

Detection of Supernova Remnants in galaxy NGC 1313

Maria Kopsacheili

**IAASARS - National Observatory of Athens,
University of Athens**

**NOA supervisor: Dr. Panayotis Boumis
Team members: Dr. Ioanna Leonidaki, Prof. Andreas Zezas**

Multiwavelength study of Supernova Remnants in nearby galaxies

In Northern Hemisphere:

NGC 2403, NGC 3077, NGC 4214, NGC 4395, NGC 4449, NGC 5204

In X-rays: 37 detected SNRs

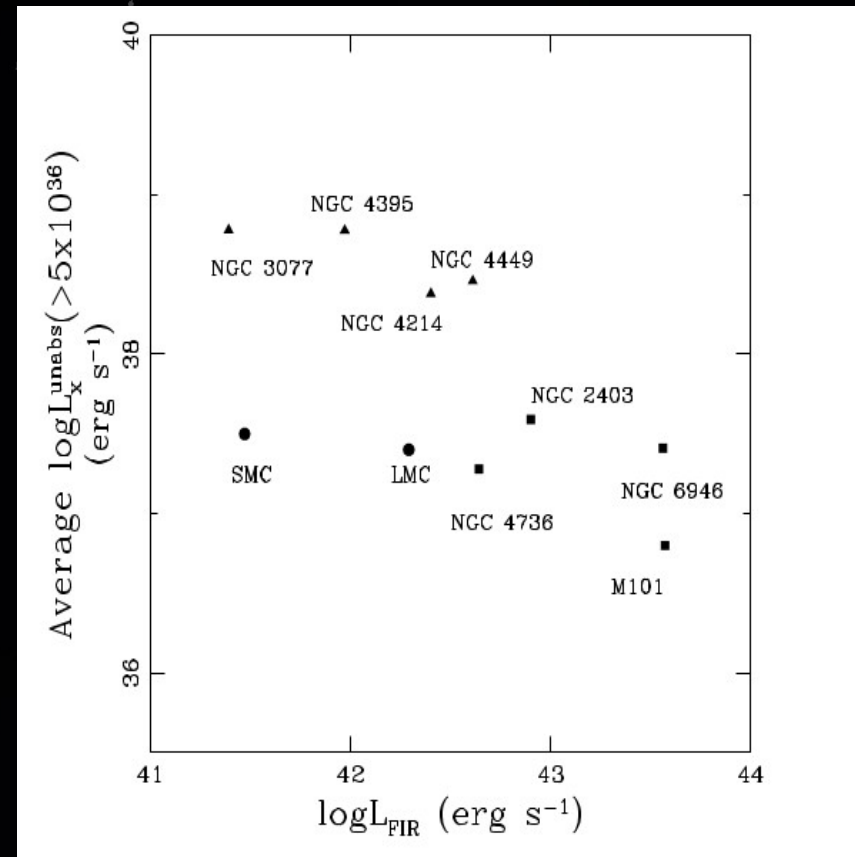
(Leonidaki et al. 2010)

In the optical: 67 spectroscopically

confirmed SNRs (out of 95 photometrically detected SNRs. 165 SNRs are going to be studied) (Leonidaki et al. 2013)

In Southern Hemisphere:

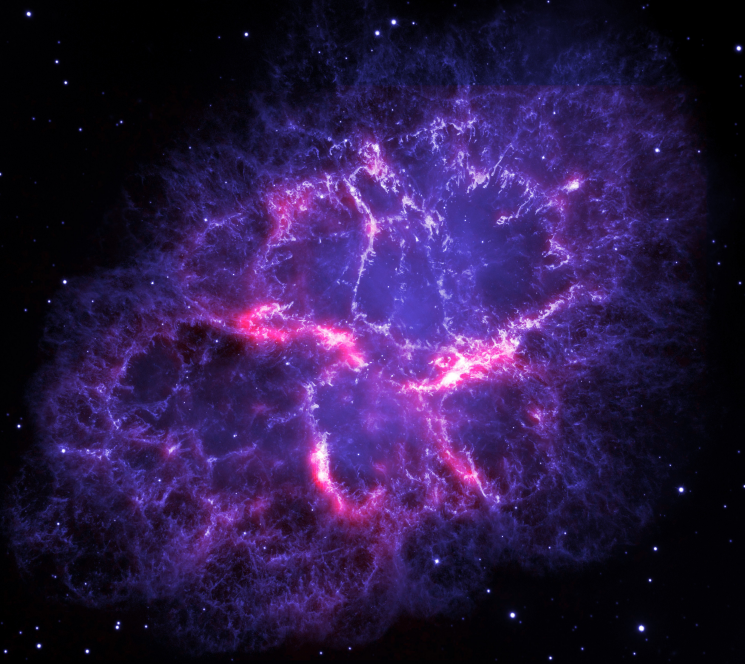
NGC 1313, NGC 45, NGC 55, NGC 1672, NGC 7793



Supernova Remnants

What is a supernova remnant?

- White Dwarf accreting material from a donor companion (Supernova Type Ia)
 - Core-collapse of massive stars ($> 8 M_{\odot}$) (Supernova Type II)
- Propagation of shock wave
- Interaction with the circumstellar medium
- Supernova Remnant (SNR)



Crab Nebula

Importance of studying SNRs

- Enrich the interstellar medium (ISM) with heavy elements
- Trigger star formation
- Yield information about the physical properties of ISM
(density, chemical composition, temperature)
- Information about stellar evolution and star formation rate

Study of extragalactic SNRs

- Wider sample
- Extinction
- Distance
- ✗ Due to large distances
 - Indistinct structures
 - Difficulty in the study of nebula physics

Evolution of SNRs

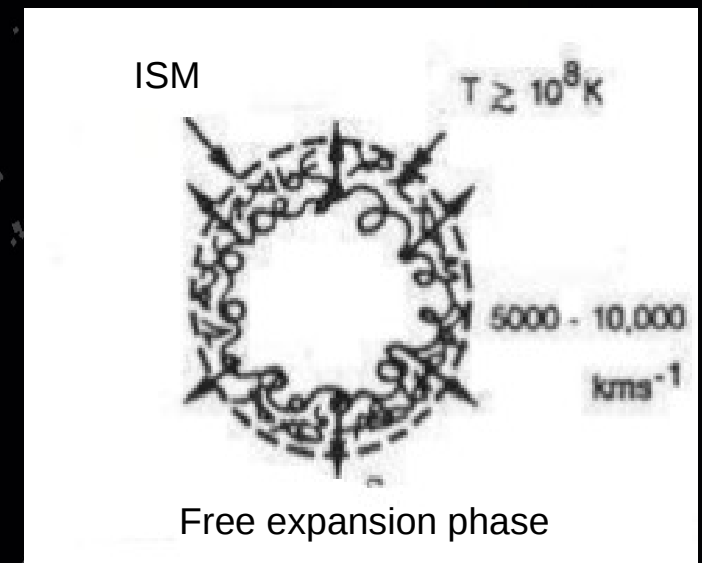
→ Free expansion phase

- $M_0 \gg M_s$

- Shock wave propagation without resistance

- $u_0 > 10,000 \text{ km/s}$

- 100-1000 years



Evolution of SNRs

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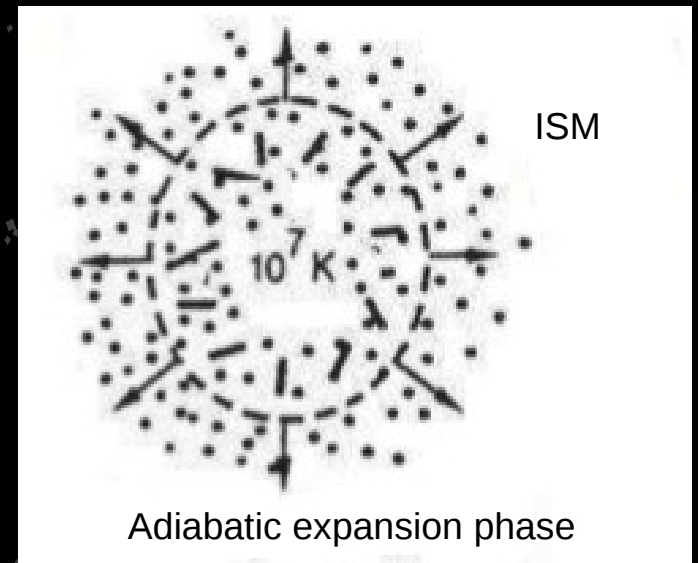
→ Adiabatic expansion phase

- $M_o < M_s$

-Inverse shock wave

-Deceleration of front shock wave

-10,000 years



Evolution of SNRs

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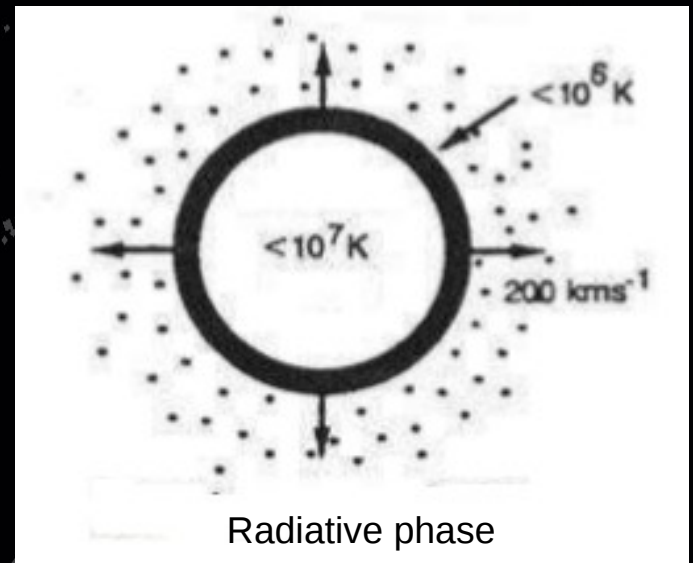
→ Radiative phase

- $M_0 \ll M_s$

- $u_0 \sim 200 \text{ km/s}$

-Radiation in the optical

-100,000 years



Evolution of SNRs

→ Free expansion phase

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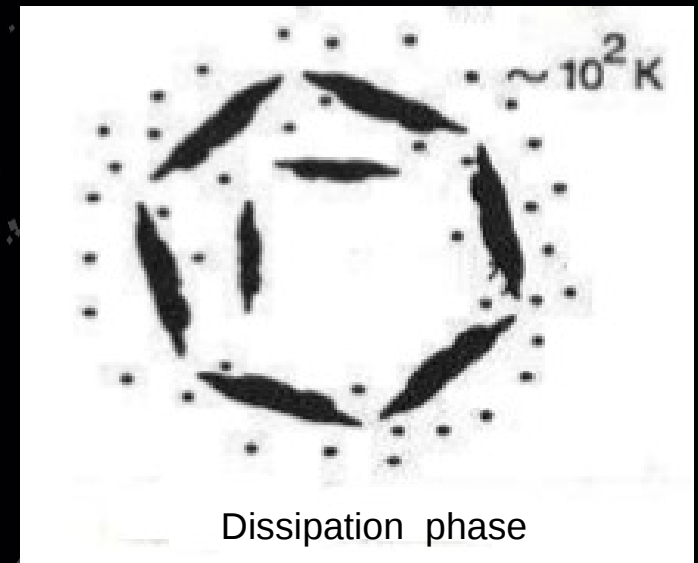
- $u_0 \sim 200 \text{ km/s}$

-Radiation in the optical

-100,000 years

→ Dissipation phase

-Assimilation with ISM → Dissipation



Emission in the optical regime

- Recombination Lines

Balmer Lines

Mainly: $H\alpha$ ($n=3 \rightarrow 2$) and $H\beta$ ($n=4 \rightarrow 2$)

- Forbidden Lines

Low density \rightarrow Spontaneous decay \rightarrow Forbidden photons

- Diagnostic tool for SNRs:

$$\frac{[S II]}{H\alpha} \geq 0.4$$

Classification of SNRs

Based on morphology

Shell-like



Plerions or Crab-like



Composite



Classification of SNRs

Based on optical spectral properties

→ Balmer-dominated

Intense hydrogen lines

Faint (or absent) forbidden lines

[O III], [S II], [N II]

→ Rich in Oxygen

Intense forbidden lines [O III]

Faint (or absent) hydrogen lines

Subject of the study

Detection of SNRs in NGC 1313

- Location: 03h 18m 15.4s, $-66^{\circ} 29' 50''$
- Dimensions: 9.1 x 7.1 arcmin



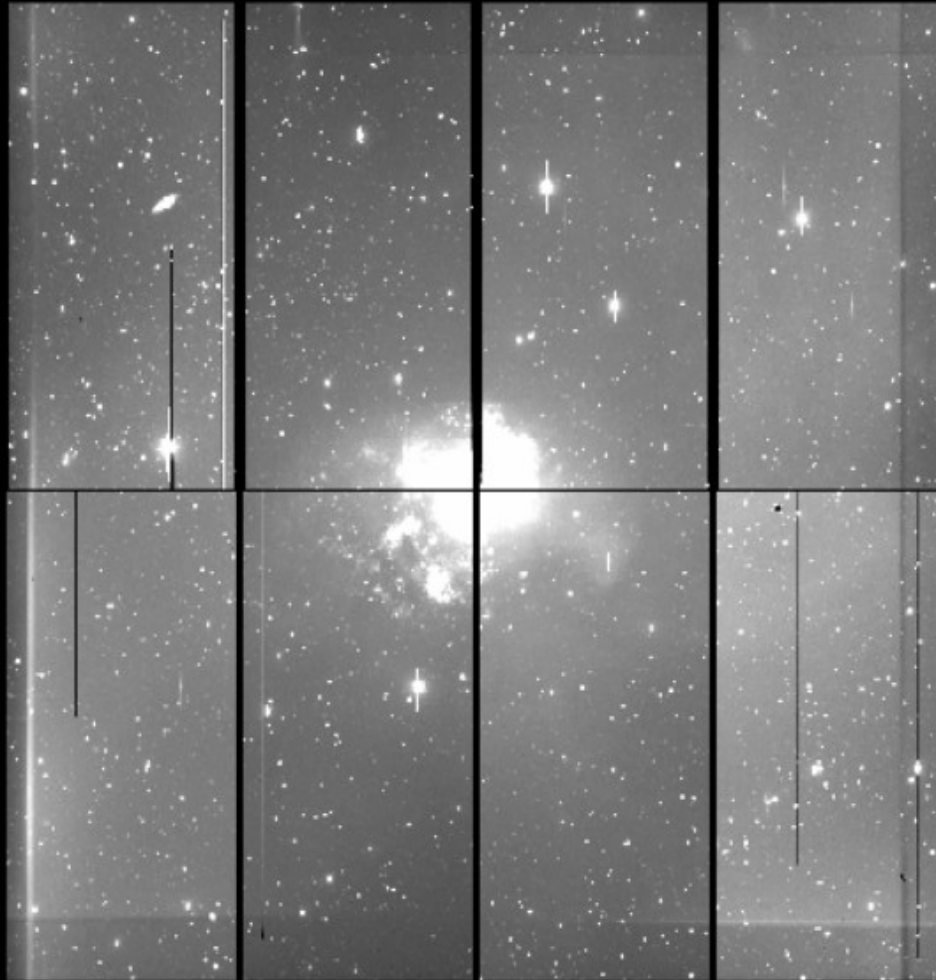
Observations



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- Blanco 4-meter telescope
CTIO, in Chile
- Mosaic II camera
field of view: 36'x36',
Pixel scale: 0.27 arcsec/pixel
- H α (narrow band) 3600 sec
(FWHM: 80Å, CWL: 6563Å)
- [S II] (narrow band) 7200 sec
(FWHM: 80Å, CWL: 6725Å)
- R (broadband) 900 sec
(FWHM: 1510Å, CWL: 6440Å)
- P. Boumis, I. Leonidaki
November, 2011

Indicative image

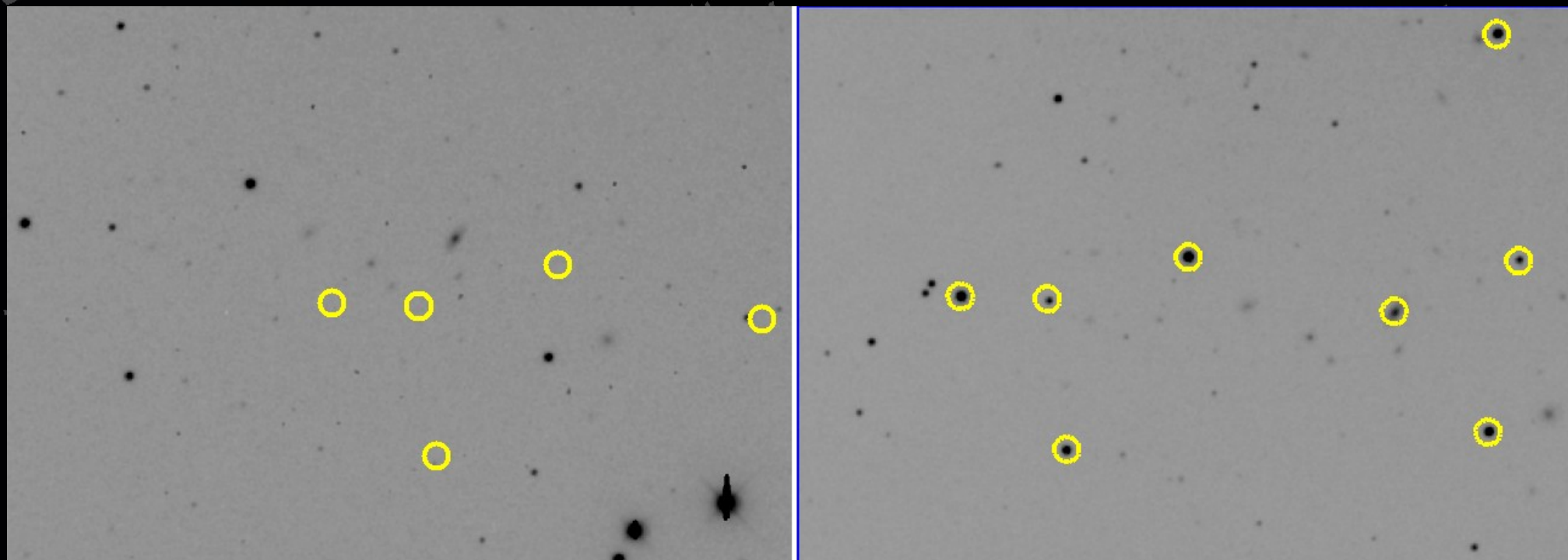


36' x 36'

H α

Data reduction

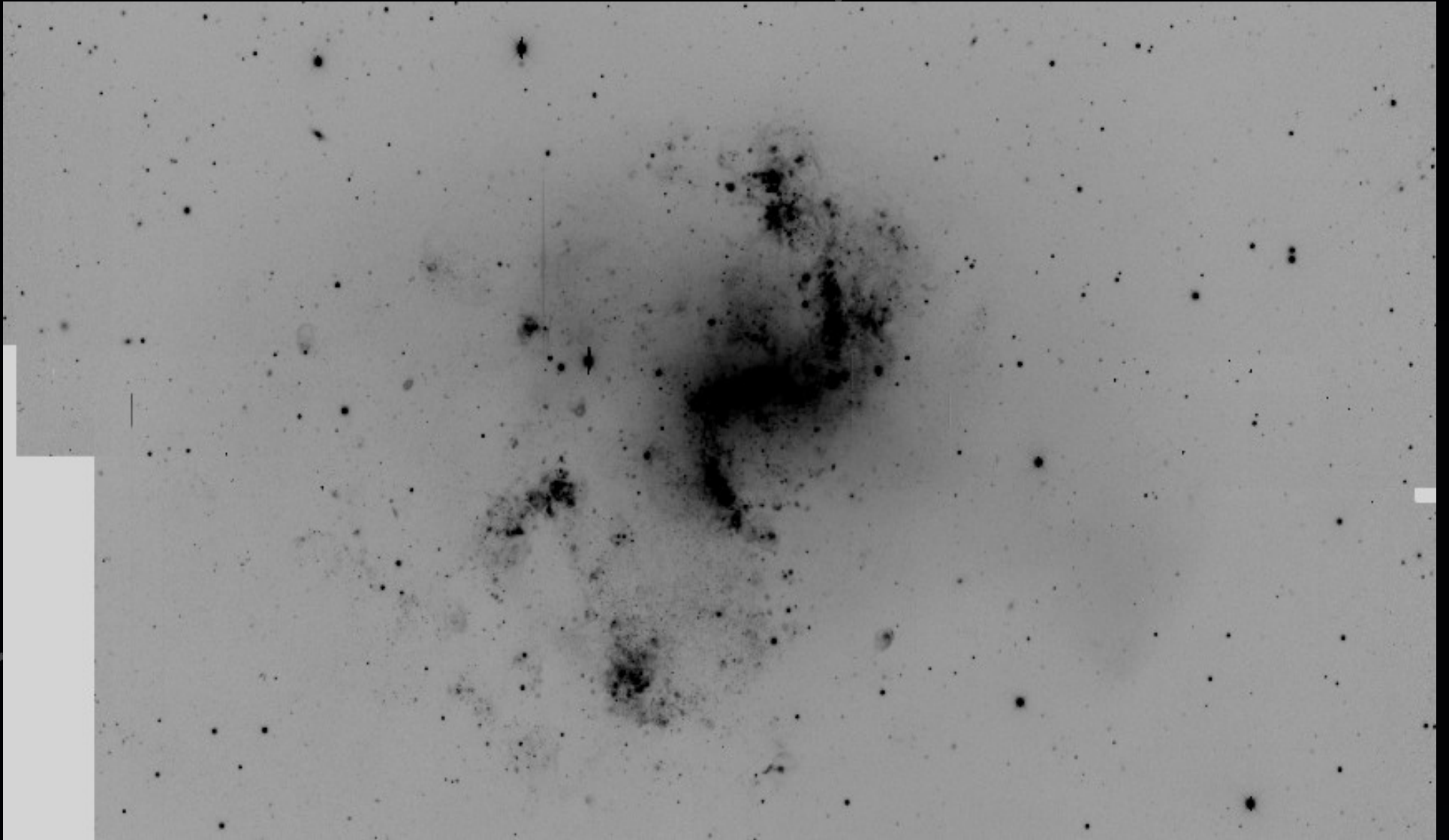
- Bias, Flat-fielding correction
- Astrometry (2MASS Catalog)



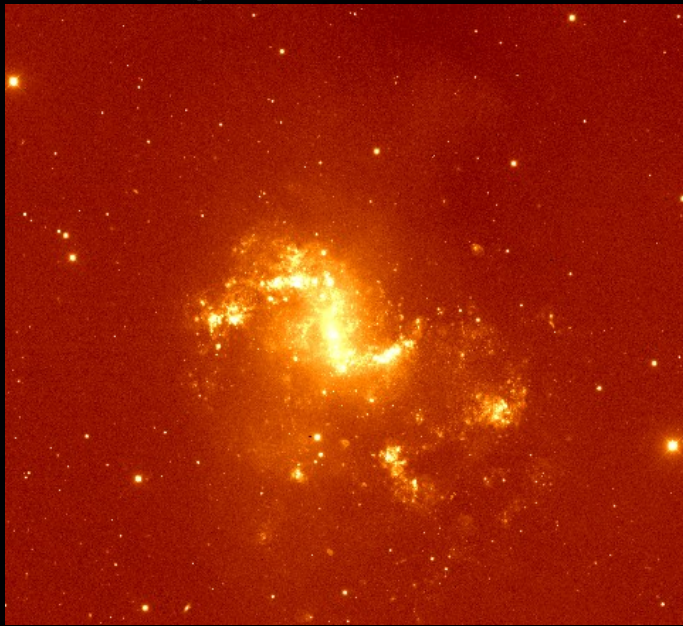
Before correction

After correction

Final Image (H α)



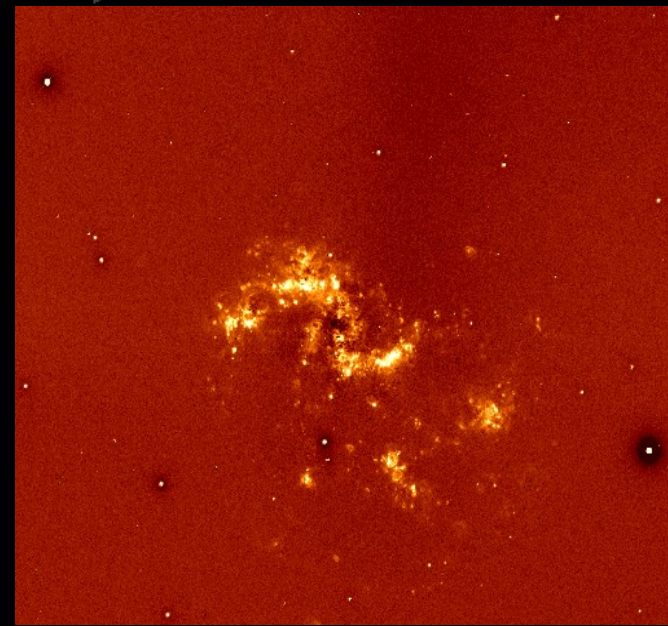
Subtraction of stars



H α

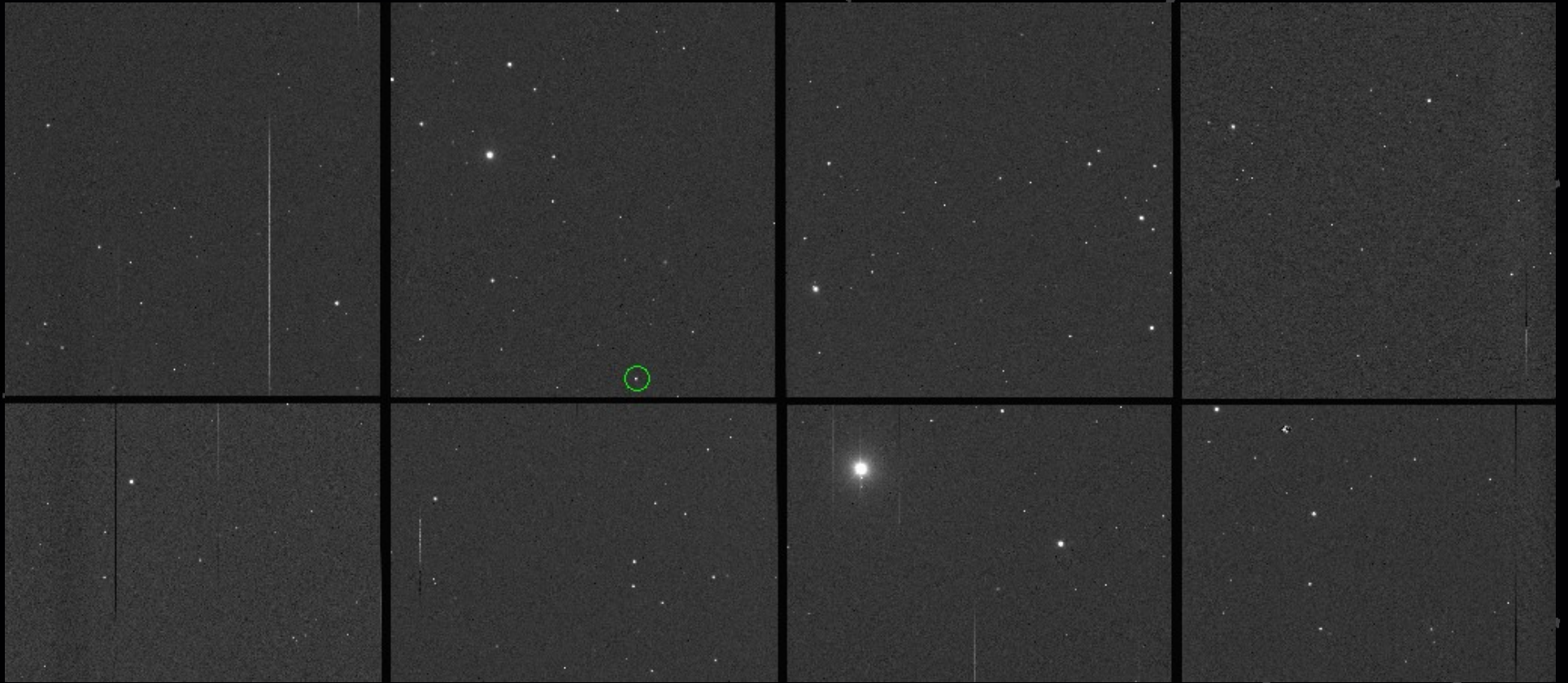


R



H α without
continuum
radiation

Flux calibration Standard Stars



Spectrophotometric standards
Massey & Strobel & Barnes & Anderson, 1988

Detection

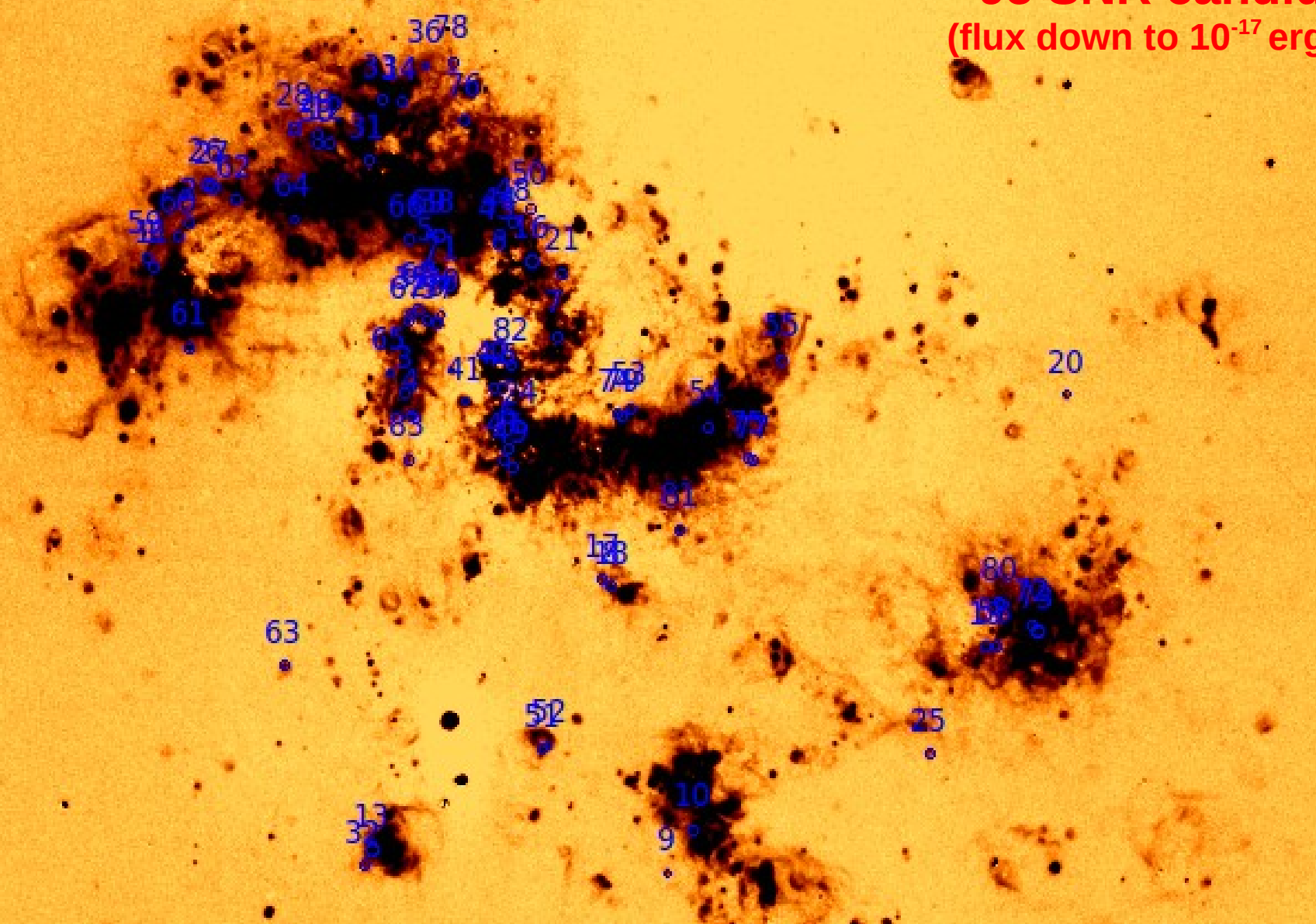
- Detected 9000 sources (SExtractor)
(stars, H II regions, planetary nebulae, SNRs, enhanced background)
- Photometry for detected sources
- SNR candidates → $\frac{[S II]}{H\alpha} \geq 0.4$ (Mathewson & Clarke, 1973)

Results

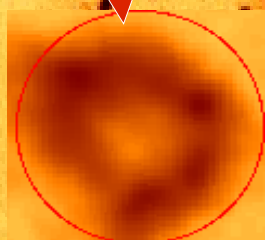
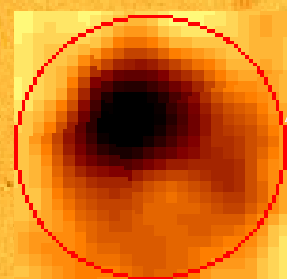
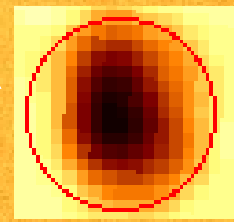
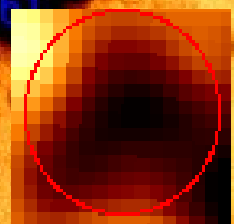
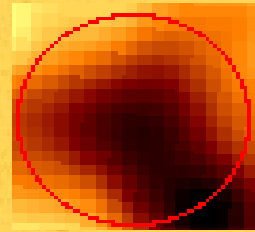
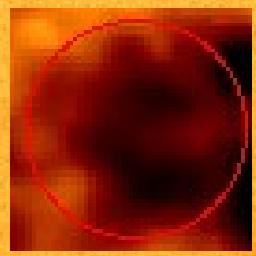
H α

95 SNR candidates
(flux down to 10^{-17} erg/cm 2 /s)

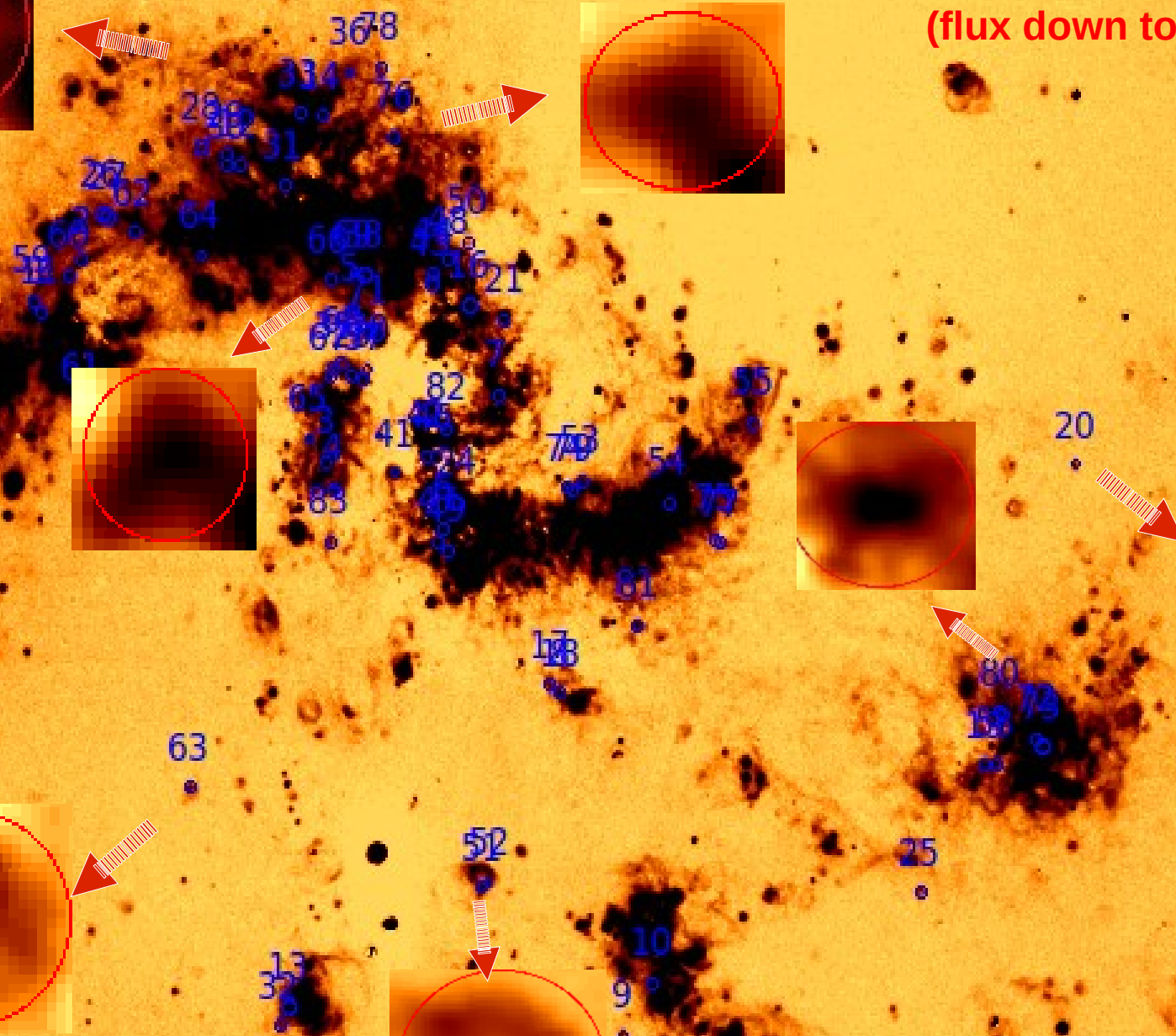
20.1' x 14.5'



95 SNR candidates
(flux down to 10^{-17} erg/cm²/s)



20.1' x 14.5'



Future goals

- Verification of shock excited nature of SNRs spectroscopically.
- Supernova remnants detection and study in the following galaxies: NGC 45, NGC 55, NGC 1672, NGC 7793.
- Investigation of interplay between SNRs and ISM, correlation between SNRs population and types of galaxies.



Thank you....