming that a US mission to L1 will already occur, on the basis that L5 offers the greatest benefit for SWE predictions. The baseline payload has been selected to address all MOSWOC/SWPC priorities using UK/US instruments, consisting of: a heliospheric imager, coronagraph, EUV imager, magnetograph, magnetometer, solar wind analyser and radiation monitor. The platform is based on extensive re-use from Airbus' past missions to minimize the cost and a Falcon-9 launcher has been selected on the same basis. A schedule analysis shows that the earliest launch could occur in 2020, assuming Phase A KO in 2015. The study team have selected the name "Carrington" for the mission, reflecting the UK's proud history in this domain.

The Solar Origins and Terrestrial Impacts of Space Weather

Peter Gallagher
Trinity College Dublin

The Sun is an active star that fills the Heliosphere with light and radiation. The solar wind and magnetic field extend from the solar surface to the outer boundaries of the Heliosphere, where they merge with the interstellar medium. From time to time, large eruptions, called coronal mass ejections (CMEs), are launched from the Sun at thousands of kilometres per second, each carrying masses of to 10^{16} g. In addition, they are accompanied by a plethora of associated phenomena, such as coronal dimmings, large-scale corona waves, shocks, radio bursts and energetic particles. CMEs are now known to result from the release of energy from complex magnetic fields associated with sunspot groups and filament channels. Indeed, it is clear that a condition for eruption is a large concentration of complex magnetic fields, where flux emergence, gradients, and shear forces can build up significant non-potential energy. When the solar wind and CMEs interact with the magnetospheres and atmospheres of the planets, they can produce a plethora of effects, from spectacular auroral displays to adverse space weather effects on technological systems here on Earth, such as GPS/GNSS, mobile phone network, and power grids. In this talk, I will describe the origins of space weather on the Sun and how it can impact our everyday lives.

The Science Case for a Mission to the Sun-Earth L5: An Ideal Research-to-Operations Space Weather Platform

Vourlidas Angelos
JHU/APL
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At the five Sun-Earth Lagrange points (L1 to L5) the combined gravitational pull of the two bodies is equal to the centripetal force required to orbit with them. The L5 point is trailing Earth by 60º and is a uniquely advantageous viewpoint for Space Weather (SpW) research and monitoring. It provides global coverage of the inner heliosphere, allows imaging and measurements of solar activity and irradiance variations at least 3 days before it becomes visible from a terrestrial viewpoint, and enables the in-situ sampling of solar wind structure, such as Corotating Interaction Regions (CIRs), 3-4 days before they encounter Earth. An L5 satellite will provide up-to-date behind-east-limb magnetograms better suited for building background solar wind models that are essential for CME and shock propagation models. The predictions of such models can be validated in advance via the solar wind measurements from L5. From an operational perspective, the L5 orbit is the SpW equivalent of the geosynchronous orbit for weather satellites. For these reasons, an L5 mission is a popular concept for both research and operational communities in Sun-Earth relations. Here, we review the science case for an L5 mission concept, its operational benefits, and introduce fresh ideas on mission and instrument design that can make an L5 mission reality.

Horizon 2020 'Hesperia' Project: High Energy Solar Particle Events Forecasting and Analysis

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Solar energetic particles (SEPs) are of prime astrophysical interest, but are also a space weather hazard motivating the development of predictive capabilities. The HORIZON 2020 project 'HESPERIA' will produce two novel SEP operational forecasting tools based upon proven concepts (UMASEP, REleASE). At the same time it will advance our understanding of the physical mechanisms that result into high-energy SEP events through the systematic exploitation of the high-energy gamma-ray observations of the FERMI mission and other novel datasets (PAMELA; AMS), together with in situ SEP measurements near 1 AU. This will put an end to the decade-long bias of remote sensing observations towards electrons, which emit the vast majority of the electromagnetic emissions analysed so far. The project will address through multi-frequency observations and simulations the chain of processes from particle acceleration in the corona, particle transport in the magnetically complex corona and interplanetary space to the detection near 1 AU. Furthermore, HESPERIA will explore the possibility to incorporate the derived results into future innovative space weather services. Publicly available software to invert neutron monitor observations of relativistic SEPs to physical parameters that can be compared with the space-borne measurements at lower energies will be provided for the first time. In order to achieve these goals HESPERIA will exploit already available large datasets stored into databases such as the neutron monitor database (NMDB) and SEPServer that have been developed under FP7 projects from 2008 to 2013. The structure of the HESPERIA project, its main objectives, as well as the added value to the SEP research will be presented and discussed.
Acknowledgement: This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 637324.

The Forecasting Solar Particle Events and Flares (FORSPEF) Tool

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Solar Energetic Particle (SEP) events related to intense eruptive events on the Sun such as solar flares and coronal mass ejections (CMEs), pose a significant threat for both personnel and infrastructure in stormy space-weather conditions. Of particular concern is the high rate of single event effects on-board spacecraft launchers which can be brought about by large increases in the radiation environment as a result of such solar activity. A new web-based service for the prediction of solar eruptive and energetic particle events is presented. FORSPEF (Forecasting Solar Particle Events and Flares) is designed to perform forecasts and nowcasts of the occurrence and the characteristics of solar flares and SEP events. The service was initially targeted at launch operators but is of interest to the broader space-weather community. The prediction of solar flares relies on a morphological method which is based on the sophisticated derivation of the effective connected magnetic field strength (Beff) of potentially flaring active-region (AR) magnetic configurations and it utilizes analysis of a large number of AR magnetograms. For the prediction of SEP events a new reductive statistical method has been implemented based on a newly constructed database of solar flares, CMEs and SEP events that covers a long time span from 1984-2013. The method is based on flare location (longitude), flare size (maximum soft X-ray intensity), and the occurrence (or not) of a CME. Warnings are issued for all > C1.0 soft X-ray flares. The warning time in the forecasting scheme extends to 24 hours with a refresh rate of 3 hours while the respective warning time for the nowcasting scheme depends on the availability of the near real-time data and falls between 15-20 minutes. The system is capable of predicting the likelihood of SEP event occurrence, as well as the timing of the peak, duration of the event, and peak flux and fluence at a range of energies. We discuss the modules of the FORSPEF system, their interconnection and the operational set up. The dual approach in the development of FORPSEF (i.e. forecasting and nowcasting scheme) permits the refinement of predictions upon the availability of new data that characterize changes on the Sun and the interplanetary space, while the combined usage of solar flare and SEP forecasting methods upgrades FORSPEF to an integrated forecasting solution. This work has been funded through the “FORSPEF: FORecasting Solar Particle Events and Flares”, ESAContract No. 4000109641/13/NL/AK

Properties of solar energetic particle events inferred from their associated radio emission

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We study selected properties of Solar Energetic Particle (SEP) events as inferred from their associated radio emissions. We used a catalogue of 115 SEP events that consists of entries of proton intensity enhancements at one AU, with complete coverage over solar cycle 23, based on high-energy (~68 MeV) protons from SOHO/ERNE. Most of the flares associated to our SEP events were located at the western hemisphere, with a peak within the well-connected region of 50°–60° western longitude. We calculated the proton release time at the Sun using the velocity dispersion analysis (VDA). After an initial rejection of cases with unrealistic VDA path lengths, we assembled composite radio spectra for the remaining events using data from ground-based and space-borne radio-spectrographs. For every event we registered the associated radio emissions and we divided the events in groups according to their associated radio emissions. The proton release was found to be most often accompanied by both type III and II radio bursts, but a good association percentage was also registered in cases accompanied by type IIIs only. The worst association was found for the cases with type II only association. These radio association percentages support the idea that both flare- and shock-resident particle release processes are observed in high-energy proton events. In cases of type III-associated events we extended our study to the timings between the type III radio emission, the proton release, and the electron release as inferred from VDA based on Wind/3DP 20–646 keV data. Typically, the protons are released after the start of the associated type III bursts and simultaneously or before the release of energetic electrons. For the cases with type II radio association we found that the distribution of the proton release heights had a maximum at ~2.5 Rs. Our study indicates that a clear-cut distinction between flare-related and CME-related SEP events is difficult to establish.

A Helicity-based Method to Infer the Near-Sun Magnetic Field of Coronal Mass Ejections: Parametric Study and Comparison with Observations at 1 AU

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Coronal Mass Ejections (CMEs) are expulsions of magnetized plasmas from the solar atmosphere into the interplanetary medium. The CME magnetic field governs their structuring, evolution and energetics as well as of their geoeffectiveness. However we currently lack routine diagnostics of the very crucial for all the above factors near-Sun magnetic field of CMEs. We have recently developed a novel method to infer the near-Sun magnetic field of CMEs. The method is based on the conservation of magnetic helicity in flux-rope CMEs. It uses determinations of the magnetic helicity in the inner active

region corona hosting CMEs along with geometrical fittings of the corresponding CMEs as observed by coronagraphs. We hereby perform a parametric study of this method. We use statistics of active region helicities and geometrical parameters of CMEs to determine a matrix of near-Sun magnetic fields as it would be inferred by our method. In addition, using a set of scaling-laws, we extrapolate this matrix to 1 AU and determine the anticipated range of CME magnetic fields in the Earth's near-space environment. We finally compare our magnetic field predictions at 1 AU with in-situ observations of magnetic fields in Interplanetary Coronal Mass Ejections.

Formation of Magnetic Flux Ropes during Confined Flaring Well Before the Onset of a Pair of Major Coronal Mass Ejections

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NOAA Active Region (AR) 11429 was the source of twin super-fast Coronal Mass Ejections (CMEs). The CMEs took place within a hour from each other, with the onset of the first taking place in the beggining of March 7, 2012. This AR fulfills all the requirements for a “super active region”; namely, Hale’s law incompatibility and a ?-spot magnetic configuration. One of the biggest storms of Solar Cycle 24 was associated with one of these events. Magnetic Flux Ropes (MFRs) are twisted magnetic structures in the corona, best seen in >10 MK hot plasma emission and are often considered the core of erupting structures. However, their “dormant” existence in the solar atmosphere (i.e. prior to eruptions), is an open question. Aided by multi-wavelength observations (SDO/HMI/AIA and STEREO EUVI B) and a Non-Linear Force-Free (NLFFF) model for the coronal magnetic field, our work uncovers two separate, weakly-twisted magnetic flux systems which suggest the existence of pre-eruption MFRs that eventually became the seeds of the two CMEs. The MFRs could have been formed during confined (i.e., not leading to major CMEs) flaring and sub-flaring events which took place the day before the two CMEs in the host AR 11429.

The nature of recurrent 3D CME-like eruptions in active regions

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We study the dynamics of CME-like eruptions in active regions using 3D MHD simulations of emerging magnetic fields from the solar interior. The emerging fields expands into the corona forming an “envelope field”. In the lower atmosphere, they experience intense shearing along the Polarity Inversion Line (PIL). The combined effect of shearing, expansion and rotation of the fieldlines across the PIL leads to efficient reconnection and the formation of a flux rope, which eventually erupts in a CME-like (approx. 400km/s) manner towards the outer space. The ultimate eruption of the heavy plasma of the CME(s) is due to the teather-cutting of the “envelope” fieldlines. The eruptions are associated with the onset of flaring due to fast reconnection of sheared fieldlines, underneath the erupting core of the flux rope. We find that the eruptions occur in a recurrent manner. We show the mechanism of the recurrent eruptions and their structure and dynamics in the 3D space.

The Role of the Background Magnetic Field in the Major Eruptions of AR11429

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It is believed that the background overlying magnetic field of active regions tends to inhibit global eruptions. This conjecture is checked against observations of two major coronal mass ejections (CMEs) that occurred in active region AR11429 during early 7 March 2012. We studied the long-term evolution of the active region's background magnetic field using line of sight (LOS) magnetograms obtained with the Helioseismic and Magnetic Imager (HMI) aboard the Solar Dynamics Observatory (SDO). The source regions of the two CMEs were determined using EUV images obtained with the Atmospheric Imaging Assembly aboard SDO. Using potential magnetic field extrapolations, we calculated both average values and maps of the decay index of the magnetic field (i.e. how fast the field decreases with height) related to each event for an interval of about 48 hours that was roughly centered around the initiation times of the two eruptions. Our results indicate that the temporal variation of the decay index is small.

Spatial correlation of solar flares and coronal mass ejections

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In order to quantify the spatial relationship between pairs of solar flares and coronal mass ejections (CMEs) we used 19 events that were associated with both solar flares and CMEs. To achieve our goal we used images at 174 Å from the Sun Watcher using APS and Image Processing (SWAP) instrument aboard Project for On-Board Autonomy-2 (PROBA-2) satellite. Those data are ideal for that kind of study because flare emission does not saturate much. To prevent additional saturation we avoided using events that were related to M-class or X-class flares. We chose eruptions that occurred close to the disk center, as viewed from Earth, while they were observed as limb events by the EUV Imagers (EUVI) aboard the Solar TErrestrial RElations Observatory (STEREO). Images at 195 Å from the EUVI instruments were used to determine the CME initiation time. Proxies for the CME source locations were the centroids of the CME-associated EUV dimmings, while proxies for the flare locations were the centroids of the flare brightenings. For each event we compared the location of the dimmings with the location of the flare brightenings' centroid and we found out that in 5 events the CME location was cospatial with the flare brightenings. The distances between each pair of flare-CME locations ranged from 12.5 Mm to 137.2 Mm with a median value of 49.7 Mm. We also examined the evolution of the surface of the dimmings over time and noticed that its decay phase is more gradual than that of the corresponding X-ray flux. We also studied the CME source locations with respect to the underlying photospheric magnetic field using magnetograms from the Helioseismic and Magnetic Imager (HMI) aboard Solar Dynamics Observatory (SDO) and noted that in 8 cases the location of the CME was above the neutral line of the magnetic field.

How Common are Hot Magnetic Flux Ropes in the Low Solar Corona? A Statistical Study of EUV Observations

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We use data at 131, 171, and 304 A from the Atmospheric Imaging Assembly (AIA) aboard the Solar Dynamics Observatory (SDO) to search for hot flux ropes in 141 M-class and X-class solar flares that occurred at solar longitudes equal to or larger than 50degr. Half of the flares were associated with coronal mass ejections (CMEs). The goal of our survey is to assess the frequency of hot flux ropes in large flares irrespective of their formation time relative to the onset of eruptions. The flux ropes were identified in 131 A images using morphological criteria and their high temperatures were confirmed by their absence in the cooler 171 and 304 AA passbands. We found hot flux ropes in 45 of our events (32% of the flares); 11 of them were associated with confined flares while the remaining 34 were associated with eruptive flares. Therefore almost half (49%) of the eruptive events involved a hot flux rope configuration. We argue that these percentages should be considered as lower limits of the actual rates of occurrence of hot flux ropes in large flares.

Magnetic energy and helicity budgets of solar quiet regions and their role in fine structure dynamics

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We investigate the free magnetic energy and relative magnetic helicity budgets of solar quiet regions and their role in fine structure dynamics. To this purpose we derive a) the instantaneous free magnetic energy and relative magnetic helicity budgets in 55 quiet-Sun vector magnetograms using a novel nonlinear force-free method that requires single solar vector magnetograms, and b) the free magnetic energy and relative magnetic helicity injection rates in 16 quiet-Sun vector magnetograms sequences using the DAVE4VM method to infer the photospheric velocity field. Our results suggest that quiet-Sun regions have no dominant sense of helicity and show monotonic correlations a) between free magnetic energy/relative helicity and magnetic network area and, b) between free magnetic energy and helicity. Furthermore, we find that helicity and energy injection in quiet Sun are mostly due to surface shuffling motions. The (free) energy-(relative) helicity diagram of quiet-Sun regions indicates that quiet-Sun free energy budgets represent a rather continuous extension of respective active-region budgets towards lower values, with a corresponding discontinuous helicity transition stemming from the incoherence of the helicity sense in contrast to active regions. Free magnetic-energy and relative magnetic-helicity budgets over an entire solar cycle are also derived and are higher than previously reported. Our analysis shows that helicity and energy release take place mostly along the network and the free-energy budgets are high enough to power fine-scale

structures residing there, such as mottles and spicules. Corresponding estimates of helicity budgets in fine structures are also provided, pending future verification with high-resolution MHD simulations and/or observations. This research was partially supported by the EU Seventh Framework Programme under grant agreement No. PIRG07-GA-2010-268245 and through the project "SOLAR-4068", which is implemented under the "ARISTEIA II" Action of the operational program "Education and Lifelong Learning" and is co-funded by the European Social Fund (ESF) and Greek national funds.

Evolution of magnetic helicity and free energy in NOAA AR 11429 as inferred by different methodologies

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We use three different methods to calculate free magnetic energy and relative magnetic helicity budgets of NOAA active region (AR) 11429 during March 6-7, 2012 when it released two powerful eruptive X-class flares. The methods that we use are: (a) a connectivity-based method that uses a single vector magnetogram, (b) a helicity/energy injection method where the photospheric velocity field is additionally required, and (c) a volume method where the required full three-dimensional coronal field is obtained via a nonlinear force-free field extrapolation. All methods agree on the sign of relative helicity and are combined to give an estimate for the eruption-related helicity changes. The results for free energy from the different methods are less consistent and this is used to place limits on the quality of the extrapolated fields. This study is part of the analysis done in the framework of the Hellenic National Space Weather Research Network (HNSWRN), a research that has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Thales. Investing in knowledge society through the European Social Fund.

Particle acceleration and heating in regions of magnetic flux emergence: a statistical approach using test-particle- and MHD-simulations

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We consider 3D nonlinear MHD simulations of an emerging flux tube, from the convection zone into the corona, and its reconnection with a pre-existing magnetic field in the solar atmosphere. We focus on the corona and, mainly, on the emission of 'standard' and 'blowout' jets, which are triggered by the eruption of dense and cool plasma from the emerging flux region. Firstly, we explore the statistical nature and spatial structure of the electric field, calculating histograms and making use of cluster analysis and 3D visualization. Then test-particle simulations are performed for electrons, in order to study heating and acceleration phenomena, as well as to determine HXR emission. We have studied and compared various phases of the MHD simulations: quiet, mildly explosive and turbulent explosive phases. Also, the importance of collisional and relativistic effects is assessed, and the role of the integration time is investigated. Particular aim of this project is to verify the quasi- linear assumptions made in standard transport models, and to identify possible transport effects that cannot be captured with the latter. In order to determine the relation of our results to Fermi acceleration and Fokker-Planck modeling, we determine the standard transport coefficients. After all, in different MHD time-instances we find heating to take place, and acceleration that depends on the level of MHD turbulence. Also, acceleration appears to be a transient phenomenon, there is a kind of saturation effect, and the parallel dynamics clearly dominate the energetics.

The applications of Complexity Theory and Tsallis Non-extensive Statistics at Space Plasma Dynamics

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As the solar and magnetospheric plasmas live far from equilibrium, they are an excellent laboratory for testing complexity theory and non-equilibrium statistical mechanics. In this study, we present the highlights of complexity theory and Tsallis non extensive statistical mechanics as concerns their applications at solar and magnetospheric plasma dynamics, especially at sunspot, solar flare and solar wind and magnetospheric substorm phenomena. Generally, when a physical system is driven far from equilibrium states some novel characteristics can be observed related to the nonlinear character of dynamics. The nonlinearity in space plasma dynamics can generate intermittent turbulence with the typical characteristics of the anomalous diffusion process and strange topologies of stochastic space plasma fields (velocity and magnetic fields) caused by the strange dynamics and strange kinetics. In addition, according to Zelenyi and Milovanov, the complex character of the space

plasma system includes the existence of non-equilibrium (quasi)- stationary states (NESS) having the topology of a percolating fractal set. The stabilization of a system near the NESS is perceived as a transition into a turbulent state determined by self-organization processes. The long-range correlation effects manifest themselves as a strange non-Gaussian behavior of kinetic processes near the NESS plasma state. The complex character of space plasma can also be described by the non-extensive statistical thermodynamics pioneered by Tsallis, which offers a consistent and effective theoretical framework, based on a generalization of Boltzmann - Gibbs (BG) entropy, to describe far from equilibrium nonlinear complex dynamics. In a series of recent papers, the hypothesis of Tsallis non-extensive statistics in magnetosphere, sunspot dynamics, solar flares, solar wind and space plasma in general, was tested and verified. Our study includes the analysis of space plasma time series at three cases: sunspot index, solar flare and solar wind data. The non-linear analysis of the sunspot index is embedded in the non-extensive statistical theory of Tsallis. The q-triplet of Tsallis, as well as the correlation dimension and the Lyapunov exponent spectrum were estimated for the SVD components of the sunspot index timeseries. Also the multifractal scaling exponent spectrum f(a), the generalized Renyi dimension spectrum D(q) and the spectrum J(p) of the structure function exponents were estimated experimentally and theoretically by using the q-entropy principle included in Tsallis non-extensive statistical theory, following Arimitsu and Arimitsu. Our analysis showed clearly the following: (a) a phase transition process in the solar dynamics from high dimensional non-Gaussian SOC state to a low dimensional non-Gaussian chaotic state, (b) strong intermittent solar turbulence and anomalous (multifractal) diffusion solar process, which is strengthened as the solar dynamics makes a phase transition to low dimensional chaos in accordance to Ruzmaikin, Zelenyi and Milovanov's studies, (c) faithful agreement of Tsallis non-equilibrium statistical theory with the experimental estimations of: (i) non-Gaussian probability distribution function P(x), (ii) multifractal scaling exponent spectrum f(a) and generalized Renyi dimension spectrum Dq, (iii) exponent spectrum J(p) of the structure functions estimated for the sunspot index and its underlying non equilibrium solar dynamics. Also, the q-triplet of Tsallis as well as the correlation dimension and the Lyapunov exponent spectrum were estimated for the singular value decomposition (SVD) components of the solar flares timeseries. At last we present novel results revealing non-equilibrium phase transition processes in the solar wind plasma during a strong shock event, which can take place in Solar wind plasma system. The solar magnetospheric plasma as well as the entire solar plasma system is a typical case of stochastic spatiotemporal distribution of physical state variables such as force fields and matter fields (particle and current densities or bulk plasma distributions). This study shows clearly the non-extensive and non-Gaussian character of the solar wind plasma and the existence of multi-scale strong correlations from the microscopic to the macroscopic level. It also underlines the inefficiency of classical magneto–hydro-dynamic (MHD) or plasma statistical theories, based on the classical central limit theorem (CLT), to explain the complexity of the solar wind dynamics, since these theories include smooth and differentiable spatial–temporal functions (MHD theory) or Gaussian statistics (Boltzmann–Maxwell statistical mechanics). On the contrary, the results of this study indicate the presence of non-Gaussian non-extensive statistics with heavy tails probability distribution functions, which are related to the q-extension of CLT. Finally, the results of this study can be understood in the framework of modern theoretical concepts such as non-extensive statistical mechanics, fractal topology, turbulence theory, strange dynamics, percolation theory, anomalous diffusion theory and anomalous transport theory, fractional dynamics and non-equilibrium phase transition theory.

Theory and applications of hyperbolic invariant manifolds in astrodynamics

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The hyperbolic dynamics in the neighborhood of the unstable Lagrangian points L1 or L2 of a Sun - planet or planet - moon system offer a wealth of new possibilities for low-cost-orbit preliminary design. These are based the existence of homoclinic or heteroclinic connections between the stable and unstable invariant manifolds emanating from unstable periodic orbits in the vicinity of L1 or L2. Such connections allow to define `patched hyperbolic paths', thus providing alternatives to a traditional orbit design based on patched conics. We will briefly review the progress in this field in the last two decades, including some true mission designs in the Sun - Earth or Earth - Moon environment. We will also present how space manifold computations can be boosted by the use of analytical techniques, i.e. the use of the hyperbolic normal form and the analytical computation of invariant manifolds.

Effect of sun's mass loss in the dynamical evolution of the Solar System

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We study the effect of the Sun's mass loss, which causes the orbits of the planets to expand, on the dynamical evolution of the Solar System. We use four different mass loss rate models and we simulate the evolution of the planetary system, starting from its early stages (~100 My) up to now (4.6 Gy), in a gravitational model suitably corrected for the main GR effects.

Different initial conditions for the major planets are studied, pertaining to different evolution models. In the first case, we assume adiabatic invariance to hold throughout the 4.5 Gy and evolve the system to its current state. In the second, we assume a multi-resonant configuration of the giant planets (Nice models) and study the stability of the system for the required 700 My (pre-LHB epoch). In all cases we confirm the dominant stabilizing role of the GR-induced correction to the precession frequency of Mercury's orbit as, without this correction, secular resonances between the planets would cause the inner solar system to dynamically dissolve.

Dynamical characterization of the Hoffmeister asteroid family

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The (1726) Hoffmeister asteroid family is located in the middle of the Main Belt, between 2.75 and 2.82 AU. It draws our attention due to its unusual shape when projected to the semi-major axis vs. inclination plane. Actually, the distribution of family members as seen in this plane clearly suggests different dynamical evolution for the two parts of the family delimited in terms of semi-major axis. Therefore, we investigate here the dynamics of the family members aiming primarily to explain the observed unusual shape, but we also reconstruct the evolution of the whole family in time, and estimate its age. The Hoffmeister family is close to the fourth degree secular resonance z1=g-g6+s-s6, and in the neighborhood of the most massive asteroid (1) Ceres, each of these possibly being responsible for the strange shape of the family. To identify which ones among the different possible dynamical mechanisms are actually at work here, we performed a set of numerical integrations. We integrate the orbits of test particles over 300 Myr, as the age of the Hoffmeister family was previously roughly estimated to be 300 ± 200 Myr. Moreover, in order to identify and isolate the main perturber(s), we repeat four times the integrations using each time a different dynamical model, taking or not into account the Yarkovsky effect and dwarf planet Ceres as a perturbing body. Our results reveal the significant role of a so far overlooked dynamical aspect, namely a secular resonance between the dwarf planet Ceres and other asteroids. In particular, we show that the post-impact evolution of the Hoffmeister asteroid family is a direct consequence of the nodal secular resonance with Ceres.

Survival of the impactor during hypervelocity collisions. An analogue for icy bodies.

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Impacts have shaped asteroids, and their size frequency distribution, through 4.5Ga of Solar System evolution. The appearance and morphology of asteroidal surfaces are also the result of impact processes, which are responsible, for instance, for the formation of craters and the production of regolith. Over the last four decades, a plethora of laboratory experiments and computer simulations have provided insights into collision processes, but our understanding of the fate of the impactor at impact speeds of several km/s is still poorly understood. However, interest has increased in the fate of the projectile and projectile debris to potentially explain phenomena such as the source of the olivine and dark material deposits observed on Vesta and the "Black Boulder" on (25143) Itokawa. Asteroid 2008 TC3 consists of a peculiar case of a multi-lithology body whose origin is still unknown.

We present the results of our laboratory programme devoted to measuring the survivability, fragmentation and state of the impactor, along with an estimation of the mass that was implanted on the target body, over a speed range of 0.4 - 3.5 km/s. Forsterite (Mg-rich olivine) and basalt projectiles were fired onto low porosity water-ice targets, using the University of Kent's Light Gas Gun. Additionally we developed a new automated technique to identify and measure the impactor's fragments applying astronomical photometry on our data, using the Source Extractor software.

Session 1: Poster Presentations

The quasi-perpendicular MHD shock as a quasi-trapping region of downstream energetic particles

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In this article we present observational features of energetic charged particles approaching a quasi-perpendicular shock from the downstream region. Following a previous study on the Earth's bow shock (*Anagnostopoulos et al.*, 2008), we present here examples in the cases of the co-rotating interaction region (CIR)-related reverse shock and the termination shock. The energetic ions can be confined within the CIR by the reverse shock, while the heliosheath can be hold by the Termination shock, although the magnetic field is much weaker upstream from both kinds of shocks. The downstream population seem to bear a temporal holding dependent on the value of $V_{EFF} = V cos\Theta_{Bn}$, where Θ_{Bn} is the angle between the magnetic field **B** and the normal direction **n** at the shock front and **V** is the solar wind speed, in agreement with previous studies (Desai et al., 1999; *Anagnostopoulos et al.*, 2008). The proposed theoretical approach may explain several open problems in the scientific literature of MHD shocks and cosmic rays.

Space based observations of electromagnetic signals in the topside Ionosphere before the M6.9 Andravida Earthquake (February 14, 2008).

Anagnostopoulos Georgios
Demokritos University of Thrace
Vassiliadis Vassilios (DUTH), Vassiliadis Efthymios (DUTH), Barlas Georgios (DUTH), Karli Anna (DUTH)

Although there is an increasing number of reports in the scientific literature of space based measurements of various earthquake (EQ) electromagnetic (EM) precursors, there are not well known such space measurements in the case of EQs occurred in the Greek territory / south east Mediterranean so far. For this reason In this study we present as an example with a set of electromagnetic (EM) precursors observed by satellites in the topside ionosphere above Greece, before the great (M6.9) EQ occurred in Andravida (February 14, 2008). We present a short analysis of space based observations of physical phenomena taking place in the atmosphere, ionosphere, and the Van Allen radiation belts. Recent studies reveal an increasing importance of radiation belt electron precipitation (RBEP) in short term (# hours) EQ prediction research. The RBEP before great EQs is produced by a cyclotron interaction of the radiation belt electrons with EQ-induced with VLF waves (in a similar way as in the case of lightnings). Furthermore, the RBEP phenomenon seen in the case of Andravida EQ is compared with the same phenomenon as seen before a characteristic EQ in Japan. In this study we also present a new physical parameter concerning the RBEP to the topside ionosphere (a clear 24/12 h signal) and a new tempo-spatial distribution of ULF emissions from the seismic region. The combined study of RBEP and EM-ULF data seem to allow a good estimation of the epicenter and the occurrence time of great (M≥5) EQs, but more work is needed to achieve a better understanding of these phenomena as EQ precursory signals. A synergy of various methods is believed that may highly improve the EQ prediction research in the next decade, which is the goal of a Chinese special satellite to be launched by the end of 2016.

Space weather research and applications to Seismology, Meteorology, Communications and Medicine in Greece.

Anagnostopoulos Georgios
Democritus University of Thrace

We present new advances of space weather research (SWR) with application to (a) earthquake prediction research, (b) atmospheric modelling, (c) effects to mental diseases and physical disabilities (sensitive to ULF radiation), (d) ionospheric variations, which are responsible for problems in communication systems , etc. Our results were obtained from a comparison of data from international space missions with data from national sources. The results of the above interdisciplinary studies greatly support previous scientific efforts, which suggest that SWR allows us to solve important problems with a priority and special benefits for the Greek society, beside -or in participation to- the SWR strategies of other countries or international organisations.

Investigation of a failed Filament Eruption During the VAULT2.0 Campaign Observations

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Vourlidas Angelos (Johns Hopkins University/APL)

We report the first results from an observing campaign in support of the VAULT2.0 sounding rocket launch on September 30, 2014. VAULT2.0 is a Lyalpha (1216Å) spectroheliograph capable of 0.4” (~300 km) spatial resolution. The objective of the VAULT2.0 project is the study of the chromosphere-corona interface. VAULT2.0 observations probe temperatures between 10000 and 50000 K, a regime not accessible by Hinode or SDO. Lyalpha observations are, therefore, ideal, for filling in this gap. The observing campaign was closely coordinated with the Hinode and IRIS missions. Several ground-based observatories also provided important observations (IBIS, BBSO, SOLIS). Taking advantage of this simultaneous multi-wavelength coverage of target AR 12172 we are able to perform a detailed investigation on a failed eruption of a Magnetic Flux Rope-like structure that was recorded in the joint observations, starting before VAULT2.0's flight.

Physics of a Critical Scaling in Solar Magnetism

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Evolution in the magnetically dominated, high-Reynolds number solar corona relatively close to the Sun's surface is largely dictated by the (B,u)-paradigm elaborated by E. N. Parker in the 1990s: the fluid-triggered velocity field of the relatively high-beta coronal base, the solar photosphere, imposes changes in the magnetic field that result in an increase of complexity in terms of (mainly field-aligned) electric currents. The crucial implications of these currents are the following: first, they elevate the energy of solar magnetic structures above the minimum, vacuum value, thus depositing free (i.e., prone to impulsive dissipation) magnetic energy in these structures. Second, they result in helical magnetic structures whose potential of instability increases with the increase of helicity. We report here on a long-standing research effort aimed at correlating the free magnetic energy with the (relative) magnetic helicity in both active-region and quiet-Sun magnetic patterns. Analysis is performed using both classical energy/helicity calculation methods and a novel, nonlinear force-free method developed by our group. Both methods are applied to observed and 3D-MHD-simulated data sets. The results show a common, surprisingly robust energy/helicity scaling applying to both active regions and the quiet Sun, independently of the method used to calculate the free energy and relative helicity. The implications of this revealed, apparently fundamental, scaling in (i) the formation mechanisms of solar active regions vs. quiet-Sun structures, (ii) the susceptibility of solar magnetic structures toward eruptions, and (iii) the essentials of the eruption mechanism and the potential for eruption prediction, are intricate and far-reaching. We briefly touch upon them in this study, making clear that substantial follow-up work is required to achieve a deeper physical understanding of solar magnetism.
 Initial stages of this research were partially funded by various NASA grants. More recently, research was partially supported by the EU Seventh Framework Programme under grant agreement No. PIRG07-GA-2010-268245 and by the European Union Social Fund (ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Thales. Investing in knowledge society through the European Social Fund.

Geoeffectiveness of SIR/CIR and ICME driven disturbances during Solar Cycle 23

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The behavior of Dst index was studied for ICME and SIR/CIR driven storms during Solar Cycle 23. To that end, the Dst response was categorized in the four familiar discreet clans of intensity : 0 to -30 nT (C1), -30 to -50 nT (C2), -50 to -100 nT (C3) and lower than -100 nT (C4). The analysis shows that a strong linear correlation between the Bs value and the Dst disturbance appears in C1 and C4 for the ICME driven events, while for the SIR/CIR driven events the linear correlation is found in C3 and C4. On the other hand, there is no linear dependence or correlation between the Bs value and the Dst disturbance either in C2 and C3 for ICME driven events or in C1 and C2 for SIR/CIR driven events. Further study of each phase of the Solar Cycle yielded somewhat irresolute results for both drivers, with the ICME driven events seemingly maintaining the linear correlation in C1 and C4 during maximum and descending phase while displaying linear correlation in all categories during the ascending phase, and with the SIR/CIR driven events displaying inconsistency during the three phases as far as the linear correlation between Dst disturbance and Bs value is concerned.

The Unusual Interplanetary Type IV Burst of 2002 May 18-23

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An intense solar moving type IV burst was observed from 2002 May 18 09:00 UT to May 23 04:00 UT by WIND/WAVES. Its appearance was accompanied by an interplanetary type II burst (May 22 04:10-23 10:40 UT) and tens of solar flares and coronal mass ejections (CMEs). The flares were, mostly, C-class and the majority of the CMEs was narrow and slow (less than 500 km/sec). In the decametric and metric range the main radio activity comprised of type III bursts. We present a multi-instrument, multi-frequency study of this event in an attempt to interpret the unusual extend and duration of the type IV burst.

The Copenhagen case of the R3BP with a Manev-type quasi-homogeneous potential

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The Copenhagen case is a well-known instance of the famous restricted three-body problem. The present work is based on the assumption that the two primaries create a Manev-type quasi-homogeneous potential instead of Newtonian potentials and forces, which implies inserting an inverse cube corrective term into the inverse square law of gravitation in order to approximate various phenomena such as the radiation pressure of the primaries or their non-sphericity. Based on this fresh approach, we have investigated various properties of the dynamical system, namely the equilibrium locations of the small body and their parametric dependence, the zero-velocity curves and the evolution of areas of permitted planar motion, the zero-velocity surfaces and their evolution in 3D motion, as well as, the focal points and curves.

A new space weather facility at the National Observatory of Athens in the framework of the PROTEAS project

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We describe a new space weather facility, initiated at the Institute of Astronomy Astrophysics, Space Applications and Remote Sensing (IAASARS) of the National Observatory of Athens (NOA). The facility is part of the PROTEAS project and aims to provide observations, processed data and space weather nowcasting and forecasting products, designed to support the space weather research community and operators of commercial and industrial systems. To this end, ground-based and space-borne observations as well as model results and tools already available or under development by IAASARS researchers are integrated. The components of PROTEAS include: a) chromospheric imaging in Ha by a small full-disk solar telescope in regular basis; b) a prediction tool for forecasting Solar Energetic Particles (SEPs) in relation to solar eruptive events; c) real time monitoring of ionospheric conditions by the upgraded Athens Digisonde; d) a database with near real-time solar observations which will be available to the community through a web-based facility (HELIOSERVER); e) additional data sets from the European Digital Upper Atmosphere Server (DIAS) integrated in an interface with the HELIOSERVER and with improved models and techniques for the real-time quantification of the effects of solar eruptive events in the ionosphere. We present science cases that demonstrate the expanded capabilities that the PROTEAS may offer.

Multi-viewpoint observations of energetic proton release in a major SEP event: EUV waves and white-light shock signatures

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During 2012 March 7, two large homologous eruptive events were launched from the same active region within an hour from each other. Each event consisted of an X-class flare, a coronal mass ejection (CME), an EUV wave, and a shock wave. The eruptions gave rise to a major Solar Energetic Particle (SEP) event that was observed at widely-separated (120°) points in the Heliosphere. From multi-viewpoint energetic proton recordings of this major SEP event we determine the proton release times at STEREO B and A (STB, STA) and the first Lagrange point (L1) of the Sun-Earth system. Additionally, we determine the evolution of the EUV waves in the low corona and reconstruct the global structure and kinematics of the first CME's shock using white-light (WL) data. We compare the energetic proton release time at each spacecraft with the EUV waves' arrival times at the magnetically well-connected regions and the timing and location of the first WL shock. We found that the origin of the SEP event at both STB and L1 was from the first event and the particle release process was shock-related. The proton release at STB is consistent with the time when the first EUV wave reached the STB's magnetically well-connected region. For the SEP event at L1 the proton release time was significantly delayed compared to STB. From 3D-modelling of the first WL shock we found that the particle release at L1 is consistent with the timing and location of the WL shock's western flank; the proton release did not occur in low corona but farther away from the Sun.

On Solutions of the Navier-Stokes-Maxwell Equations in MHD

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An outline of theoretical estimates is given regarding the Navier-Stokes-Maxwell equations in magneto-hydrodynamics in its corresponding differential evolution equation form. We consider the evolution of an incompressible plasma, i.e. a highly ionized gas, which is a mixture of two fluids (electrons and ions). Therefore, we consider the interaction of two fluids with the electromagnetic field. Applying operator-theoretic formulation and if $L^2(\Omega)$ is the usual Hilbert space of Lebesgue square integrable complex valued functions on Ω, where Ω is a domain in R^3 with smooth boundary, then the system of Navier-Stokes-Maxwell equations can be written in the corresponding evolution equation in a suitable Hilbert space. We establish bounded and continuous solutions for the linear problem and under suitable assumption of Caratheodory-Lipschitz-type we find solutions for the non-linear problem.

Galactic cosmic ray spectrum of the Forbush decreases of March 7, 2012

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In March 2012, a lot of intense solar events took place and three great Forbush decreases were produced starting from the March 7, 2012 and are considered as the biggest storm of the solar cycle 24. It was affected from X- and M-class flares and Halo CMEs with velocity up to 2684 km/s. In this work, the analysis of the geomagnetic and solar events producing these Forbush decreases that were recorded from March 7th to 21st, 2012 is presented. Daily values of the cosmic ray intensity derived from the data of the neutron monitor network (www.nmdb.eu) are used on the analysis of these events. Moreover, all mathematical arguments for the derivation of the galactic cosmic ray spectrum during this intense series of Forbush decreases, using the coupling coefficient method that couples the secondary cosmic rays recorded at Earth to the primary cosmic ray flux at the edge of the magnetosphere, i.e. in free space, are presented analytically. Our calculations provide a spectrum of the galactic cosmic rays free of the detectors' local characteristics. The calculated spectral index was varied from the value 2 at the beginning of the Forbush decreases to the value 0.5 at its minimum.

Hysteresis effect of the cosmic ray intensity of 10 GV

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In this work the hysteresis effect of the cosmic ray intensity with rigidity of 10 GV at the top of the atmosphere which are obtained from all ground- based neutron monitors of the worldwide network in comparison to the sunspot number and the solar flux of 10.7 cm have been studied, during the solar cycles 20- 23. The anticorrelation between the cosmic ray variations of 10 GV and the above solar indices as well as the hysteresis effect, are obvious. Our results are in very good agreement with those obtained from previous works on individual neutron monitor stations. It is also confirmed that the time lag of the cosmic ray intensity of 10 GV against the two solar indices presents a different behavior between even and odd solar cycles due to the polarity reversal of the solar magnetic field. Finally, it is concluded that the time series of cosmic rays of 10 GV is in response to the neutron monitor data and is very useful for the cosmic ray modulation and space weather studies.

The extended geomagnetic storm of March 2015

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It is known that the current solar cycle 24 started at the year 2009 after an extended minimum, it reached its maximum very fast at the year 2012-2013 and now is at the declining phase. Although all this time period is characterized by low solar activity, on March of the year 2015 the most intense geomagnetic storm (G4) of the current solar cycle was recorded. It started on March 17th and it was the result of the interaction between the complex solar activity which spotted at the active region AR2297 S22W29 and Earth's magnetosphere. Especially a magnetic filament erupted between 00:45 UT and 02:00 UT accompanied by a C9.1 class solar flare with peak time at 02:13 UT hurled an Earth directed CME into the interplanetary space. This ICME arrived at Earth in the first hours of March 17th and a minimum of Dst index of -223 nT (preliminary data) was noticed at 22:00-23:00 UT. At this time interval the Kp index reached the maximum value of 8, the Ap index was 179 for the time 21:00-23:59 UT and a ~3% decrease of cosmic ray intensity recorded at Athens neutron monitor. In the case of March 2015 comparing cosmic ray intensity data between polar and middle latitude stations a decrease of cosmic ray intensity on polar stations was observed, while on middle latitude stations the intensity of cosmic rays remained unaffected. This fact proves the existence of a geomagnetic storm as the abnormally increased cosmic ray intensity on middle latitude stations can be explained by the compression of Earth's magnetic field affecting mainly middle latitude stations, such as Athens and Rome ones. Another proof of the geomagnetic storm is the variation of the energy threshold and magnetic rigidity of middle latitude stations. We can notice that the value of the cut-off rigidity of Athens Neutron Monitor station is decreased by ~0.5GV, while of the polar stations did not changed. Moreover an extended study of the asymptotic cones of polar and middle latitude neutron monitor stations during this event showed that negative values of the Dst index lead the cones to be removed to bigger geographic latitudes. For Dst =228 and Kp=6 (March 18, 00:00) we have the biggest variation from the normal cones, while it is not happened the same with Dst=-86 and Kp=8 (March 17, 15:00). It means that the disturbances of Kp are recorded before those of Dst index according to Tsyganeko T96 model. Interesting results on the geomagnetic indices are discussed.

3d Asymmetric Periodic Orbits in the Sun-Jupiter-Trojan Asteroid-Spacecraft System

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Baltagiannis Agamemnonas (Researcher)

We consider the Sun, the Jupiter and an hypothetical Trojan Asteroid to lie at the apices of an equilateral triangle while a Spacecraft is moving under the Newtonian gravitational attraction of these three primary bodies. This problem has planar families of non-symmetric periodic orbits which we have already found in previous work cite{bal13}. The planar family which emanates from the equilibrium point L_3 has two vertical-critical periodic orbits. From these two critical points we found two families of three-dimensional asymmetric periodic solutions. Then we focused our research to find 3D periodic orbits close to Asteroid. We found a family of non-symmetric three-dimensional periodic orbits around the Asteroid and the stable equilibrium points L_6 and L_7 of the problem. Characteristic curves of all these families are presented. The stability of each periodic solution we found is also studied.

Families of 3D Periodic Orbits in ihe Photogravitational Restricted Four-Body Problem

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Papadouris John (University of Patras)

Let m_1, m_2 and m_3 be the masses of three bodies, called primaries, with $m_1>>m_2=m_3$ moving in circular periodic orbits around their center of mass fixed at the origin of the coordinates. These masses always lie at the vertices of equilateral triangle with the dominant body m_1 (Sun) being on the negative x-axis at the origin of time. The Sun is a radiation source. A massless particle is moving under the Newtonian gravitational attraction of the primaries and does not affect the motion of the three bodies. Using the vertical-critical orbits of planar families of symmetric periodic orbits as starting points, we determine and present in this paper, families of three-dimensional periodic solutions of the problem as the dominant body m_1 radiates. The stability of every three-dimensional periodic orbit which numerically calculated is also studied.

ULF wave power features in the topside ionosphere revealed by Swarm observations

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Recently developed automated methods for deriving the characteristics of ultra low frequency (ULF) waves are applied to the Swarm datasets in order to retrieve, on an operational basis, new information about the near-Earth electromagnetic environment. Processing Swarm measurements with these methods helps to elucidate the processes influencing the generation and propagation of ULF waves, which in turn play a crucial role in magnetospheric dynamics. Here we present the first ULF wave observations by Swarm, obtained by applying our analysis tools to the latest ten months of the mission (i.e., after the constellation attained its final configuration) using scalar magnetic field data. We find evidence for the decay of the intensity of Pc3 wave events with altitude in the upper ionosphere as predicted by the theory. We show that the major characteristics of the ULF wave power maps generally agree with respect to the maximum wave activity seen by the upper satellite and the lower pair of satellites when the power spectrum of the higher satellite is shifted by one hour in magnetic local time (MLT). Moreover, we compare these maps to 10 years long ULF wave observations at low Earth orbit (LEO) by the CHAMP mission.

Long-term variation of the barometric coefficient of the neutron component of cosmic rays

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In this work a detailed analysis of the barometric coefficient of the Athens Neutron Monitor Station (A.Ne.Mo.S.) during the solar cycles 23 and 24 is presented, studying the dependence of the barometric coefficient on the different phases of the solar cycle. The barometric coefficient is calculated on yearly and monthly basis for the time period from January 2001 to December 2014, in order to study yearly and seasonal variations during this time period. A preliminary result of this study shows that the variation of the calculated barometric coefficient follows the 11-years behavior of the solar cycle. The variations of the primary cosmic ray flux are subtracted by using data from the Rome neutron monitor station as a reference one. The barometric coefficient of Athens Neutron Monitor Station takes values between -0.72% mb^{-1} and -0.67% mb^{-1} with an average value of 0.70% mb^{-1} for the above time period. For this work the online barometric coefficient tool which is provided as a web application through the Athens Cosmic Ray Station (cosray.phys.uoa.gr) and which obtains the neutron monitor data from the European High Resolution Neutron Monitor Database (NMDB; www.nmdb.eu), is used.

What does determine the polarity of core in Magnetic Flux Rope structures of the Earth's Magnetotail.

Sarafopoulos Dimitrios
University of Thrace

This paper primarily examines the key factors being involved in precisely determining the sign of the core field in a magnetic flux rope (MFR) like structure embedded in the tailward plasma flow associated with the Earth's magnetotail. Magnetic flux ropes are frequently detected by satellites moving smoothly northwards (upwards) or southwards (downwards) and crossing almost the whole plasma sheet; the sign of the rope's core is associated with the local tail's motion: If the tail is bending to an upward or downward direction, then the sign of the rope's core, being essentially an intense By deviation, will be positive or negative correspondingly. On the basis of this observational finding, a major question concerns the mechanism by which the tail's motion is dictated. The reconnection process acting in the tail will obviously produce symmetric structures of MFRs (with respect to the neutral sheet plane); therefore, the detected organized asymmetry may be an additional indication in the whole magnetotail's dynamics. Moreover, we discuss the issue of the core's sign in cases without any significant magnetotail's motion. A model interpreting the diagnosed behavior is introduced: Once a tailward ion jet is produced in a thinned plasma sheet, it might form clockwise or counterclockwise ion vortices (i.e., loop-like ion currents) providing the "magnetic core" with the appropriate sign. The crucial role of the interplanetary By deviation of the magnetic field (IMF) is scrutinized and taken into account. The whole model is tested under the condition of long-lasting extraordinary events characterized by a persistent-intense By deviation with a duration up to 34 min. This work, based on Geotail single-satellite measurements, is not a statistical one; it is a first approach allowing the reconstruction of measurements in the whole range of the magnetotail's deflections, from negligible up to stronger significant magnetotail movements, and should be therefore elucidated in more detail. The average duration for the studied ropes is ~90 sec; they occur at distances greater than 25 RE from the Earth.

Radio Observations of the March 20, 2015 Solar Eclipse in Thessaloniki

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We present the results of radio observations of the March 20, 2015 solar eclipse (of magnitude 38% in Thessaloniki). For the observations we used the newly constructed custom-made radio telescope of the Laboratory of Astronomy of the University of Thessaloniki. The 3.2m axial dish is mounted on a fully automated computer-controlled equatorial mount. It was constructed by upgrading an old polar axis satellite antenna in 2014. The total power observations were made at 11 GHz. A series of bidirectional RA transits, both before and after the eclipse were recorded. The data collected allowed us to find the intensity relation between the solar and lunar radio emission at 11 GHz. Between 1st and 4th contact we continuously tracked the Sun. As expected the intensity dropped significantly. However, it is interesting that around the middle of the eclipse, there was a noticeable increase of the observed emission, which could be attributed to terrestrial interference or to intrinsic activity of the Sun. Additional transit observations of the sun and moon were made exactly one synodic month later (on April 18) that confirmed the previously observed intensity relation.

Spectroscopic observations of the pre-eruptive configuration prior to the ejection of two CMEs from Active Region NOAA 11429

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Gontikakis Costis (RCAAM), Patsourakos Spiros (University of Ioannina), Tsinganos Kanaris (UoAthens)

We present a spectroscopic analysis of the pre-eruptive configuration of active region (AR) NOAA 11429, prior to the ejection of two Coronal Mass Ejections (CMEs) on March 7, 2012. We study the thermal components and the dynamics associated with the ejected flux ropes. We perform a Differential Emission Measure (DEM) analysis using Hinode/EIS and AIA/SDO observations to identify the emission components of the active region associated with the flux ropes. We studied separately the East and West part of the active region, from which two different CMEs originate during two X-class flares. We identified a high temperature (log T = 6.8 - 7.1) flux rope emission component in both the East and West part of the AR. The time evolution of the East region showed increase of the mean DEM in this temperature region by an order of magnitude 5 hours prior to the first CME ejection. We associated this emission increase with a gradual expansion of the flux rope (blueshifts around ~20 kms) and gradual heating (increased non-thermal velocities in Ca XV~200.97AA). Using the ratio of Ca XV~181.90AA over Ca XV~200.97AA, we measure an electron density of $7x10^{9} – 6x10^{10}$ cm^{-3}. We argue that the ejection of the CME from the East part triggered the CME from the West part of active region.

Non-twisted flux tube emergence and dynamics

Syntelis Petros
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Archontis Vasilis (University of St Andrews), Gontikakis Costis (RCAAM), Tsinganos Kanaris (UoA)

We study the emergence of a non-twisted flux tube from the solar interior into the solar atmosphere using 3D MHD simulations. We investigate the initial emergence and resulting dynamics in respect to the length of the buoyant part of the flux tube λ. We find considerable differences on the dynamics of the emergence of the flux tube when λ is varied. We find the formation and ejection of plasmoids, and the onset of hot and fast jets from the interface in a recurrent and intermittent manner. We show that small λ is a parameter contributing to the coherence of the emerging flux tube.

Cosmic ray diurnal anisotropy during different phases of the solar cycles 23 and 24

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The diurnal variation of cosmic ray intensity for the time period 2001 to 2014 is studied, covering the maximum, the descending phase of the solar cycle 23, the minimum of the solar cycles 23/24 and the ascending phase of the solar cycle 24. Data from two neutron monitor stations at Athens (Greece, cut-off rigidity 8.53 GV) and Oulu (Finland, cut-off rigidity 0.81 GV) are obtained. These stations have the same geographic longitude, but different geographic latitude. ?he amplitude and phase of the diurnal anisotropy vectors have been calculated on annual and monthly basis using Fourier analysis. From our analysis, it is resulted that there is a different behaviour during the different phases of the solar cycles depending on the

solar magnetic field polarity. Comparison with corresponding phases of other solar cycles has been performed. The characteristics of the diurnal anisotropy during extreme events of cosmic ray activity are also discussed.

Analysis and interpretation of ion injections into the ring current during magnetospheric substorms

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Katsavrias Christos (University of Athens), Anastasiadis Anastasios (IAASARS,NOA), Daglis Ioannis A. (University of Athens)

We investigate the origin and transport of ring current particles during magnetospheric substorms, their interaction with the tail current and the correlation of their dynamics with the substorm phases. A test-particle solver, developed for such purposes, is coupled to models providing the Sun-driven geomagnetic field and the electric fields due to convection, corotation and magnetic induction. In order to trace the plasma sources in substorm-time injections, test-particle simulations are conducted in reverse-time, using data from RBSP measurements as "final" conditions and following the particle motions up to the "initial" state. The dependence of the results on the variations of Kp and of the electric potential amplitude, as well as on the time scaling of the substorm event, is investigated.

Fermi acceleration models for weakly and strongly turbulent plasmas

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We constructed a 2D lattice gas model to study the first and second order Fermi acceleration in a finite system. The famous "magnetic cloud" used by Fermi is in our model an "active scatterer". Particles colliding with this scatterer gain or lose energy in weak turbulence, or gain systematically energy in strong turbulence. The active scatterers are only a small fraction of the total number of the grid points. Using typical parameters from solar active regions, we have explored the validity of our model using the well studied case of the second order Fermi acceleration (weak turbulence). The electrons and ions are released at random places inside the box with initial velocity following statistically a Maxwellian distribution with temperature 10^6 K.The scatterers are initially moving with the Alfven speed inside the simulation box. We have shown that our model represents well the findings of the analysis presented initially by Fermi, but there are some very interesting variations on Fermi's initial theme. We have also explored the case were the scatterers are "shock" waves moving with velocity 2-3 the Alfven speed. In this case, the accelerator has two new characteristics, (1) it is first order, and (2) it has a threshold in energy. Finally, we mixed the accelerators assuming that waves moving with a Kolmogorov spectrum include scatterers with sub-Alfvenic (weak turbulence) and super-Alfvenic velocities (strong turbulence).

Electron acceleration by Langmuir waves in weakly and strongly turbulent plasma

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In many astrophysical plasmas the presence of strong currents due to global motion of the magnetic field or sharp magnetic gradients can excite electrostatic plasma waves. The interaction between charged particles and plasma waves can lead to particle acceleration. We assumed a spectrum of exited Langmuir waves in a plasma of temperature 100 eV and density 10^9 cm^{-3}, and constructed the corresponding wave electric field on a 1D spatial grid. The amplitudes of the waves are chosen to follow a power law with random phases and have magnitude such that the interaction with the particles can be considered to be quasilinear. We then considered test-particles in this environment, with assumed initial Maxwellian velocity distribution, and which are uniformly distributed along the linear dimension of our box. With these assumptions, we follow thousands of particles in their evolution, estimate the velocity diffusion coefficient, and compare the numerical estimates with our analytical, quasi-linear results. In the velocity distribution, the formation of the well-known plateau around the resonant velocity was observed, while accelerated particles were also present. The numerical diffusion coefficient was found to be in good agreement with the analytic, quasi-linear one. We also tested the applicability of the quasilinear theory, by increasing the energy of the waves and monitoring when the agreement between theory and simulations is lost. We found that the quasilinear theory is limited to very weak electric fields, in order the agreement of the numerical simulations with the analytical results not to break down.

Session 2: Extragalactic Astronomy and Astrophysics

Oral Presentations

Tracing the evolving interstellar medium of star forming galaxies over the last 10 billion years

Magdis Georgios
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Recent observations have revealed that the stellar birth-rate in our cosmos peaked approximately ten billion years ago and have identified distant, massive galaxies as the principle hosts of star-formation activity. Was the star-formation in these galaxies mainly driven by smooth cold gas accretion, similar to what we see in the majority of local star-forming galaxies, or rather by short lived starburst events triggered by galaxy mergers? Is there a universal star-formation law that governs the efficiency at which galaxies form stars? What are the physical processes that shaped the evolution of the star formation activity in the galaxies over the last 10 billion years? Key answers to these questions are hidden in the interstellar medium of the galaxies, which is mainly made of gas and dust. By studying the dust and gas properties of star forming galaxies from z=0 to z=3, using state of the art observations carried out with the Herschel Space Observatory as well as with ground based interferometric facilities (IRAM/ALMA), I will present evidence that the majority of star forming galaxies at all cosmic epochs follow some simple scaling laws between the star formation rate, the molecular and stellar mass and the luminosity of the far infrared atomic lines. These scaling laws along with the dynamical and morphological properties of the ionised gas as traced by integral field spectroscopy (VLT/KMOS) suggest a great degree of homogeneity in the star formation activity throughout the star formation history of the Universe and favor smooth gas accretion over violent starbursts triggered by major mergers, as the dominant mode of star formation in the Universe.

Probing the Physical Conditions of Dense Molecular Gas in ULIRGs with LVG modelling

Leonidaki Ioanna
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The gas-rich content of Ultra Luminous Infrared Galaxies (ULIRGs) constitutes a great laboratory in characterising the physical processes occuring in molecular gas and hence probing star formation properties. In particular, molecules with large dipole moments such as CS, HCN, HCO+, which are the fuel of star formation, can reveal the physical/excitation conditions of molecular gas phases in galaxies. For that reason, we compiled the aforementioned dense gas tracers in a sample of local (U)LIRGs in order to investigate the physical properties of the gas while at the same time put constrains on their excitation conditions. The sample in use consists of 26 galaxies all observed within the framework of the Herschel Comprehensive (U)LIRG Emission Survey (HerCULES). For all galaxies, we compiled our ground-based spectral line observations as well as all available data from the literature.

Using Large Velocity Gradient (LVG) radiative transfer models in these spectral lines and in a wide parameter space [nH2, Tkin, Nmol], and combining multiple molecules and multiple excitation components, it is possible to break the degeneracy between different parameters and to probe molecular gas physical conditions ranging from the cold and low-density average states in giant molecular clouds all the way up to the state of the gas found only near their star-forming regions. We then analyse the best LVG solution ranges to match the observed SLEDs (using more than one excitation components where necessary) in order to disentangle different molecular gas phases and possibly different molecular gas heating mechanisms.

Gas, Dust and Stars in Early-Type Galaxies

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Early-type galaxies hold important clues to how galaxies form and evolve. Interstellar medium studies have uncovered that an important fraction of them contains significant amounts of gas and/or dust. We consider a sample of local early-type galaxies simultaneously detected in submillimeter and CO observations. We discuss our results on scaling relations relating their star formation and interstellar medium properties on global scales, as well as their implication.

Probing the AGN - Star formation connection through the Lens of the Star Formation Reference Survey (SFRS)

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Zezas Andreas (UoC / FORTH), Ashby Matthew L. N. (Harvard-Smithsonian Center for Astrophysics), Willner Steven (Harvard-Smithsonian Center for Astrophysics), Bonfini Paolo (Swinburne University)

Understanding the interplay between star formation (SF) and AGN activity is one of the most challenging subjects of modern Astrophysics, as both phenomena play crucial role in galaxy evolution. We probe the SF - AGN connection through the lens of Star Formation Reference Survey (SFRS), a multi-wavelength project aiming to study the process of star formation in galaxies in the local Universe. Using a sample of 369 Infrared-selected nearby galaxies we carefully distinguish those that harbor AGN activity using spectroscopic and photometric diagnostics combined with SED fitting methods. We derive the galactic parameters, such as star-formation histories, star-formation rate (SFR), metallicity and galaxy mass by introducing a novel approach in the SED fitting process, incorporating spectroscopic information alongside the photometric data which, at the same time, allows us to disentangle the star-formation and AGN components. This grands us the opportunity to derive the galaxy main sequence for a representative sample of star-forming galaxies without the influence of AGN emission, and explore the AGN host galaxy locations on the main sequence plain. Additionally, based on the univariate and bi-variate SFR and stellar mass functions for IR selected star-forming galaxies (Bonfini et al, in prep), we calculate the corresponding functions for AGN and non-AGN galaxies. We find that both star forming and AGN host galaxies span the same stellar-mass range. By examining the relative contribution of the different galaxy activity types in the bivariate M(solar) - sSFR function plane we clearly see the signature of the main sequence for the star-forming galaxies, but most importantly we find that Seyfert galaxies together with the so-called Transition Objectsts appear to also form a "main sequence".

Are [CII] 158um Broad-line components of local ULIRGs related to the presence of molecular outflows?

Christopher Natalie
University of Oxford

Mass outflows driven either by stars and/or active galactic nuclei (AGN) feature as a key element in many current models of galaxy evolution; they are believed to regulate and quench both star formation in the host galaxy as well as black hole accretion. Powerful galactic-scale molecular outflows capable of displacing a significant fraction of the entire molecular ISM of their host galaxy, as traced by hydroxyl (OH) or carbon monoxide (CO) molecules, have been reported in several sources. We have investigated if the presence and strength of a broad line component in the FIR fine structure line [CII] at 158um depends on the presence or velocity components of an OH or CO outflow. The ability to use [CII] as a signpost for molecular outflows would be of significant importance for high redshift objects, where CO and OH observations are impossible, but [CII] is easily detectable. The results from a search for broad components in the [CII] line profile in a sample of 21 local ($z < 0.09$) ultra-luminous galaxies (ULIRGs) are presented. Observations were made with Herschel/PACS as part of the SHINING key project. Eleven sources show high-velocity wings in their [CII] line profiles, with the FWHM of the broad component (FWHM_B) exceeding 1000 km/s in some sources. In order to understand the effect of AGN or starburst activity on the presence of a broad component, the [CII] profile features in different types of ULIRGs are compared. While the [CII] outflows show no statistical dependence on the star formation rate, there is tentative evidence that FWHM_B scales with AGN fraction. We discuss under which circumstances we find the high dispersion in the gas to be correlated with the molecular outflow and provide a physical explanation to the origin of the [CII] outflow itself.

Physics of extragalactic plasma elements through high cadence, multi-frequency linear and circular radio polarization monitoring

Myserlis Ioannis
MPIfR

AGN jet emition spans from radio to TeV energies and it is polarized at the low frequencies due to the incoherent synchrotron emission mechanism. Furthermore, the intrinsic polarization characteristics can potentially change when the emission is propagated through the magnetized jet plasma through a number of effects like Faraday rotation and conversion. The detection of their polarized emission can be though very challenging due to the low intrinsic polarization levels as well as several depolarizing effects like the complex source structure or the tangledness of the jet's magnetic field which decrease the linear and circular polarization degrees of the emission. Nevertheless, the linear and circular polarization characteristics carry information for the physical parameters in both the jet regions where the radiation is emitted and

propagated through, like the magnetic field strength and topology, the energy content of these regions or even the composition of the emitting particles. Furthermore the jet radio emission is highly variable which is usually attributed to standing or propagating shocked regions in the jet where the magnetic field is compressed, resulting to an increase of the polarization degree. The regions' optical depth evolution after the initial compression, according to theory, changes the observed polarization characteristics in a very specific manner. Thus, linear and circular polarimetric monitoring provides insight to the evolution of the physical parameters at the emission site during such periods of increased variability. In this talk we will present the methodology we have developed to practice high precision linear and circular radio polarimetry, using the vast database of the F-GAMMA program which monitored ~60 gamma-ray loud blazars over the last 8 years at 11 radio frequencies in the range of 2.64 to 228.93 GHz with a mean cadence of 1.3 months. Its database contains a large number of concurrent linear and circular polarization observations at 5 radio frequencies between 2.64 and 14.6 GHz conducted with the Effelsberg radio telescope. Our methodology can measure both linear and circular polarization of bright sources at an accuracy of 0.1 %. We will also present the study case of the source 3C454.3 which shows pronounced variability and optical depth evolution and thus favors the investigation of the physical parameters at its emission regions dynamically.

Jet-Environment Interactions

Vlahakis Nektarios
University of Athens
Katsoulakos Grigorios (University of Athens), Millas Dimitrios (KU Leuven)

The interaction of astrophysical jets with the surrounding plasma may significantly affect their dynamics. We explore this possibility in the case of relativistic, magnetized jets, by means of analyzing the associated time-dependent and steady Riemann problems, and try to connect the results with observable features such as the characteristics of the HST-1 region in the jet of galaxy M87.

The large scale jets of quasars: 100 TeV accelerators lossy pipelines

Georganopoulos Markos
UMBC-NASA/GSFC

The Chandra X-ray observatory has discovered dozens of resolved, kiloparsec-scale jets associated with powerful quasars in which the X-ray fluxes are observed to be much higher than the expected level based on the radio-optical synchrotron spectrum. The most popular explanation for the anomalously high and hard X-ray fluxes is that these jets do not decelerate significantly by the kiloparsec scale, but rather remain highly relativistic. By adopting a small angle to the line-of-sight, the X-rays can thus be explained by inverse Compton upscattering of CMB photons (IC/CMB), where the observed emission is strongly Doppler boosted. Using over six years of Fermi monitoring data, we show that the expected hard, steady gamma-ray emission implied by the IC/CMB model is not seen in PKS 0637-752, the prototype jet for which this model was first proposed. IC/CMB emission is thus ruled out as the source of the X-rays, joining our recent results for the jet in 3C 273. We further show that the Fermi observations require that the jets are not highly relativistic. This has two surprising consequences: These jets need to accelerate particles up to 100 TeV energies and their angle-integrated emission rivals that of their blazar core, making them powerful TeV emitters.

The New Proper Motions Frontier: Recent Discoveries on AGN Jets with HST

Meyer Eileen
STScI

The long operating lifetime of Hubble has resulted in an increasingly valuable archive of images of AGN jets taken over the last twenty years. With recent advances in state-of-the-art astrometric methods, we can now leverage this archive to measure the motions of the relativistic plasma in these jets in galaxies as distant as 500 Mpc, reaching accuracies of 10% the speed of light. I will present the recent discovery of colliding knots leading to an internal shock in nearby radio galaxy 3C 264 (Meyer, Georganopoulos, et al. 2015, Nature), and show movies of the moving jet components in 3C 264 and M87. I will discuss the advances in technique which have enabled even very short exposures (e.g. early WFPC2 “snapshot” images) to be registered using background galaxies, and discuss future observations which will continue to push the envelope of HST proper-motions science.

Population Statistics of Beamed Sources

Liodakis Ioannis
University of Crete

Our understanding of relativistic jets is hindered by the large diversity in observed properties induced by relativistic effects. With this work, we aim to lift this obscuring veil through a population-model approach, and get to the intrinsic variability properties of jets in their rest frame. The questions we address are: (a) What is the relativistically induced spread in observed event timescales? Could blazar behaviours in the time domain observed to be very varied be in fact very similar in the jet rest frame? (b) How different is the beaming between sources in flux-limited samples? Lacking any additional information, is it useful to make statistics-based assumptions for the viewing angle of a single source? (c) Do BL Lacs and Flat Spectrum Radio Quasars have different beaming properties? Could differences observed between them in the time domain be attributed to how relativistic effects differently affect each population? (d) Do single-blazar Doppler factor estimation techniques (such as equipartition Doppler factors and self-synchrotron Compton Doppler factors) yield distributions consistent with population models when applied to flux-limited samples?

The importance of inner boxiness for understanding barred galaxies Dynamics.

Patsis Panos
RCAAM, Academy of Athens

Boxy features are usually associated with the edge-on morphology of disk galaxies. In the present talk We discuss the dynamical mechanisms that reinforce the formation of boxy structures in the inner regions, roughly in the middle, of bars observed nearly face-on. Outer boxiness, at the ends of the bars, is usually related with orbits at the inner, radial 4:1 resonance region and can be studied with 2D dynamics. However, in the middle of the bar dominate 3D orbits that give boxy/peanut bulges in the edge-on views of the models. We show that 3D quasi-periodic, as well as 3D chaotic orbits sticky to the x1v1 and x1v1' tori, especially from the inner Lindblad resonance (ILR) region, have boxy projections on the equatorial plane of the bar. The majority of vertically perturbed 2D orbits, initially on the equatorial plane in the ILR resonance region, enhance boxy features in face-on bars. The extent of the inner boxiness along the major axis is about the same with that of the peanut supporting orbits in the side-on views. Fece-on inner boxiness can also appear in 2D models if sticky chaotic orbits with the appropriate energies are present.

Convergence regions of the Moser normal forms and the structure of chaos

Harsoula Mirella
RCAAM, Academy of Athens

We use convergent series in order to represent analytically the Moser invariant curves in the chaotic domain around unstable periodic orbits of multiplicity 1 in the case of the hyperbolic Henon map. We apply our method to the main unstable periodic orbit "O" at the origin (x=y=0) and to another unstable periodic orbit "S" of multiplicity 1. We find that chaotic orbits with initial conditions inside the region of convergence around "O" remain always inside this region. On the other hand orbits with initial conditions outside this region have successive iterations closer and closer to the limit of the convergence region but can never enter inside it. Similar results apply to the convergence regions around every unstable periodic orbit inside the main convergence region around "O". Thus the various convergence regions partly overlap. Finally, we derive analytically the homoclonic and heterolinic points of the asymptotic curves of the periodic orbits "O" and "S" and find good agreement with the points computed numerically from the map. Our results can be generalized for higher order unstable periodic orbits and thus we are able to describe in detail the structure of chaos in dynamical systems. An important application of this study in Dynamical Astronomy, is in mappings derived from the averaged Hamiltonians of N-body models simulating barred-spiral galaxies. In this case, the shape of the region of convergence around the "PL1-PL2" unstable periodic orbits gives the spiral structure and defines the path that chaotic orbits follow before escaping from the system.

Magnetism along Spin

Contopoulos Ioannis
RCAAM, Academy of Athens

We review recent observational evidence that the magnetic moments of astrophysical bodies are preferentially oriented along the direction of their spin. Such an association between magnetism and spin cannot be explained by standard magnetohydrodynamics (MHD). Instead, it makes a strong case for a Cosmic Battery acting at the innermost edge of the accretion disks around astrophysical black holes.

Too few and too light? Testing LCDM cosmology with field dwarf galaxies

Papastergis Manolis
Kapteyn Institute/U. of Groningen

The LCDM cosmological model has proven extremely successful in reproducing the large-scale properties of our universe. However, a number of observational challenges to the model have been identified on the small scales relevant for dwarf galaxy formation. Perhaps the best studied among them are the missing satellites (MS) and too big to fail (TBTF) problems, which both originally referred to the satellite population of the Milky Way. In this talk, I will show that the same small-scale cosmological challenges are also present for dwarf galaxies in the field. This statement has important scientific implications, because most proposed solutions to the MS and TBTF problems have so far been based on satellite-specific processes and considerations. Lastly, I will briefly describe the subset of proposed solutions that are also applicable to isolated galaxies, and speculate about their prospects for providing a comprehensive solution to the small scale challenges of LCDM.

DRAGNET: A high-speed, wide-angle radio camera for LOFAR

Sanidas Sotirios
API/University of Amsterdam

The characterization of the transient sky is becoming one of the top priority science projects for all major telescopes in the world, since transient events are usually linked with the most energetic and exotic astrophysical phenomena in the Universe. DRAGNET, will extend the capabilities of the LOFAR radio telescope, turning it into a groundbreaking synoptic radio telescope, that will characterise the transient radio sky in sub-second time resolution searching and detecting fast radio bursts in real time. The unique computational capabilities of the DRAGNET observing system (>600TFLOPS) will also enable additional pulsar science, like observing at full LOFAR bandwidth ~100 pulsars simultaneously for microsecond timescale studies. In this talk we will give a brief overview of DRAGNET, the commissioning of which is going to take place this summer.

X-ray reverberation studies of Active Galactic Nuclei

Papadakis Iossif
University of Crete

Active Galactic Nuclei (AGN) are powered by accretion of matter onto a supermassive black hole. X-ray emission is a ubiquitous feature in their spectra. Variability arguments and microlensing observations indicate that the X-rays are produced in a region which is less than 10-15gravitational radii. X-rays are also thought to be emitted from the innermost parts of the central source, where most of the gravitational power is released. Consequently, the X-ray emission presents the most reliable probe of the physics of accretion closest to the AGN central engine. If the accretion disc extends to the innermost stable circular orbit, and the X-rays irradiate its inner part, general and special relativity effects should leave their mark on the X-ray reflection features. The best studied case is the shape of the emitted iron line which is expected to be asymmetrically broadened. Furthermore, there should be time delays between the primary X-ray continuum and the reprocessed emission. These time delays depend on the distance of the X-ray source from the reprocessing material, for a given X-ray geometry. I will review the recent developments in the search for the X-ray "reverberation lags" in the various energy bands ("soft", the iron line and the Compton hump energies) and I will present new theoretical ideas as to how we can probe the signature of the relativistic effects in the X-ray emission from AGN.

A deep Chandra observation of the interacting star forming galaxy Arp299

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Zezas Andreas (University of Crete/FORTH), Della Ceca Roberto (INAF), Ballo Lucia (INAF)

We present Chandra ACIS-S observations of the X-ray luminous galaxy Arp299 (NGC 3690+IC 694). We detect 26 X-ray sources with luminosities above ~10^{39} erg/sec all of which belong to the class of Ultra-Luminous X-ray sources (ULXs). We measure the spectral parameters and fluxes of 20 sources with more than 50 net counts by performing spectral fitting. We find that in all cases but three, an absorbed power law model gives a good fit with photon indices ranging from $\Gamma = 0.9$ to $\Gamma = 3.9$ and hydrogen column density typically greater than the Galactic. We also identify the nucleus of NGC 3690 as an AGN with a prominent Fe Kα line. For the remaining 6 sources with less than 50 net counts we estimate their spectral parameters from their hardness ratios. We also find that their photon indices range from $\Gamma = 0.5$ to $\Gamma = 3.5$. The hard X-ray spectra of the discrete sources strongly indicate that they are X-ray binaries. Comparison with HST ACS data in the blue and UV band shows that the brightest X-ray sources are associated with young (< 100 Myrs) star forming regions suggesting that they are High Mass X-ray binaries (HMXBs). This is also consistent with the typically large HI column density of these sources. Finally we derive the X-ray luminosity function (XLF) of the sources in Arp299 and we compare it with the XLFs of X-ray binaries in other star forming galaxies.

The "iron-line/continuum" time-lags in AGN

Epitropakis Anastasios
University of Crete
Papadakis Iossif (UoC), Dovciak Michal (Astronomical Institute, Academy of Sciences, Czech Republic)

We have performed a detailed study of the statistical properties of traditional time-lag estimators, using extensive simulations in the case of constant delay, power-law and "reverberation"-like model time-lag spectra. Using the results from this study, as well as a large amount of archival XMM-Newton data, we have calculated the time-lag spectra between the "continuum" (i.e. 2-4 keV) and "iron-line" (i.e. 5-7 keV) energy bands for seven bright AGN, resulting in time-lag estimates with statistical properties suitable for traditional model-fitting techniques (i.e. estimates that are unbiased, normally distributed and with a known error). We used model transfer functions for an X-ray reverberation scenario in the case of the "lamp-post" geometry, which takes all relativistic effects into account, and fitted the resulting model time-lag spectra to the data. We also used archival ASCA and Suzaku data to determine the time-lag spectra at longer time-scales, and compared them with the best-fit model predictions in order to investigate the validity of the resulting best-fit models. We will discuss our results with those presented in the literature in the case of the "soft-excess/continuum" time-lags, and their implication regarding the innermost geometry (i.e. X-ray source distance from the disc and inner disc radius) in these AGN.

First results from the 1.1 Ms Chandra X-ray Visionary Program of the Small Magellanic Cloud

Antoniou Vallia
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Zezas Andreas (UoC, FORTH/IESL, SAO), Drake Jeremy J. (SAO), SMC XVP Collaboration

We present the results from the 1.1 Ms Chandra X-ray Visionary Program of the SMC. The 11 selected fields represent young (<100 Myr) stellar populations of different ages. From the analysis of 13 fields (including 2 archival observations with similar exposures), we detected 910 sources with S/N>3 down to Lx~6x10^{32} erg/s, well within the regime of the X-ray emission of quiescent X-ray binaries (XRBs). We discuss the results of timing analysis and a search for variability within each exposure and between the two-split 100 ks observations of each field, and of spectral analysis in which a variety of spectral models were fitted. Although the majority of the detected sources are background AGN, 105 sources are associated with early-type stars. We also derive the X-ray luminosity function of the identified high-mass XRBs (HMXBs) and find clear evidence for a break. We attribute this to the "propeller effect", whereby accretion and its associated X-ray emission are inhibited by outward magneto-centrifugal acceleration within the magnetic field of the spinning neutron star. Finally, we measure the formation efficiency of HMXBs as a function of age, showing evidence for enhanced production between 20-50 Myr.

Variability signatures in the context of the one-zone hadronic model for blazars and GRBs

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Past studies have shown that the accumulation of relativistic protons in compact sources may result in very different variability signatures of the escaping photon emission. In particular, we have identified two operating regimes of the physical system, namely the sub-critical and super-critical ones, which are characterized by different radiative efficiencies, photon spectra and temporal behaviors. First, we examine the variability patterns that ensue in the subcritical regime for a time dependent proton injection, and show that the photons ("output signal") retain the time signatures of the injected protons ("input signal"). We apply our findings on the prototype blazar Mrk 421 that shows time-variable emission from optical wavelengths up to TeV energies. In the supercritical regime and for a constant proton injection, we showed that the global energetics, as well as the spectral of the ensuing photon flare resemble strongly to the corresponding ones of the so-called prompt Gamma Ray Burst (GRB) emission. We extend our calculations to include cases of variable proton injection that lead the system intermittently inside the supercritical regime. We find that this results in strong non-linear photon variability with characteristic power spectral distributions that are largely independent of the input. We compare this behavior to the one that is observed from GRBs.

Constraining the Properties of AGN host galaxies with Spectral Energy Distribution modeling

Charmandaris Vassilis
NOA & Univ. of Crete
Ciesla Laure (Univ. of Crete), Georgakakis Antonis (MPE), Georgantopoulos Ioannis (NOA/IAASARS), Xilouris Manolis (NOA/IAASARS), Magdis George (Oxford)

Detailed studies of the Spectral Energy Distribution (SED) of normal galaxies are been increasingly used in order to understand the physical mechanism dominating their integrated emission, mainly due to the availability of high quality multiwavelentgh data from the UV to the far-infrared (FIR). However, systems hosting dust-enshrouded nuclear starbursts and/or an active galactic nucleus (AGN) due to an accreting supermassive black hole, are especially challenging to study. This is due to the complex interplay between the heating by massive stars and the AGN, the absorption and emission of radiation from dust, as well as the presence of the underlying old stellar population.

I present our analysis, based on mock cataloques, on the influence of the AGN emission to the estimates of stellar mass and star formation (SF) activity using the latest version of the CIGALE, a sophisticated galaxy SED fitting model, relying on energy balance between the various emission components from the UV to the FIR. Our results (Ciesla et al. 2015a and Ciesla et al 2015b) indicate that we can readily constrain the AGN contribution when it is larger than 20% of the bolometric luminosity, while we underestimate the SF rate in Type 1 systems when the AGN power increases. Finally I compare our ability to identify dust enshrouded hidden AGN in the COSMOS field using SED fitting with other semiempirical methods relying on X-ray detection and/or mid-IR color selection.

A complete census of mid-infrared spectral features in AGN

Hatziminaoglou Evanthia
ESO

I will present results of a comprehensive study of the mid-infrared (MIR) spectral characteristics of almost 800 active galactic nuclei (AGN) with available spectra from the Spitzer InfraRed Spectrograph (IRS), the largest such sample ever presented in the literature, and derive in an unequivocal fashion the MIR spectral characteristics of AGN. We quantify the contribution of the host galaxy to the MIR emission of AGN and find the emission of the host galaxy to contribute, on average, more to the MIR spectra of type 2 AGN compared to their type 1 counterparts. The strength of silicate feature at 9.7 micron, Ssil, is measured before and after subtracting the host galaxy emission from the IRS spectra. As previously established, Ssil exhibits on average weak emission in type 1 AGN and absorption in type 2 AGN. The numbers of type 1 and 2 AGN with the feature in emission increase by 20 and 50 per cent, respectively, once the host galaxy is removed, while 35 per cent of objects with the feature originally in absorption exhibit it in even deeper absorption after subtraction of the host. Using the luminosity at 7 micron as a proxy to the bolometric luminosity, covering thus almost 6 orders of magnitude, we find that Ssil can be in emission even in the faintest AGN. Intermediate Seyfert types see their Ssil go from weak emission to absorption as the type increases (i.e. from Sy1.2 to Sy1.9), and this is an independent proof that these sub-types are the result of orientation effects. The derived distribution of Ssil provides a solid test bed for modeling the dust distribution in AGN, as they dramatically constrain the parameter space of the models in terms of morphology (smooth or dusty distribution), chemistry, emission spectrum of the primary source, as well as geometry. Furthermore, for 20 per cent of the objects with the feature in emission there is a shift of the peak wavelength towards longer wavelengths of at least 10 per cent. Regarding the incidence of star formation in AGN and using the fractional contribution of the AGN to the MIR luminosity, as well as the equivalent width of the Polycyclic Aromatic Hydrocarbon (PAH) features, we find the type 2 AGN to exhibit, on average, more prominent ongoing star formation than their type 1 counterparts and conclude that at least part of the obscuration must come from the host. However, we find no correlation between the AGN and star formation tracers, implying that even though the two phenomena co-exist, they are not necessarily causally related.

Non-parametric morphological classification of LIRGS

Psychogyios Alexandros
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We present our detailed analysis of the morphological classification of a sample of 86 luminous infrared galaxies (LIRGs) from the Great Observatories All-sky LIRG Survey (GOALS) using non-parametric coefficients and compare their morphology as a function of wavelength. We rely on Hubble images obtained in the B and I-band using the Advanced Camera Survey (ACS), in the H-band with the Near Infrared Camera and Multi-Object Spectrometer (NICMOS) as well as 5.8μm using the Infrared Array Camera (IRAC) of Spitzer. Our method is based on the calculation of Gini (G) and M20 non parametric coefficients by creating a segmentation map for every galaxy at each band. We identify the emitting region using the corresponding Petrosian radius and extend our analysis by adding the M50 coefficient . We contrast our classifications using the G-M20 plane of Lotz et al. (2004) with those of Haan et al. (2011). We find that classifying the morphology of LIRGs in these 4 bands is not straightforward and the G and M20 plane presents a number of degeneracies. Furthermore, M20 is a better morphological tracer than Gini because it can better separate LIRGs which are members of multiple systems than isolated LIRGs from B to H band. Finally, we confirm the fact that as the luminosity of our sample increases, these LIRGs are getting more compact and the specific star formation rate increases.

Spatial variations in the IR/radio correlation in Luminous Infrared Galaxies

Vardoulaki Eleni
University of Crete

Luminous infrared galaxies in the local Universe, due to their dusty nature, are excellent laboratories to study dust properties of galaxies and investigate the possible dust heating mechanisms, attributed either to an active galactic nucleus (AGN) or a starburst (SB). We use Spitzer and Herschel data to create dust temperature maps for a sample of LIRGs from the GOALS sample at low redshift ($z < 0.088$), which appear to be most extended at radio VLA 1.49 GHz observations (6 arcsec resolution). The purpose is to explore the connection of radio emission to star formation and dust heating mechanisms. We use PACS and Spitzer photometry to investigate cold and warm dust, and get a census of the warm/cold dust distribution and of the extend of the obscured nuclear regions in these LIRGs. With the aid of spatially resolved q maps ($q = \log(f_{IR} / S_{radio})$, q8um & q24um) we point to the location of regions of intense synchrotron emission due to a SB or an AGN. By comparing dust temperature variations to variations in the IR/radio correlation, given by the q maps, we explore the AGN/SB connection in these LIRGs spatially. Finally, we compare the spatially resolved IR/radio correlation to radio spectral index maps for these sources in order to understand the physics behind the variations in q, the role of the environment and the rate of energy loss from the point of acceleration.

ISM Properties of Cold and Warm local LIRGs

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Universidad Diego Portales

Luminous and Ultra-luminous Infrared Galaxies ((U)LIRGs) represent the most important galaxy population at redshifts $z > 1$. They account for more than 50% of all star formation produced in the Universe at those epochs and encompass what it is called the main-sequence (MS) of star-forming galaxies. Investigating their local counterparts –low luminosity LIRGs– is therefore key to understand the physical properties of their inter-stellar medium (ISM) – a task that is rather challenging in the distant Universe. On the other hand, high-z star-bursting (out of the MS) systems, although small in number, account for a modest yet still significant fraction of the total energy production. Here I present far-IR line emission observations ([CII]158μm, [OI]63μm, [OIII]88μm and [NII]122μm) obtained with Herschel for two large samples of nearby LIRGs: The Great Observatories All-sky LIRG Survey (GOALS), a sample of more than 240 relatively cold LIRGs, and a survey of 30 LIRGs selected to have very warm mid- to far-IR colors, indicative of an ongoing intense nuclear starburst and/or an AGN. Using photo-dissociation region (PDR) models we derive the basic characteristics of the ISM (ionization intensity and density) for both samples and study differences among systems as a function of AGN activity, merger stage, dust temperature, and compactness of the starburst – parameters that are thought to control the life cycle of galaxies moving in and out of the MS, locally and at high-z.

The formation of supermassive black holes accross cosmic time

Georgakakis Antonis
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In recent years there have been new exciting results on the formation history of supermassive black holes at the centres of galaxies. Large extragalactic survey programmes provided new constraints on the cosmological evolution of Active Galactic Nuclei (AGN, i.e. signposts of accretion events onto supermassive black holes) and yielded new measurements of the AGN space density by pushing the boundaries to earlier cosmic times, fainter accretion luminosities and larger columns densities of obscuring gas and dust clouds. At the same time, our understanding of the physical conditions under which supermassive black holes grow their masses have also developed significantly in the last few years. Studies that link the accretion properties of AGN to the characteristics of their host galaxies have placed new constraints on the relation between accretion events onto supermassive black holes and the formation of stars in galaxies as well as the role of diverse AGN fuelling/triggering mechanisms to the accretion history of the Universe. In my presentation I will discuss the above developments and present the current state-of-the-art on two key questions related to AGN evolution: when and how supermassive black holes at the centres of galaxies grow their masses.

Unveiling the behaviour of matter around black holes

Emmanoulopoulos Dimitrios
University of Southampton

Detection of negative X-ray reverberation time delays (i.e. soft band X-ray variations lagging behind the corresponding hard band X-ray variations) in Seyfert galaxies, can yield significant information about the physical and geometrical properties around the very near black hole (BH) environment. The physical origin of these delays is greatly debated, as is the question of their ubiquity in accretion systems. In the frame-work of the lamp-post geometry, I will be presenting for an ensemble of Seyfert galaxies, observed by XMM-Newton, the first X-ray time-lag modelling results using general relativistic (GR) transfer functions, yielding a plethora of system parameters such as: heights, viewing angles and BH masses and spin parameters. All the GR effects on both the photon energies and trajectories e.g. aberration and light bending, are incorporated during the modelling improving significantly on the currently used parametrisation models of simple top-hat transfer functions.

Modeling the AGN X-ray spectra with Monte Carlo simulations: the case of torii with density gradients

Lefa Eva
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A. Akilas, A. Georgakakis (MPE/NOA), A. Mastichiadis (University of Athens)

The central engines of active galactic nuclei are believed to harbour obscuring material that absorbs and reprocesses high-energy photons from the central X-ray source. We perform Monte-Carlo simulations modelling the propagation of the centrally emitted X-ray photons, taking into account down-comptonization of the photons, as well as photo-absorption and line emission. We consider cases where the reproccessing torus exhibits a density gradient, instead of the usually assumed constant density. The geometry and structure of this material substantially affect the output spectrum, making the viewing angle of the observer a critical parameter that affects the received flux and the spectral shape.

The physical properties of local galaxies with Spitzer mid-IR spectra: UV to infrared modelling

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It has been well established that mid-IR spectroscopy is a powerful probe of the energy sources in the nuclear regions of galaxies while modelling their UV to infrared SED can provide important constrains in their integrated properties. Using the Cornell Atlas of Spitzer/IRS Sources (CASSIS) we have identified a sample of ~1500 galaxies for which Spitzer/IRS 5-35um spectra are available. The sample spans a broad range of magnitudes and galaxy types up to z~0.2 and it is well covered in the wavelength range from UV to mid-IR. In order to construct the SEDs we collected broadband mid-IR imaging from WISE and near-infrared data from the 2MASS and UKIDSS, as well as optical images from SDSS, and UV data from GALEX. Making use of CIGALE (the Code Investigating GALaxy Emission) we provide a database of physical properties for each galaxy such as specific star formation rate, stellar mass, and bolometric luminosity and examine the evolution of the average SED templates per bins of sSFR, stellar masses, luminosities and morphological types. Additionally, we explore the connection between the measured nuclear properties extracted from the CASSIS mid-IR spectra with the parameters derived with the CIGALE SED modelling.

RoboPol: First season rotations of optical polarization plane in blazars

Pavlidou Vasiliki
University of Crete

We present first results on polarization swings in optical emission of blazars obtained by RoboPol, the first monitoring program of an unbiased sample of gamma-ray bright blazars specially designed for effective detection of such events. A possible connection of polarization swing events with periods of high activity in gamma rays is investigated using the dataset obtained during the rst season of operation. We conclude that: the full set of observed rotations is not a likely outcome of a random walk of the polarization vector simulated by a multicell model; furthermore, it is highly unlikely (more than 4 sigma) that none of our rotations is physically connected with an increase in gamma-ray activity; the brightest gamma-ray flares tend to be located closer in time to rotation events, which may be an indication of two separate mechanisms responsible for the rotations; finally, blazars with detected rotations have significantly larger amplitude and faster variations of polarization angle in optical than blazars without rotations.

Unveiling the role of radio jets to the AGN/Star-formation connection

Kalfountzou Eleni
University of Hertfordshire

One of the fundamental problems in modern cosmology is to understand the formation of galaxies, and their evolution through cosmic time. Feedback from AGN has become a major component in understanding the evolution of galaxies. However, its role still remains hotly debated. Understanding of jet feedback is currently one of the major shortcomings of 'radio mode' feedback scenarios on galaxy scales. Radio feedback is particularly important for the galaxy evolution if we consider that 1) radio jets provide an ideal mechanism that allows AGN to interact with the host galaxy and 2) radio galaxies make up over 30% of the massive galaxy population, and it is likely that all massive galaxies go through a radio-loud phase, as the activity is expected to be cyclical.

In this context, I will discuss our recent results on the impact of radio-jets in the host galaxies of powerful AGN using multi-wavelength observations and surveys (e.g. XMM-Newton, SDSS, Herschel, VLA). I will describe the need of constructing a multi-wavelength sample with wide range of AGN properties and in which the effect of AGN luminosity and redshift are decoupled in order to understand the process and the sequence of radio and AGN feedback.

A radio jet drives a molecular & atomic gas outflow in multiple regions within 1 kpc^2 of the nucleus of IC5063

Dasyra Kalliopi
University of Athens

IC5063 is an elliptical galaxy that has a radio jet nearly aligned with the major axis of a gas disk in its center. Using near-infrared IFU data, we demonstrated that the jet passage initiates a molecular and atomic gas outflow in this galaxy. Gas with a velocity excess of ~ 600-1200 km/s with respect to ordered motions is detected near four different bending points of the jet. Near these points, gas gets scattered in different directions. It forms a diffuse outflow that extends >700 pc parallel and perpendicular to the jet trail. In the diffuse outflow, high H2 (1-0) S(1)/S(3) flux ratios indicate that part of the molecular gas is non thermally excited. These results validate theoretical predictions that the propagation of jets can have large-scale effects upon galaxies.

Subaru and e-Merlin observations of NGC3718. Diaries of a supermassive black hole recoil?

Markakis Konstantinos
University of Cologne/MPIfR

NGC3718 is a LINER L1.9 galaxy, lying at a distance of about ~17.4 Mpc away from earth and its similarities with NGC5128 often award it the name "northern Centaurus A". The presence of a compact radio source with a candidate jet structure, a prominent dust lane, and a strongly warped molecular and atomic gas disk are indicative that NGC3718 has undergone some sort of a large scale gravitational interaction sometime in the recent past. This channeled gas towards the center, feeding the black hole and igniting the central engine. One proposed scenario involves an encounter with the close neighboring galaxy NGC3729, while other authors favor a merging event with mass ratio >(3-4):1, as the origin of NGC3718.

We use high angular resolution (~100 mas) e-Merlin radio and SUBARU NIR (~170 mas) data, to take a detailed view of the processes taking place in its central region. In order to preserve some objectivity in our interpretation, we combine our results with literature values and findings from previous studies. Our NIR maps suggest, on one hand, that towards the stellar bulge there are no large scale absorption phenomena caused by the apparent dust lane and, on the other, that there is a significant (local) contribution from hot (~1000 K) dust to the nuclear NIR emission. The position where this takes place appears to be closer to the offset compact radio emission from our e-Merlin 6 cm map, lying offset by ~4.25 pc from the center of the underlying stellar bulge. The shape of the radio map suggests the presence of one (or possibly two, forming an X-shape) bipolar structure(s) ~1 (~0.6) arcsec across, which combined with the balance between the gas and the stellar velocity dispersions and the presence of hard X-ray emission, point towards effects expected by AGN feedback. We also argue that NGC3718 has a "core" in its surface brightness profile, despite the fact that it is a gas-rich galaxy and we discuss its mixed photometric and spectroscopic characteristics. The latter combined with the observed spatial and radio offsets, the relative redshift between the broad and the narrow Ha line, the limited star formation activity and AGN feedback, strongly imply the existence of an SMBH recoil. Finally, we discuss a possible interpretation, that could naturally incorporate all these findings into one physically consistent picture.

Session 2: Poster Presentations

The link between young X-ray binaries and star formation in our nearest low-metallicity star-forming galaxy

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We present the results of the investigation of the link between high-mass X-ray binaries (HMXBs) and star-formation (SF) in the Large Magellanic Cloud (LMC). Using optical photometric data, we identify the most likely counterpart of 45 X-ray sources listed in the literature as HMXBs. Regarding the previously known candidate HMXBs, we re-classify 4 systems as later-type sources, while we also double the number of the identified supergiant X-ray binaries (SG-XRBs). Using this up-to-date HMXB census and the published spatially resolved SF history map of the LMC, we find that the HMXBs (and as expected the X-ray pulsars) are present in regions with SF bursts ~6-25 Myr ago, in contrast to the SMC, for which the population peaks at later ages (~25-60 Myr ago). We also estimate the the HMXB and the Be-XRB production rate to be equal to 1 system per ~(1.2+/-0.2)x10^{-3} Mo/yr, and ~(1.4+/-0.4)x10^{-3} Mo/yr, respectively. We also set limits on the kicks imparted on the neutron star during the supernova explosion.

Multi-wavelength monitoring of the highly active blazar Mrk 421. Investigating the high vs. low energy correlated variability

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Our study presents a long multi-wavelength monitoring on blazar Mrk421, obtained simultaneously with orbital and ground based instruments. Highly dense optical observations started as a follow-up monitoring on Mrk421 at the University of Athens Observatory, after the major flare which occurred on 12 April, 2013. This data set is compared with the gamma-ray, X-ray and UV observations obtained with Fermi/LAT, MAXI and SWIFT satellite telescopes respectively, as well as with the 95 and 15 GHz data from the CARMA and OVRO 40-m radio telescope. We investigate the existence of correlated variations between the different wavebands, as well as the timing properties of Mrk 421 in various energy bands as a probe of the radiating electron distribution and emitting regions.

The robotic and remotely controlled telescope at the University of Athens Observatory

Gazeas Kosmas
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A fully automatic remote telescope and dome control system has been installed at the University of Athens Observatory in August 2012. It was constructed in the Laboratory of Astronomy and Applied Optics of the department and incorporated the already existing automation for observations and data gathering techniques. The system proved to be reliable and functions faultlessly up to date, enabling the astronomers to observe remotely from any place, using the network. The observing nights have been increased significantly after the first year of remote operation, reaching the number of 280 observing nights per year (77% annual usage), half of which are characterized as photometric nights of highest quality. This utility favours long-term monitoring projects of blazars and long periodic variables in general. Sample light curves of galactic and extragalactic objects are also presented and discussed.

Complex Instability and Hopf Bifurcation in a 3D Galactic Potential

Katsanikas Matthaios
RCAAM, Academy of Athens
Patsis Panos (RCAAM, Academy of Atrhens)

We study the dynamics close to complex unstable periodic orbits after a Hamiltonian Hopf Bifurcation (transition from stability to Complex Instability) in a 3D galactic potential. This happens using the method of the space of section. In our case the space of section is 4D. To visualize this space of section we use the method of color and rotation (Patsis & Zachilas 1994). We find, using this method, disk structures (that are initially 4D spirals) that coincide with the invariant manifolds of the complex unstable periodic orbits, 2D confined tori and sticky orbits on confined tori. We find that these structures are close to the complex unstable periodic orbits that are close to the Hopf Bifurcation. But in the case that we are far away from the complex unstable periodic orbits or the Hopf bifurcation, we find clouds of points in the 4D space of section.

The Cosmic Battery in Accretion Discs

Katsanikas Matthaios
RCAAM, Academy of Athens
Contopoulos Ioannis (RCAAM, Academy of Atrhens)

The Cosmic Battery is a mechanism that is established by Contopoulos and Kazanas in 1998. In the present work we perform realistic numerical simulations of this important astrophysical mechanism in advection-dominated accretion flows-ADAF. We confirm the original prediction that the inner parts of the loops are continuously advected toward the central black hole and contribute to the growth of the large scale magnetic field, whereas the outer parts of the loops are continuously diffusing outward through the turbulent accretion flow. This process of inward advection of the axial field and outward diffusion of the return field proceeds all the way to equipartition, thus generating astrophysically significant magnetic fields on astrophysically relevant timescales. We confirm that there exists a critical value of the magnetic Prandtl number between unity and 10 in the outer disk above which the Cosmic Battery mechanism is suppressed.

BPT diagrams: The far-IR properties of the missing population

Kouroumpatzakis Konstantinos
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BPT (Baldwin, Phillips & Terlevich) diagrams have been a widely used tool for the galaxy classification. However there is a large number of sources that are not included in the BPT diagrams due to their low S/N ratio (<3) of them used emission line fluxes. Our purpose is to study these populations in order to compare them with those included in BPT diagrams in terms of star-formation rates, far-infrared emission and host galaxy properties. Two populations will be used, one with S/N > 3 and the second with S/N < 3, of narrow emission line galaxies from the Sloan Digital Sky Survey (Abazajian et al. 2009) that overlap with the Herschel-ATLAS survey (Eales et al. 2010) . FAR-IR observations will be used along with multi-wavelength data (GALEX, SDSS, WISE, UKIDSS, FIRST, NVSS, CSC) for SED fitting in order to extract information about the host galaxy,star-formation rate and the dust mass of the sources. Then we will be able to compare SED to BPT classifications for about 1000 galaxies and also compare Far-IR properties and SED outputs of the two sub-samples.

Testing the Modified Lognormal Probability Distribution with Young Stellar Clusters

Lianou Sophia
Western University
Madaan Deepakshi (Western University), Basu Shantanu (Western University)

The initial mass function is a distribution function describing the number of stars formed per mass interval at birth during a star forming event. Its importance lies in its application, as well as impact, in galaxy formation and evolution studies. We use young stellar clusters in the Local Group to test the Modified Lognormal Probability distribution recently proposed in Basu et al. 2015. We compare this distribution with the most commonly used functional forms describing the initial mass function in stellar populations analyses (Madaan et al.).

Galaxy clusters and large scale structures formation using Cellular Automata models

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Th. Pisokas (Dept. of Physics, AUTH), L. Vlahos (Dept. of Physics, AUTH)

We developed a Cellular Automaton model to study the creation of large scale structures in the early universe. The 3D simulation box is a cubic domain divided uniformly in each direction, representing a distance of a few Mpc. A grid point can have two states, white ("normal" or "almost empty") or black ("attractor"). The initial condition is a white grid that contains an almost homogeneous gas cloud of elementary masses (EM) gas and, each occupying one grid point. Those elementary masses are set into motion, towards randomly chosen directions in the simulation box, leading to "collisions" between the EM and that cause perturbations in the density of the gas. When the mass in one grid point exceeds a critical value (critical mass: mc), the grid point becomes an attractor, that corresponds to a galactic structure, and is marked as black. The EM in those black cells are now inactive and stop moving. The amount of EM in a grid point however is not the only factor that determines its black or white state, since even the presence of different colored neighbors is enough to alter that state. This possibility is expressed by a second parameter, the unification probability (pu). We examined the time evolution of the distribution of black grid points and the clusters they form throughout the simulation box, following simple statistical data and a visual depiction of the galaxy formation. Considering the simplicity of our model, in comparison to models used in general to examine the same problem, we reached to reliable results concerning the spatial distribution of the galaxies in the early universe.

Subaru observations of CenA: A luminous yellow supergiant in a region of jet-induced star formation?

Markakis Konstantinos
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We present the analysis of high angular resolution (~230 mas), AO assisted, SUBARU J, H and Ks band data, of a field located along the middle radio lobe of the Centaurus A jet. Our field lies at a distance of ~15 Kpc away from the center of NGC5128, towards the NE. Our analysis of distinctive, >3σ above the background mean, flux peaks at the expected position of the brightest star on the HST field, in all three NIR bands, suggests visual-NIR and NIR color indices expected from a G-type extra-galactic supergiant star. Age-wise, the presence of evolved massive stars in this part of Centaurus A is consistent with the age estimation of the young blue stars that were found to populate the region and are believed to have formed in a jet-induced star formation event ~10-15 Myr ago. Moreover, the probability of appearance of such strong (>3σ) flux peaks in the same position in three independent measurements due to stochastic background fluctuations alone is negligible, implying that they, realistically, could originate from the presence of a nearly resolved bright star known to be present (HST images) in this position. Partially resolving distant extra-galactic stars with ground based observations implies that fully resolving extra-galactic stellar populations through deeper observations is now possible. Deeper future observations will enable us to shed light onto the mass and luminosity functions of these stellar populations.

On the multiwavelength emission from compact sources in the inverse Compton catastrophe limit

Petropoulou Maria
Purdue University

The inverse Compton catastrophe is defined as a dramatic rise in the luminosity of inverse Compton scattered photons. It is described by a non-linear loop of radiative processes that sets in for high values of the electron compactness, and is responsible for the efficient transfer of energy from electrons to photons, predominantly through inverse Compton scatterings. We search for the physical conditions that drive a non-thermal emitting source to the inverse Compton catastrophe regime, and then study the emergent multi-wavelength photon spectra. We find that the escaping radiation from a source that is driven deep in the Compton catastrophe regime bears some unique features. The multi-wavelength photon spectrum is a broken power law with a break energy of ~ mel c^2 (as measured in the comoving frame) due to the onset of the Klein-Nishina suppression. While the spectral index above the break energy depends on the power-law index of electrons at injection, this does not apply to the spectral index below the break, which depends logarithmically on the electron and magnetic compactnesses and typically lies in the range 0.5-0.9.

Tracing star formation relations across the CO ladder and redshift space

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IAASARS, National Observatory of Athens
Leonidaki Ioanna (IAASARS/NOA), Greve Thomas (ICL), Zhang Zhi-Yu (ESO)

We present IR–CO luminosity relations (i.e., log LFIR = a log L'CO + b) across the CO rotational ladder (continuously from J=1-0 to J=13-12) for a sample of 87 (Ultra) Luminous Infra-red Galaxies observed either with Herschel SPIRE-FTS and/or with ground-based telescopes. To extent our analysis to high redshifts, we included 76 (sub)-milllimeter selected dusty star forming galaxies from the literature with robust CO observations and well-sampled far-IR/sub-millimetre spectral energy distributions (SEDs). The derived FIR–CO luminosity relations are linear (i.e. slopes, a, consistent with unity) for J=1-0 to J=5-4 (corresponding to gas densities of ~3×10^2- 4×10^4cm^{-3}), and become increasingly sub-linear (a < 1) for the higher transitions. The latter is attributed to the higher-J lines becoming sub-thermally excited, as seen in the turn-over at high-J in the CO SLEDs of our sources. We provide a simple theoretical framework with which to understand the observed trends.

Session 3: Cosmology and Relativistic Astrophysics

Oral Presentations

Neutron stars: cosmic laboratories of gravity and dense matter

Glampedakis Kostas
University of Murcia

This talk will provide a bird's-eye view of the physics and astrophysics of neutron stars, describe how these objects can be used as probes of relativistic gravity and supra-nuclear matter and highlight their role in the forthcoming era of gravitational wave astronomy.

Jet formation in black-hole X-ray transients and implications

Kylafis Nikolaos
University of Crete

I will explain the formation and evolution of jets in black-hole X-ray transients (BHTs). The hot flow of matter around the black hole is the place where strong poloidal magnetic fields form by the Cosmic Battery. These fields, together with the rotation of the flow, guarantee the formation of the jet. The thickness of the jet in a BHT is dictated by the radial thickness of the hot flow. Our model implies that, as the outburst increases, the phase lags (of the hard X-rays with respect to the soft ones) and the power-law index of the X-ray spectrum will increase with time, while the cutoff energy of the power law will decrease with time. This has been confirmed by recent observations.

Black holes, radiation and the accretion disk

Koutsantoniou Leela - Elpida
RCAAM, Academy of Athens

Black holes have been known, as mathematical concepts, for over a century and, following their discovery as physical entities, they now appear less exotic day by day. But how well do we know what the immediate environment around a black hole is like? The radiation field created by the hot accretion disk plays a very important part in the stability, the structure and the evolution of such systems. In our work, we study this radiation field and calculate its impact on the disk itself and its dynamics. We present numerical results and simulation images of what a black hole and its disk look like from far away and from close up. We calculate the radiation forces exerted on the particles and we re-examine common assumptions such as the disk stability and structure, the accretion mechanism and the angular momentum diffusion. Finally, we look into the possibility of a battery mechanism that might be effective enough to generate astrophysically important magnetic fields in such environments.

Neutron stars: Are they bald like black holes?

Apostolatos Theocharis
University of Athens

Black holes, these exotic objects or general relativity are very simple objects. They are perfectly described by their mass and spin. This fact is graphically encapsulated in the so-called "no-hair theorem". Neutron stars, although highly compact relativistic objects are made of matter the properties of which is quite unknown at such high pressure. One would expect that the details of matter behavior should have a strong impact on the gravitational field around such an object. We show that our intuition goes wrong in this case. The gravitational field of a stationary object can be uniquely characterized by its multipole mass- and current-moments. The multipole moments of neutron stars though have been found to depend on the first three (the mass, the spin, and the quadrupole) almost independently of the equation of state describing the matter. These universal relations make neutron stars look a lot like their relativistic cousins, black holes. Apparently, they are almost bald like them, with one more "hair" than black holes!

Inferring neutron-star properties from the gravitational-wave emission of binary mergers

Bauswein Andreas
Aristotle University of Thessaloniki

The talk will focus on ideas how to infer unknown stellar properties of neutron stars from the gravitational-wave emission of binary neutron-star mergers. For a large range of binary mass configurations the coalescence of neutron stars typically leads to the formation of a massive stellar merger remnant. In particular, the dominant oscillations frequency of the postmerger remnant of such events provides tight constraints on neutron-star radii. We will also discuss first steps towards a practical implementation of this method in future gravitational-wave searches. Moreover, we will outline a possibility to estimate the unknown maximum mass of nonrotating neutron stars from such types of measurements. Finally, we will discuss the origin and scientific implications of secondary peaks in the gravitational-wave spectrum of neutron-star mergers.

Relativistic simulations of oscillating slender torus.

Manousakis Antonios
Nicolaus Copernicus Astronomical Center
Mishra Bhupendra (CAMK)

We present two dimensional general relativistic hydrodynamic slender torus simulations using COSMOS++, a GRMHD code. We applied small vertical, radial, and diagonal perturbations of the torus from its equilibrium to study their effects. High level products (LCs and PSDs) were derived in the postprocessing of the hydro simulations using ray-tracing code, GYOTO. We found that various perturbations can trigger different high frequency quasi-periodic oscillations (QPOs) modes, which depend on the initial torus' configuration. This allows to identifying the various QPO modes of the numerical simulations when compared to analytically ray-traced models.

Magnetic Field Evolution in Neutron Star Crusts through 3-D Simulations

Gourgouliatos Konstantinos
University of Leeds
Hollerbach Rainer (University of Leeds), Wood Toby (University of Newcastle)

The evolution of the crustal magnetic field in neutron stars is dominated by two processes: Hall drift and Ohmic dissipation. Hall drift is the advection of the magnetic field lines by freely moving electrons in the rigid crust. Despite the fact that Hall drift conserves energy it is possible to strongly accelerate Ohmic dissipation, as it may lead to the formation of small scale magnetic structures through turbulent cascade or instabilities of the magnetic field. These localised entities have short decay times efficiently converting magnetic energy into heat and may also cause plastic deformation of the crust because of the strong Lorentz forces. The latter can trigger magnetar activity. I will present the results of 3-D simulations of the magnetic field evolution in strongly magnetised neutron stars. I will discuss under what conditions the magnetic field can indeed trigger such instabilities and their implications on the long term evolution of magnetars and high-magnetic field pulsars.

Geometrodynamics in Cosmology: from Planck to modified gravity

Basilakos Spyros
RCAAM, Academy of Athens

In this review talk I will discuss some ideas based on Geometrodynamics towards explaining the accelerated expansion of the Universe. In particular, I will describe some basic modified gravity models namely f(R), Dvali, Gabadadze, and Porrati(DGP) braneworld, Gauss-Bonnet and Finsler, and I will discuss their Cosmological implications.

New constraints on the cosmic string tension from the European Pulsar Timing Array

Sanidas Sotirios
API/University of Amsterdam

Cosmic strings are 1-D topological defects created during phase transitions in the early Universe. A cosmic string network, once created, evolves along the expansion of the Universe and is expected to create a broadband Stochastic Gravitational Wave Background, potentially detectable by all current and future gravitational wave detectors. Here, we will present the constraints set on the energy scale of such a cosmic string network, using the 2015 limits on an isotropic stochastic gravitational wave background set by the European Pulsar Timing Array (EPTA). The generic approach used to obtain this constraint, makes it directly competitive to those set from CMB observations, whereas it is the first time that such a PTA constraint has reached the level of the best CMB result, obtained by the Planck satellite.

Frequency spectrum of radiation from accelerated charged particle in a magnetized curved space time

Papadopoulos Demetrios
Dept. of Physics, Aristotle University of Thessaloniki
I. Contopoulos (RCAAM, Academy of Athens), K. D. Kokkotas (Theoretical Astrophysics, Eberhard Karls University of Tuebingen), and N. Stergioulas (Dept. of Physics, AUTH)

We derived a semi-analytic expression for the spectral distribution of the electromagnetic emission from charged particles in an eccentric, bound equatorial orbit around a Schwarzschild black hole, embedded in a dipolar magnetic field. The expression is written in compact form, truncated up to the lowest order harmonic contributions. The spectrum of the emitted radiation is composed of spectral lines at frequency intervals and , where N is the generalized Kepler frequency. A rough estimate of the total radiated power for an electron in orbit around a ten solar mass Schwarzschild black hole with , and Schwarzschild radius immersed in a dipole magnetic field of order has been computed to be . This implies a timescale for back-reaction on the orbit much longer than the dynamical one. Thus, for the low magnetic fields required for our approximations to be valid, the electromagnetic emission does not modify the orbital characteristics.

Looking at the black hole that powers Long Gamma Ray Bursts

Nathanail Antonios
Academy of Athens & University of Athens

Gamma-ray bursts (GRBs) are violent explosions, coming from cosmological distances. They are detected in gamma-rays (also X-rays, UV, optical, radio) almost every day, and have typical durations of a few seconds to a few minutes. Some GRBs have been reported with extraordinary duration of 10^4 sec. These are called Ultra Long GRBs. According to Blandford & Znajek (1977), the spin energy of a rotating black hole can be extracted electromagnetically, should the hole be endowed with a magnetic ?eld supported by electric currents in a surrounding disk. We argue that this can be the case for the central engines of GRBs and we show that the lightcurves of several long GRBs are following closely the theoretical curve of Black Hole Spin Down, thus their duration is completely characterized by the magnetic flux accumulated at the event hotizon of the black hole. We discuss the possibility of gravitational waves from long GRBs.

Session3: Poster Presentations

Computing differentially rotating general-relativistic polytropic models by a post-Newtonian hybrid approximative scheme

Geroyannis Vassilis
University of Patras
Karageorgopoulos Vasileios (University of Patras)

We use the so-called "hybrid approximative scheme", developed by the authors in the framework of the post-Newtonian approximation, for computing general-relativistic polytropic models simulating neutron stars in differential rotation. The differential equations governing our model are considered as a "complex initial value problem", solved by the "complex-plane strategy". We compare our numerical results with corresponding results of other methods.

Anisotropies in the Hubble flow traced by SNIa

Plionis Manolis
Aristotle University of Thessaloniki
Migkas Konstantinos (Bonn-Cologne Graduate School of Physics & Astronomy)

Using the Union2.1 SNIa compilation we have identified one sky region, with galactic coordinates $35^{o} < l < 83^{o}$ & $79^{o} < b < 37^{o}$, containing 82 SNe Ia (15% of total with $z>0.02$), that shares a different Hubble expansion behavior indicating a possible anisotropy, if confirmed. We have excluded as a possible cause systematic effects related to the different surveys that constitute the Union2.1 set. An alternative explanation is the existence of a bulk flow that could affect significantly the redshifts of the specific SNIa.

The Large European Array for Pulsars: First years of operation

Sanidas Sotirios
API/University of Amsterdam

The Large European Array for Pulsars (LEAP) is the most ambitious project within the European Pulsar Timing Array (EPTA). The five largest radio telescopes in Europe, the Effelsberg (GER), the Lovell (UK), the NRT (FRA), the WSRT (NL) and the SRT (IT), are forming a tied-array, full-steerable telescope (~194m equivalent dish) with sensitivity comparable to SKA Phase I. In LEAP-mode, the aforementioned telescopes observe simultaneously a subset of the (EPTA) millisecond pulsars for >24h per month, aiming to provide extremely high precision pulsar timing data for gravitational wave detection purposes. The unique sensitivity achieved with LEAP, has enabled it for more generic pulsar science that goes beyond its initial scope. In this talk we will overview the LEAP setup and operations, and briefly presented the scientific output.

Session 4: Stars, Planets and the Interstellar Medium

Oral Presentations

The link between X-ray binaries and stellar populations in galaxies

Zezas Andreas
University of Crete

The past decade has seen a revolution in studies of accreting binaries in nearby galaxies which has led to: (a) direct calibration of their total number and luminosity as function of star-formation rate and stellar mass, and (b) the first measurements of their formation efficiency as a function of the age of their parent stellar populations. Furthermore the launch of NuSTAR gave us the first picture of the hard X-ray emission from extragalactic X-ray binaries. I will discuss results from recent observational studies of the accreting binary populations in nearby galaxies with the Chandra and NuSTAR observatories, and how they can be used together with population synthesis models to constraint parameters related to accreting binary evolution. Finally I will discuss prospects for studies of extragalactic with future X-ray missions.

BeXRBs in the Large Magellanic Cloud

Vasilopoulos Georgios
MPE, Garching

Nearby galaxies are ideal laboratories for investigating X-ray source populations, and X-ray binaries in particular. Compared to Galactic sources, they have well determined distances and their X-ray spectrum is not heavily affected by absorption since they reside away from the direction the dust of the Galactic plane. High-mass X-ray binaries (HMXBs) are composed of a highly magnetized (~10^{12} G) neutron star (NS) that accretes mass from a high mass star (>10 Msun). The main characteristic of HMXB as a population is that they require young stellar populations to be formed, thus their number is related to the recent star formation episodes. The Large (LMC) and the Small (SMC) Magellanic Clouds (MC) are the nearest gas-rich star-forming galaxies. These two irregular galaxies harvest a high number of HMXBs. The SMC has about 100 confirmed HMXBs, with ~60 of them showing X-ray pulsations, due to the NS rotation. On the other hand the LMC, being larger in size, has only 17 confirmed HMXB pulsars. This divergent is mainly due to the different recent star formation history of the two galaxies. A parameter that prohibit us from directly comparing the two populations is that the LMC due to its larger area is less frequently observed with large X-ray telescopes, while these observations do not cover the complete surface area of the LMC yet. Given the transient nature of the HMXB systems this lack of observations introduce some bias that makes the LMC HMXB population incomplete. Our group has been directly involved in large X-ray programs for a large area of the LMC and most of the SMC. The XMM-Newton large program for the LMC has just been completed and covers an area of about 10 square degrees, reaches a limiting luminosity of 10^{32} erg/s and thus, provides a unique data set for X-ray source population studies. Among the most interesting results of the survey is the discovery of new Be/XRBs. Here, we present an overview of some newly confirmed Be/XRB pulsars in the LMC (e.g. RX J0520.5-6932). To investigate the spectral and temporal characteristics of the sources, we used XMM-Newton and Swift X-ray data, along with optical observations (spectroscopy and light-curves). Apart from the obvious interest in the properties of individual sources, the detection of a more complete sample of Be/XRBs in the LMC is necessary for the study of their population and the comparison with other galaxies, like the SMC.

Investigating Massive Stars in the Galaxy M83

Williams Stephen
IAASARS, National Observatory of Athens
Bonanos Alceste (IAASARS, NOA), Whitmore Bradley (STScI), Prieto Jose (Universidad Diego Portales, Chile), Blair William (Johns Hopkins University, USA)

We have undertaken a program to detect and categorize the frequency and nature of the mass loss in massive stars like red supergiants (RSGs), yellow supergiants (YSGs), and supergiant Be stars (sgB[e]). Making use of imaging from Spitzer mid infrared (IR), ground-based near-IR from the FourStar instrument on the Magellan Baade telescope, and optical HST WFC3, we have selected the brightest point-like sources in the galaxy M83. Our catalog of near- and mid-IR sources contains 4258 entries across J, Ks, Spitzer IRAC 3.6, 4.5, 5.8, and 8.0 micron bands. We employed a combination of photometric criteria in concert with the appearance of candidates in HST optical (U, B, V, I) images to select 49 strong candidates for individual massive stars. Here, we will briefly describe the photometric selection criteria, and the spectroscopic follow-up of 18 probable RSGs from our period 95 approved proposal for VLT/KMOS time (095.D-0189(A)).

Identification of red supergiants in the Local Group with mid-IR photometry

Britavskiy Nikolay
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Bonanos Alceste (IAASARS, NOA), Mehner Andrea (ESO), Garcia David (Instit. de Astrofisica de Canarias)

Star forming dwarf irregular (dIrr) galaxies serve as ideal laboratories for investigating the evolution and mass loss phenomenon of red supergiants (RSGs) within the context of different metallicities of host galaxies. Also, RSGs may be used for abundance determinations in dIrrs. The extremely low number of spectroscopically confirmed RSGs in external galaxies makes the identification of new RSGs statistically significant. We present a systematic survey of RSGs and luminous blue variables (LBVs) with the goal to complete the census of these objects in the Local Group. Using the fact that RSGs and LBVs are bright in mid-infrared colors due to dust, we propose and apply a technique that allows us to select dusty massive stars based on their [3.6] and [4.5] Spitzer photometry (Britavskiy et al. 2014). We present the results of our spectroscopic follow-up of luminous infrared sources in 7 nearby dIrrs (Phoenix, Pegasus, Sextans A, Sextans B, WLM, IC 10 and IC 1613) based on VLT/FORS2 and GTC/OSIRIS observations. In total we have observed ~100 targets, among which we have so far identified 16 RSGs and 2 new emission line objects in these galaxies. Moreover, using the newly discovered RSGs, we have revised the mid-IR and optical photometric selection criteria for this type of objects, which can be applied to other galaxies of the Local Group and beyond.

Tracing the disks around B[e] supergiants in the Magellanic Clouds

Maravelias Grigoris
Astronomical Institute, CAS
Kraus Michaela (Astronomical Institute, CAS), Aret Anna (Tartu Observatory)

Massive stars strongly affect the insterstellar medium through their intense stellar winds, which transfer momentum and energy to the interstellar medium and enrich it with chemically processed material as they evolve. This interaction becomes substantial in short-lived transition phases of massive stars (e.g. B[e] supergiants, luminous blue variables, yellow hypergiants) in which mass-loss is more enhanced and usually eruptive. Since these phases are not well-understood and not predicted accurately by theory, observations are needed in order to understand the complex circumstellar environment around these stars. In particular, B[e] supergiants are often surrounded by rings or disk-like structures, combining atomic, molecular and dust regions of different temperatures and densities. Using high-resolution optical spectra, obtained with the FEROS instrument mounted at the MPG/ESO 2.2m telescope, we examine a number of important emission features which probe the structure and the kinematics of their circumstellar environment. We investigate the [OI] and [CaII] emission lines in comparison to our previous work (Aret et al. 2012), which we further extend by doubling the number of B[e]SG studied in the Magellanic Clouds.

Stellar wind accretion onto High Mass X-ray Binaries

Manousakis Antonios
Nicolaus Copernicus Astronomical Center

The supergiant High Mass X-ray Binary systems (sgHMXBs) consist of a massive, late type star and a compact object. The massive stars exhibits strong, radiatively driven, stellar winds. This wind is therefore accreted by its compact companion (either black hole or neutron star) and triggers X-ray emission, which subsequently alters its surroundings significantly. Hydrodynamic simulation (together with X-ray observations) has been used to study the stellar wind - compact object interaction. The classical sgHMXB (i.e., Vela X-1) has been studied in depth to understand the origin of its X-ray off-states and variability. The match of the simulation and observations are remarkable. Also, a Black Hole Candidate (e.g., Cyg X-3) is studied to understand its interaction with the stellar wind of the donor star. Among these systems, self-organized criticality of the accretion stream may be likely cause of the observed behavior.

Twin binaries as a laboratory for testing wind-driven mass loss theories

Nanouris Nikolaos
IAASARS, National Observatory of Athens
Kalimeris Anastasios (Technological and Educational Institute of Ionian Islands), Chiotellis Alexandros (IAASARS, NOA), Boumis Panayotis (IAASARS, NOA)

In the present work, we evaluate the efficiency of the wind-driven mass loss during the main sequence phase of rapid rotating, late spectral type binary stars by monitoring their eclipse timing variations (ETV). In this group of particular interest, strong magnetic fields and tidal forces can potentially elevate the stellar wind mass loss rates and thus affect the binary evolution. To measure the contribution of these processes to the mass loss rate, we properly select a sample of short-period detached binaries with components of similar physical parameters. Provided that their observed orbital history is dense enough for a reliable inference, twin binaries serve as a direct probe for investigating this mechanism by eliminating the involvement of many free parameters. We show that the inferred mass loss rates are substantially enhanced up to several order of magnitudes, suggesting that the presence of a close companion can strongly affect the mass loss history of a late-type star and thus the evolution of the binary system itself. We discuss the impact of such an enhanced wind in the single-degenerate evolutionary channels of type Ia supernovae.

Seeing double or triple with Aristarchos telescope?

Christopoulou Eleftheria-Panagiota
University of Patras

With the advent of high precision satellite photometry from Kepler, I discuss the motivation supporting ground-based multiwavelength photometric observations of interesting W UMa type eclipsing binaries (EBs) from Kepler field with periods < 0.45d and Kp(mag) =12.6-16 mag, as part of a program initiated in 2013 with the 2.3 m Aristarchos telescope at Helmos Observatory, Greece. In this talk we show the tools used to derive the results for KIC objects with Eclipse Timings Variation signals suggesting the possible presence of a third body. Modern analysis techniques such as heuristic scanning with parameter perturbation and genetic algorithm (PIKAIA), enable to reveal and optimize the astrophysical parameters of selected EBs.

Poetry in motion: Asteroseismology of delta Scuti stars in binaries using Kepler data

Liakos Alexios
IAASARS, National Observatory of Athens
Niarchos Panagiotis (Dept. of AAM/University of Athens)

The results of our six year systematic observational survey on candidate eclipsing binaries with a delta Sct component are briefly presented. A new catalogue for this kind of systems as well as the properties of their delta Sct members are also presented. The comparison between the components-pulsators and the single delta Sct stars shows that both the evolution and the pulsating properties differ significantly. Finally, we introduce the new era of studying stellar pulsations using high accuracy data from the Kepler mission and emphasizing the great opportunities that have been opened for a deep knowledge of the properties of stellar pulsations.

The Manchester-Athens Wide-Field Camera (MAWFC): A new state-of-the-art ~30 degree diameter, narrow-band, optical filter camera

Boumis Panos
IAASARS, National Observatory of Athens

The Manchester-Athens Wide-Field (Narrow-Band) Camera (MAWFC) is the first scientific instrument for astronomy that constructed and tested completely in Greece. The instrument is ready and after the first light tests, it started to conduct a large-area sky survey that will provide maps at 1 arcmin resolution, in order to investigate the very extensive, but faint, line emission regions over the whole sky. Deep observations of the northern sky in the optical emission lines of Halpha, [O III], and Hbeta are started to be taken and it is expected the results to have significant impact on topical astronomical areas of research e.g. subtracting the foreground for the cosmic microwave background, investigating the giant, high latitude, radio filaments from the Galactic centre or very close objects in the Galactic plane of extreme angular extent etc. The instrument and its first results are presented here.

New supernova remnant candidates in nearby galaxies in the Southern hemisphere

Kopsacheili Maria
IAASARS, National Observatory of Athens

Supernova remnants (SNRs), are objects of high importance since they provide major amounts of energy to the Interstellar Medium while at the same time depict the end-point state of massive stars (M>8 solar masses). In order to investigate the physical properties of these objects and their interplay with their environment, we have embarked in an extensive investigation of the SNR populations, focusing on six nearby galaxies of different morphological types in the southern hemisphere. In this work, we present new candidate SNRs detected in the barred spiral galaxy NGC 1313, based on deep narrow-band Hα and [SII] images observed with the 4m Blanco telescope in La Serena, Chile. The new detections were achieved by calculating the [S II](λ6716,6731)]/Hα(6563) flux ratios for every source. Sources with this ratio over 0.4 are considered as candidate SNRs while sources with 0.3<[SII]/Ha<0.4 are considered as possible candidate SNRs. Following this criterion, 95 candidate and 11 possible candidate SNRs were detected, with fluxes down to 10^{-15} $erg/cm^2/s$. The verification of these sources as SNRs will be attained by follow-up spectroscopy. The largest number of sources was found in the spiral arms of the galaxy, as it was expected. This is due to the morphology of spiral galaxies since during the galaxy rotation, a great amount of dust and gas is gathered that compressed triggering the formation of stars.

Fast and furious: Modeling the cometary structure of the planetary nebula HFG1

Chiotellis Alexandros
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P. Boumis (IAASARS, NOA), N. Nanouris (IAASARS, NOA), J. Meaburn, G. Dimitriadis

The Galactic planetary nebula HFG1 reveals an intriguing morphology consisting of a bow shaped shell which surrounds the central star followed by a collimated tail. This unique cometary-like morphology of HFG1 has been attributed to the systemic motion of the planetary nebula (PN) with respect to the local ambient medium. In this work we model HFG1 and we find that its main features can best be explained by the time dependent stellar winds of a supersonically moving star during its Asymptotic Giant Branch (AGB) and post-AGB phase. Given that the primary component of its central binary system (V664 Cas) is a ~0.6 Msun O-type subdwarf, we consider the mass of its progenitor to be 3 Msun as predicted by stellar evolution theory.

We perform two-dimensional hydrodynamic simulations modeling the formation of the PN from the interaction of the mass outflows of a runaway star with the local ambient medium. To keep the model self-consistent the time variable stellar wind is described by following the predictions of the AGB, post-AGB stellar evolution theory for a 3 Msun star. The results show a good agreement with the present morphological and emission properties of HFG1 achieving to connect the evolutionary history of its central star with the observables of the PN. We discuss the possible implications of our study in the understanding of the evolutionary paths towards the formation of O-type subdwarf and the observed properties of their surrounding PNe.

Filaments and magnetic fields as probes of the early stages of star formation

Tassis Konstantinos
University of Crete

The initial conditions that ultimately lead to the formation of stars are not yet well understood. To gain insight into this process, we study systematically the structure and dynamics of the birthplaces of stars: molecular clouds. Observations reveal the intricate structure of molecular clouds that includes networks of filaments and smaller condensations, the molecular cloud cores. These observations have sparked an intense discussion of a possible new paradigm in star formation: is it the filaments that form first in clouds, and then fragment to form molecular cloud cores and, later, stars? We have systematically studied filaments in 13CO emission in the Taurus cloud, and we have shown that the reverse interpretation - that molecular cloud cores are the primary unit into which molecular clouds fragment, and the widespread filamentary net seen in clouds may only be apparent - is at the moment also viable. An additional topic of continued debate on the physical conditions in molecular clouds is the structure and dynamical importance of the magnetic field. We demonstrate the use of a new, unique instrument, the RoboPol polarimeter which is installed at the Skinakas Observatory, to map the magnetic field of a low-density molecular cloud, the Polaris Flare, through wide-field measurements of the optical polarization of background stars induced by absorption of their starlight by magnetized dust in the Polaris cloud. We show that the magnetic field has a large-scale, ordered pattern, with dynamically important features, including an eddy-like structure, and alignment with faint striations.

Interstellar chemistry as a diagnostic in the quest for the true shape of prestellar cores

Tritsis Aris
University of Crete

In order to understand the processes that regulate star formation we need to probe the earlier stages manifested as gravitationally contracting overdensities in molecular interstellar clouds, called "prestellar cores". The shape of prestellar cores hold important clues since it results from the interplay of forces responsible for the cloud fragmentation and core formation. Unfortunately the two dimensional projection of a prestellar core, probed by dust emission maps, on the plane of the sky can be identical for different intrinsic 3D core shapes. Therefore, we need a simple but reliable method to lift this shape degeneracy and probe the prestellar core's 3D structure. To this intent interstellar chemistry can be a useful ally. We have employed hydrodynamic numerical simulations of dynamically contracting prestellar cores combined with a full chemical network considering three intrinsic geometries: spherical, prolate/filamentary and oblate/disk-like. We have demonstrated that the true shape of the core can be identified by a metric that involves the column density profiles of pairs of commonly observed molecules or by a simple comparison of 2D emission maps of specific molecules. We have performed extensive parameter studies and established that our method is robust against the choice of free parameters associated with the interstellar chemistry.

OGLE-IV the Largest Sky Variability Survey

Udalski Andrzej
Warsaw University Observatory

We present the current status of the fourth phase of the Optical Gravitational Lensing Experiment. OGLE-IV is currently one of the largest sky variability surveys worldwide, targeting the densest stellar regions of the sky. The survey covers over 3000 square degrees in the sky and monitors regularly over a billion sources. The main targets include the inner Galactic Bulge and the Magellanic System. Shallower Galaxy Variability Survey covers the extended Galactic bulge and 2/3 of the whole Galactic disk. The cadence of observations varies from 18-60 minutes in the inner Galactic bulge to 1-3 days in the remaining Galactic bulge fields, Magellanic System and the Galactic disk.

Stellar spots and Transit Timing Variations

Ioannidis Panagiotis
Hamburg Observatory

We report the results of our study on the effects of the activity (spots) of planetary host stars, on the mid-transit time measurements of their planets. While one planet is transiting in front of the parent star, it can cross over spots. This causes deformations of the transit light curve, which can lead to errors in the mid-transit time determination. We investigate the dependence of this error on different parameters of the planet and the star, in an effort to identify special occasions where the effect becomes strongest.

Revealing the atmospheric composition of transiting extra-solar planets with HST/WFC3 spatial scanning

Tsiaras Angelos
University College London
Waldmann Ingo (UCL), Tinetti Giovanna (UCL)

The number of extra-solar planets is now already very high and the future seems to be even more promising as many teams, all around the world, are dedicated to exploring the sky and finding new ones. Having made this progress, the next challenge is to investigate what these planets are made of and the conditions on them, and the study of their atmospheres is the first step towards answering these questions. Optical photometry of transiting planets provides us with a lot of information about them. In addition, observing the transit and the eclipse of a planet in different wavelength channels in the infrared can reveal the signature of key molecules such as water, methane and ammonia and make possible the measurement of their abundances. Currently, one of the most successful instruments for observing exo-planetary atmospheres is the Hubble Space Telescope WFC3 camera. In particular, the use of the spatial scanning method has allowed us to improve the performances of said instrument for the study of exoplanet atmospheres: the advantage of this method is that as HST slowly slews, it maximises the number of collected photons without saturating the detector, making the observation of bright targets possible. The main problem with such observations is the necessary precision of 1 over ten thousand which is usually below the level of the systematics. Our team has put a lot of effort in order to cope with all the kinds of systematics that are included in these data, both parametrically, in the case of known systematics, and non-parametrically, for systematics with unclear or unknown cause and behaviour. Such methods include, PCA, ICA and wavelet decomposition techniques, which are being used in other fields of astronomy, and other sciences, for many years. To effectively retrieve the planetary spectrum from the above data, members of our team have developed Tau-Rex, a new full line-by-line emission/transmission spectroscopy retrieval code, based on the most complete hot line-lists from the ExoMol project.

Analytic orbit propagation for transiting circumbinary planets

Georgakarakos Nikolaos
NYU Abu Dhabi
Eggl Siegfried (IMCCE, Observatoire de Paris, France)

We present an analytical framework that fully describes the motion of coplanar systems consisting of a stellar binary and a planet orbiting both stars on orbital as well as secular timescales. Perturbations of the Runge-Lenz vector are used to derive the short period evolution of the system, while octupole secular theory is applied to describe its long term behaviour. A post Newtonian correction for the stellar orbit is also included. Our analytical estimates are tested against results from numerical integrations of the full equations of mo- tion. The analytical model is then applied to investigate the dynamical history of some of the circumbinary planetary systems discovered by NASA's Kepler spacecraft.

Orbits of long-term stability in three-planet systems

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Observations of extrasolar systems reveal the existence of a large number of multiplanet systems consisting of two, three, or even more exoplanets, which show orbital features very different of our solar system. By taking into account the mutual planetary interactions, the long term stability is guaranteed only under particular dynamical mechanisms. Such a mechanism is e.g. the phase protection provided by resonant motion. The dynamics of two-planet resonant systems have been extensively studied. In this work we study three-planet systems and we search for orbital configurations that show long-term stability. As basic model we consider the general four-body problem. Our method is based on the planetary migration mechanism provided by the addition of dissipative forces which can drive the system to a stable configuration. Our study showed that the Laplace resonant configuration (1:2:4) is the most likely stable configuration. Also the 1:3:6 resonant configuration appears frequently, as has been also noted in other works. Apart from the above cases, other resonant configurations have been revealed from our numerical simulations providing possible orbital configurations of extrasolar systems, which seem to evolve regularly beyond our numerical integration time that ends at 100My.

Highly eccentric exoplanets trapped in mean-motion resonances

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The majority of exoplanets has common attributes, such as the orbital eccentricity ($e<0.1$), mass (order of Jupiter) and orbital period (8-10 days). But, how come a minority of them, evolving on highly eccentric orbits, outlasts? We herein utilize the general three-body problem (GTBP) as a model, in order to simulate resonant systems consisting of a star and two planets, where at least one of them is highly eccentric. In particular, we focus on HD 82943 and HD 3651 which evolve in 2/1 MMR, HD 7449 and HD 89744 trapped in 3/1 MMR and HD 102272 which is locked in 4/1 MMR. We study them in terms of their long-term stability, via the construction of maps of dynamical stability. We identify the way their survival is connected with the regions of regular motion in phase space, which, in turn, were created by stable resonant periodic orbits in their vicinity. Consequently, a phase protection mechanism is provided and the planets avoid close encounters and collisions on long timescales. Within such dynamical studies, the large deviations in observational values, which often locate the exoplanets in chaotic regions, can be revised.

Free-floating planet scattering by a star-planet pair: the 3D case

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We perform a 3-dimensional study of the interaction of a free-floating planet approaching a star-planet pair. The dynamical system consists of a Sun-like star and a Jupiter-like planet (BP) orbiting the star (binary system) plus a Jupiter-like free-floating planet (FFP) placed sufficiently away from the gravitational potential of the binary. Initially the binary lays on the x-y plane while the FFP is ejected from a spherical surface and has a parabolic velocity that points at the binary. By changing the initial angle of the BP as well as, the initial position of the FFP on the spherical surface and the orientation of the velocity vector, we have tried to map and statistically study the four possible outcomes of this encounter: flyby, resonance, exchange and disruption of the system. We also tried to incorporate the Sundman's function in the integration, in an effort to predict the final outcome of the system avoiding the need for lengthy computations.

Session4: Poster Presentations

Exoplanet and variable star search in the ThReT 2012 field

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We used the data from the ThReT [1] project 2012 in order to explore and characterise new variable stars and possible transiting exoplanets. We search for variable stars by employing the Pulsation Factor (Kjelden et al 1992), and the SiDRA algorithm. The light-curves were also scanned for transit-like signals with the BLS algorithm (Kovacs et al 2002) and remove systematic noise with the TFA algorithm (Kovacs et al 2005). The integration time was 90 seconds, with a 60 seconds space between captures for read out. A total number of 28284 stars were detected with more than 5000 stars having a photometric accuracy under 3%. The selected target field was the region around R.A. 00h 08m 00s and Dec 33o 30' 00 in the Andromeda constellation (ThReT ExoField 2011). The ThReT survey started on the 19th of September and finished on the 6th of October 2011. Ten of the eighteen days were useful for further analysis. Our results indicate that most of the variable star candidates in our sample were binaries of the W UMa type with periods between 0.3-0.7 days. There are also two short period delta Scutti candidates with periods about 0.16 days.

Photometric observations of recent classical novae with the 2.3m Aristarchos telescope

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Photometric variability caused by orbital motion and different kinds of rapid brightness variations in a classical nova system are undetectable during the outburst phase, until the components emerge from the optically thick envelope ejected. In this later phase, the brightness of the system declines making it unavailable for observation with small telescopes. Thus, there is only a small number of photometric periods and rapid brightness variation studies published, as compared to the novae observed. In order to detect (or to confirm) photometric periodicities and rapid variations. V and R band CCD observations of three recent classical novae, during their latter phase of activity decline, were carried out in 2014 with the 2.3m Aristarchos telescope (Helmos Observatory, Greece). The monitoring duration for two of them, KT Eridani and V2467 Cygni does not allow to look for periodicity, but the curves show characteristic flickering variations. The third, V2362 Cyg, has been monitored extensively and allowed us to estimate a period of about 0.1525 days.

The Aristarchos Wide-Field Camera (AWFC): A new high-resolution imager for the 2.3m Aristarchos telescope

Boumis Panos
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The Aristarchos Wide-Field Camera (AWFC) is a new state-of-the-art wide field imager which will be used at the 2.3m Aristarchos telescope (Helmos Observatory). It's construction was funded by the PROTEAS/KRIPIS grant and its main scientific goals are: (a) Calculation of precise photometric redshifts of objects in sky fields already covered by XMM using the SDSS filters (u,g,r,i,Z,Y), and (b) Detection and/or study extended faint filamentary structures using narrow-band interference filters (Hα,[O III],[S II],[N II]). The instument is expected to be manufactured in summer 2015 and be ready for lab tests in Autumn 2015. First light is expected in summer 2016.

Supernova Remnants: Powerful agents of stars formation feedback. The case of IC443

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We present the results from our study on the effects of SNRs shocks on molecular clouds. We focused on the dense gas phase ($n > 10^4$ cm^{-3}) from which the IMF emerges. We have used optical high-resolution echelle spectra as well as fully-sampled maps of 12_CO J=1-0 and 13_CO J=1-0. These sets of data along with published available 2MASS, Spitzer and 1.4GHz continuum maps are used as constraints on our radiative transfer codes in order to deduce the physical conditions fo the dense gas in the shock-impacted areas of the molecular clouds.

Detection of starquakes on magnetically active red dwarfs.

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The results of the analysis of the one colour (B, or U) observations of the Stefanion Observatory for different red dwarfs (EV Lac, AD Leo, YZ Cmin, UV Cet) 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 0.0083Hz (period 2min) and 0.3 Hz (period 3s) not rigorously bounded; (3) The phenomenon is most pronounced during the flare state; (4) The presence of high frequency optical oscillations is a general characteristic of all the stars of the program. The quiescence parts of the light-curved which were analyzed belong to the pre- or after- flare state i.e. are connected with a major magnetic even (the observed flare). It is interesting to realize if starquakes appear far apart from the observed flares, during the quiet state of the stars, as a result of the general magnetic activity of the star. In this paper we present the analysis of the quiet state observations of the stars EVLac, BY Drac and AD Leo. The result of our analysis indicate that during the so called quiet state of these star high frequency optical oscillations also exist.
Key words: Flare stars, Transient Optical Oscillations, Fourier Analysis

Photometric study of the eclipsing systems DU Boo, CW Lyn, HS Aqr and MR Del

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A photometric study of the contact binary systems DU Boo and CW Lyn, based on new BVRI observations made at the University of Athens Observatory, are presented. The new light curves were analyzed by using the Wilson-Devinney light curve synthesis code and new geometric and photometric elements are derived. It is found that DU Boo has one of the longer orbital periods ever observed on contact binaries and its components show large temperature difference of about 1000 K. In addition, the system shows light curve asymmetries and therefore a spot model is introduced, in order to explain the O'Connell effect. On the other hand, CW Lyn has one of the smallest mass ratios among other contact binaries. A non spotted solution is proposed, being the first given in the literature for this system.

A parallel code for multiprecision computations of the Lane-Emden differential equation

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We compute multiprecision solutions of the Lane-Emden equation, which is used in several astrophysical models. This equation arises when introducing the well-known polytropic model into the equation of hydrostatic equilibrium for a nondistorted (thus spherical) star. Since the multiprecision computations are time-consuming, we apply to this problem parallel programming techniques and thus the execution time of the computations is drastically reduced.

Discussion on the numerical results of the "global polytropic model" for the exoplanet orbits of 15 systems

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We discuss numerical results regarding the exoplanet distances of 15 observed exoplanetary systems (indicatively: 55 Cnc, HD 40307, Kepler-20, Kepler 26, Kepler-90, Kepler-275 etc.), computed by the so-called "global polytropic model" (GPM). This model is based on the assumption of hydrostatic equilibrium for an exoplanetary system and its structure is described by the well-known Lane-Emden differential equation. In particular, a polytropic sphere of appropriate polytropic index n and radius R1 represents the central component S1 (in our case, the host star) of a resultant polytropic configuration with further components the polytropic spherical shells S2, S3, ..., defined by the pairs of radii (R1,R2), (R2,R3), ..., respectively, where R1, R2, R3, ..., are the roots of the real part Re(theta(R)) of the complex Lane-Emden function theta(R), defined in the so-called "complex-plane strategy". Such polytropic shells can be considered as appropriate places for exoplanets to be "born" and/or "live". We find that the numerical results of GPM are in satisfactory agreement with the observations. So, GPM can be considered as a theoretical basis for the "generalized Titius-Bode relation".

A Real-time data reduction pipeline for stellar time-series photometry

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We have developed a real-time data reduction pipeline optimized for stellar time-series photometric observations. The photometry code is controlled through the widely used Saoimage DS9 package via the XPA messaging system. Incoming images from a telescope are processed and accurate photometric and astrometric solutions are available in real-time. Python and Fortran routines are used to determine shifts in pixel-space between successive images and each image is time stamped (if required) with Barcycentric Dynamical Julian Date. The photometry is carried out using both standard aperture as well as optimal photometry algorithms for maximum S/N extraction. The software package is designed to be modular and requires minimum human supervision so that it can be easily implemented as a real-time robotic telescope photometry pipeline on any observatory.

The Optical Light Curve of the Black Hole Candidate SWIFT J1753.4-0126

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We present preliminary results of a campaign to measure the optical light curve of the transient X-ray source SWIFT J1753.4-0126. The data were acquired with the Argos high-speed CCD photometer on the 2.1-m Otto Struve Telescope of the University of Texas McDonald Observatory. We measured the light curve of the source on 28 nights over a 4 year period. J1753.4-0126 remained in the optical high state where it has persisted since it was detected by the SWIFT X-ray satellite in 2005. We find a period in the light curve at 3.245 hr, in agreement with the period found by Zurita et al. (2008). If this is the orbital period, J1753.4-0126 has the shortest orbital period of any known black hole candidate. The light curve also exhibits significant non-periodic variability. Some patterns in the variability appear to recur although at uneven intervals.

Discovery of new variable stars at the University of Athens Observatory

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New variable stars have been discovered at the University of Athens Observatory, as a result of a routine photometric data reduction of already known variable stars during the period of 2014-2015. Two of these new discoveries are classified as pulsating variable stars, while two others are eclipsing binaries of Algol type. The rest discoveries are classified as eclipsing binaries of W UMa type. Their absolute parameters were calculated by comparing their physical properties with a wider sample of similar systems. Their components lie close to ZAMS and TAMS region, sharing the same evolution properties among solar type MS stars. In all cases, the astronomical ephemeris is calculated and times of maximum or minimum light are determined.

A new insight into the possible triple system AV CMi

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In this work, we discuss the latest results of our work on the eclisping binary system AV CMi. We analyze a large photometric data set collected during a collaboration with amateur astronomers. Furthermore, we present the revised parameters both for the stellar and for the third body's orbit and perform a dynamical analysis in order to determine if the observed orbit is stable. Finally, we explore the possibility observing TTV's in this system.

The effects of defocused photometry on the estimation of transiting exoplanets parameters

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In this work, we test the effectiveness of defocused photometry and compare it to the classical aperture photometry. Specifically, we analyze lightcurves from confirmed exoplanets that were constructed using both methods. Using Pal's transit model, we try to locate any divergences in the physical parameters caused solely by the nature of each photometric method.

The enigmatic explosion of supernova SN2014J in M82 and Nova Delphini 2013. Using novae and supernovae as distance tracers.

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Gazeas Kosmas (University of Athens)

On January 21, 2014 a supernova erupted in M82 galaxy (NGC 3034), being the closest type-Ia supernova discovered in the past 42 years. On the other hand, on August 14, 2013 a Galactic white-dwarf erupted in the constellation Delphinus, producing the brightest nova since 2007. It is classified among the 30 brightest novae ever recorded. Both events were observed from the University of Athens Observatory, in order to study their long-term light variation. Galactic and extragalactic novae and supernovae can be used as standard candles and their observed light curve can be used for estimating the distance of their explosive progenitor. It is found that while Nova Delphini follows the expected light variation for the known novae in our Galactic vicinity, supernova SN2014J gives a clear disagreement with the known bibliographic value. Apparently the peak brightness does not fit the currently existing model of type-Ia supernovae or the light coming from the supernova is strongly reddened. Alternative models are investigated, for explaining this enigmatic event.

A search for stable orbits in triple-star systems

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We model a triple star system with the planar general three-body problem (GTBP). The mutual gravitational interactions of the bodies are perturbations of the integrable Keplerian motion, which holds in a two-body framework. Such mutual interactions become very strong when all bodies are of masses and distances of the same order. When the two bodies are very small (planets), with respect to the third one (star), we get the GTBP of planetary type. In this model, and under the introduction of a rotating frame, we can obtain many families of periodic orbits, which can be linearly stable. Also, it has been shown that these periodic orbits are continued with respect to the planetary masses. In this work we apply the continuation technique and try to compute periodic orbits by increasing the planetary masses up to values which approach the mass of the star. Thus, we obtain families of periodic orbits in triple-star systems. The challenge is to find orbits for masses of the same order that are periodic and, also, linearly stable. Our computations include continuation of periodic orbits that are almost circular and stable in the planetary model.

Image reconstruction using the Manchester-Athens wide field camera pipeline

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The Manchester-Athens Wide Field Camera (MAWFC) is a joint project between the National Observatory of Athens and the Jodrell Bank Centre for Astrophysics of the Manchester University which aims to conduct a large-area sky survey with the aid of a customized camera and narrow-band filters properly designed for studying extended interstellar medium (ISM) structures in the optical emission lines of Ha, [O III], and Hb. Here, we present the main steps of the automated image processing pipeline which, apart from the basic analysis (e.g., bias, dark, and flat-fielding calibration), intends to remove the stellar contamination from the narrow-band images by means of advanced detection and smoothing techniques, and to compose mosaics of pure large-scale ISM filaments as further step. The procedure is applied to the first raw images of the survey (expected to be obtained during the spring/early summer of 2015) as well as to unprocessed images taken from older surveys.

Distance and age determination of the Galactic clusters NGC 2682 and NGC 6205

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We present a multi-band photometric study on the Galactic clusters NGC 2682 and NGC 6205, which was conducted at the University of Athens Observatory. NGC 2682 is relatively close to our Solar System, while there is negligible interstellar absorption towards its direction. It has approximately similar age to our Sun and this makes it a perfect candidate for stellar evolution models. On the other hand NGC 6205 is one of the oldest globular clusters in our Galaxy, setting a good constraint for the lower limit on the age of the Universe. The distance modulus for each cluster was calculated by inspecting characteristic regions on these diagrams, while we estimated their age, utilizing the most recent theoretical isochron models. The photometric properties of the blue stragglers in NGC 2682 were derived and compared with the very few available studies conducted on this cluster in a homogeneous way.

Searching for a critical analysis of the eclipsing binaries timing variations

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The divergence of the eclipse timings in eclipsing binaries stars as accurate clocks implies orbital variations due to physical phenomena such as mass transfer between the components of the system and/or the presence of a third body revolving the eclipsing binary system. Monitoring of W UMas has revealed a lot of unseen companions during the last decade, thus an extensive investigation of the parameters derived from cyclic period variations is needed in order to confirm or reject the hidden companion (s). Dealing with non-linear problems in the analysis/modeling of the Eclipse Timing Variations (ETVs) always come up against correlations between the parameters, degenerate solutions and local minima in the parameter hyperspace. Thus, an extensive investigation using the state-of-art modeling techniques to locate the global solution and to estimate the uncertainties is needed. The code, implemented in Python, is set up to handle Heuristic Scanning with parameter perturbation, Bootstrap Resamping, Marcov Chain Monte Carlo and the classical approaches of Nelder-Mead and Levenberg-Marquardt algorithms. Computational examples using synthetic ETVs and real data are demonstrated.

The correlation between magnetic field lines and filamentary structures in the Polaris Flare

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One of the most fundamental yet open questions in modern astrophysics is how stars are formed. From the early 80s it was known that elongated structures called “filaments” play a role in star formation. Their significance was even more highlighted by recent Herschel observations. However, the exact mechanism that prevents the cloud from collapsing under its self gravity is not yet fully understood. Insights can be gained by studying the magnetic field of molecular clouds such as the Polaris Flare which is believed to be in the early stages of its formation. We have cross-correlated Herschel dust emission maps and magnetic field directions in the Polaris Flare using polarimetric data from RoboPol. We have carried out the first detailed study of the connection between filamentary structures and the magnetic field orientation. We identified linear structures in this cloud. We made a detailed map of the polarization segments on the filaments. Our results show that the magnetic field lines tend to be parallel to the filaments while other factors (like the intensity of the filaments) play a role as well.

X-ray time lags in black-hole binaries during outbursts

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The X-ray spectrum of black-hole binaries consists of a soft component that follow a blackbody distribution and a power law at higher energies (> 10 keV). While there is general consensus that the blackbody component comes from an optically thick, geometrically thin accretion disk and that the hard component results from inverse Comptonization of low-energy photons emitted from the disk, the geometry and dynamics of the comptonizing medium remains unknown. Spectral information alone does not help because different models can result in very similar energy spectra. To fully understand the structure of black-hole binaries, it is essential to consider X-ray timing variability. In particular, time lags between two different energy bands set tight constraints on the models of the X-ray production. We present a study of the time-lag Fourier spectrum of black-hole binaries during major X-ray outbursts. Our main objective is to determine the origin of the lags and to constrain the geometry of the comptonizing region. If the X-rays result from comptonization, then we expect to detect positive lags, that is, hard photons lagging soft photons. This is because hard photons suffer more scatterings, hence they spend more time in the comptonizing medium. In Cyg X-1, a power-law dependence with Fourier frequency with index ~0.7 has been observed. In our analysis of five black-hole binaries, we find that the time-lag Fourier spectra of some systems deviate from a power-law function. In some cases, we even measure negative lags (soft photons lag hard photons). We suggest that the lags from the reflection component affects the shape of the time-lag Fourier spectrum.

Automated spectroscopic data reduction applied on stellar classification

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A spectroscopic program towards a complete atlas of spectroscopic standards is carried out at the University of Athens Observatory. Processing a large amount of data would be both ineffective and time consuming. Therefore, in order to minimize manual interaction and increase effectiveness, an automated spectroscopic data reduction script was developed. For testing the automated reduction procedure, we applied the script on stellar spectral classification. The results are very promising for stellar objects with apparent magnitude down to 9 mag with a 0.4 m telescope. Soon we will be able to perform automated, pipe-line reduction of wider range of spectra obtained with various telescopes in a uniform way, increasing sensitivity and magnitude limit down to 11 mag with a 1.2 m telescope and 13 mag with a 2.3 m telescope.

Maser-emitting planetary nebulae

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We present updated information about a special type of PNe, those showing maser emission (of OH and/or H2O). These masers are expected to extinguish shortly after (<1000 yr) the end of the asymptotic giant branch phase and therefore, maser-emitting PNe could be in their very earliest phases. Their youth make them key objects for understanding the formation and evolution of PNe. Up to now, only 9 PNe are known to harbour maser emission. Most of these sources show a bipolar morphology in the radio continuum, optical and/or infrared images. However, these sources do not form a homogeneous group. Some objects are optically obscured, and compact in size (~10 000 AU), while others are optically bright and very extended (~1 pc), and thus, they might be PNe in a somewhat more evolved stage. Here we review the properties of these sources and their implications in our understanding of PN formation.

An X-ray survey of the LMC with XMM-Newton

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We have conducted an X-ray survey of the Large Magellanic cloud with XMM-Newton. The complete program, consists of 70 pointed observations, with more than 2 MS of exposure time in total, and covers an area of ~10 deg^2. The effective area and large field of XMM-Newton allowed us a consistent study of the point source population (down to a limiting luminosity of $2x10^{33}$ erg/s), as well as the detailed spectral analysis on the supernova remnant (SNR) population in the LMC. Here we present the X-ray mosaic image of the LMC together with an overview of some of the highlight results produced from the survey.