Gamma-ray sources & Supernova Remnants

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THE CONTEXT

To understand the nature of the γ-ray sources we need:

- to identify the particle accelerator
- to characterize the physical properties of the target particles and radiation fields.

This is usually done by:

- searching inside the γ -ray source error box for astrophysical objects able to accelerate particles to CR energies and
- gathering information about the distribution and physical conditions of the local interstellar medium.

In our Galaxy, the majority of the identified γ–ray sources are associated with:

- Pulsar wind nebulae (PWN)
- Supernova Remnants (SNR)
- Binary systems

About 1/5 of them still remain unidentified

In TeV energies:

- **13 sources** have been associated with **shell-like SNRs**
- **10** with **SNRs** associated with **molecular clouds**

In the GeV regime:

- **7 SNRs and have been firmly detected (plus 4 other suggested)**

And *58 sources detected by Fermi-LAT are proposed as possibly associated with a SNR and/or a PWN, but await confirmation.*

Radio continuum observations, directly measuring the non-thermal radiation originated in ultra-relativistic particles, are an excellent tool to help :

- in the identification of the sites where the particles are accelerated to cosmic rays energies
- to investigate the energy spectrum of the particles

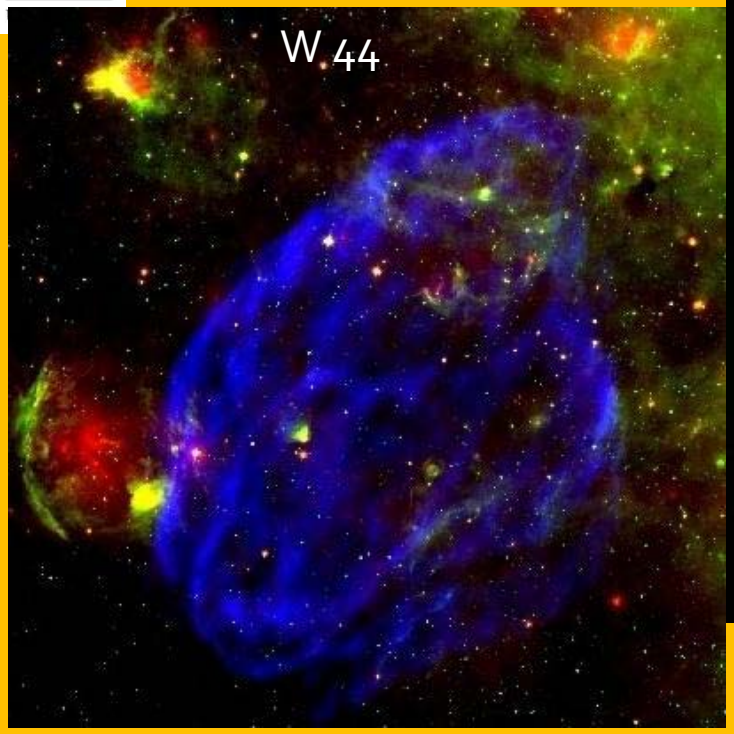
Millimetric and submillimetric studies permit the search for sites where cosmic rays generate γ-ray emission via π^0 decay

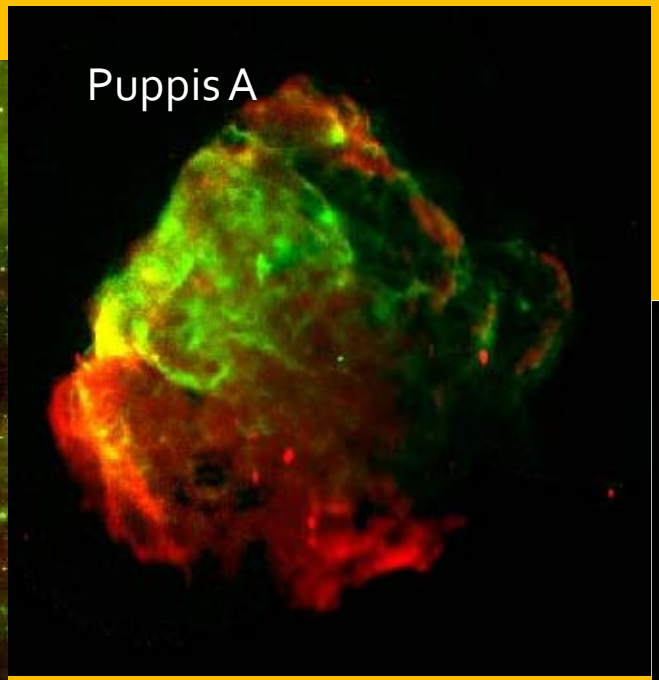
Our group working on **SNRs & ISM *at IAFE, in Buenos Aires,*** has conducted dedicated studies of many catalogued Galactic SNRs, producing:

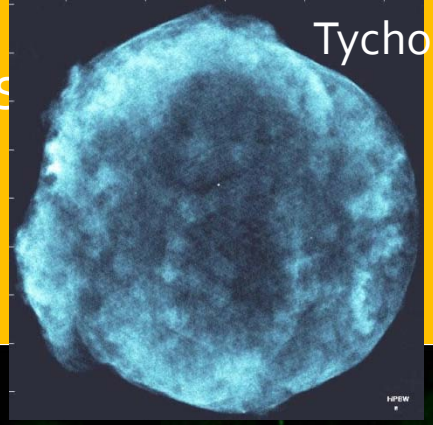
- High-resolution radio images at different frequencies
- Spectral studies
- Measurements of the expansion of the shock front in historical SNRs
- Surveys of the surrounding interstellar gas through atomic and molecular lines observations
- Searches for star formation in regions adjacent to SNRs
- Searches for radio counterparts to unidentified TeV sources

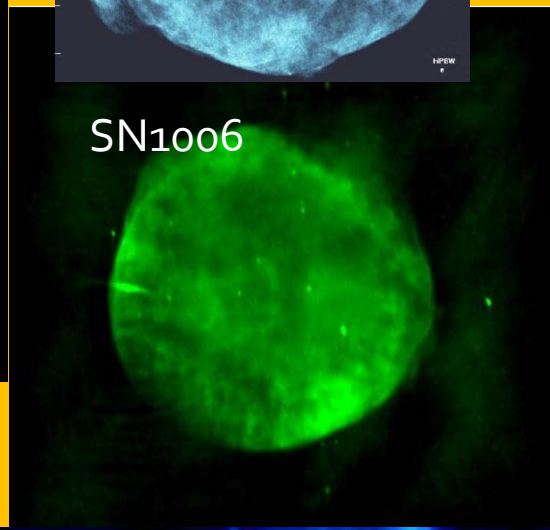
GMRT, India

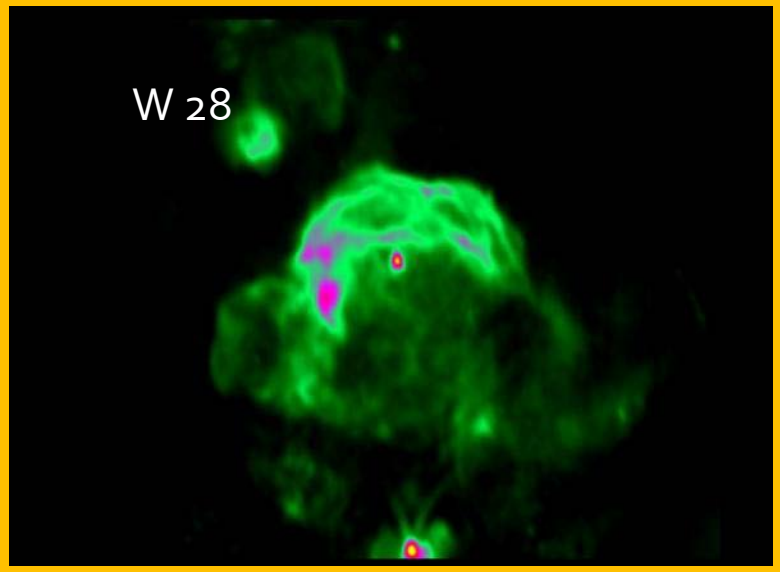
ALMA, Chile

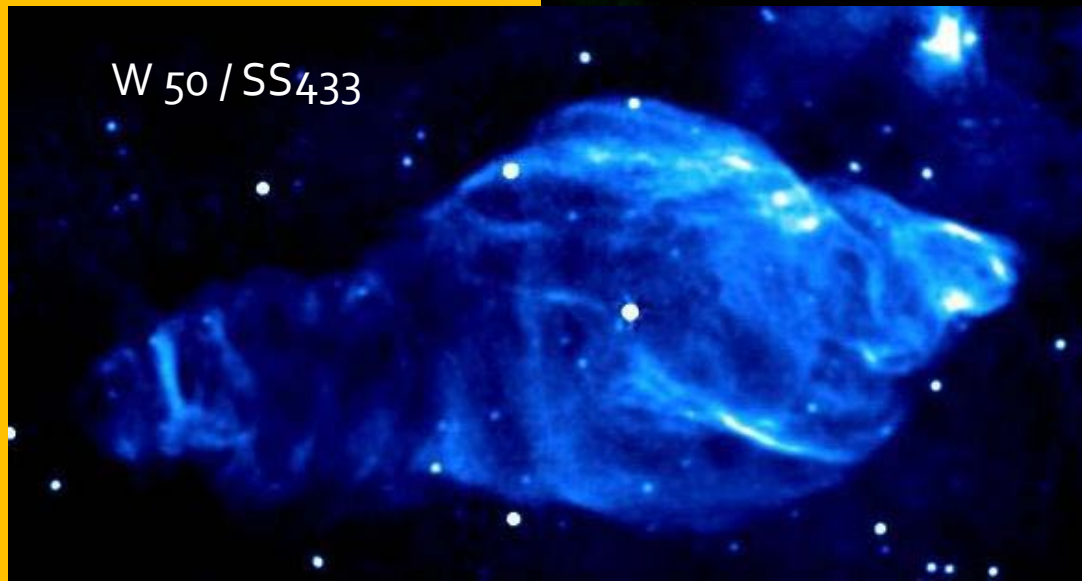

W 44


Puppis A

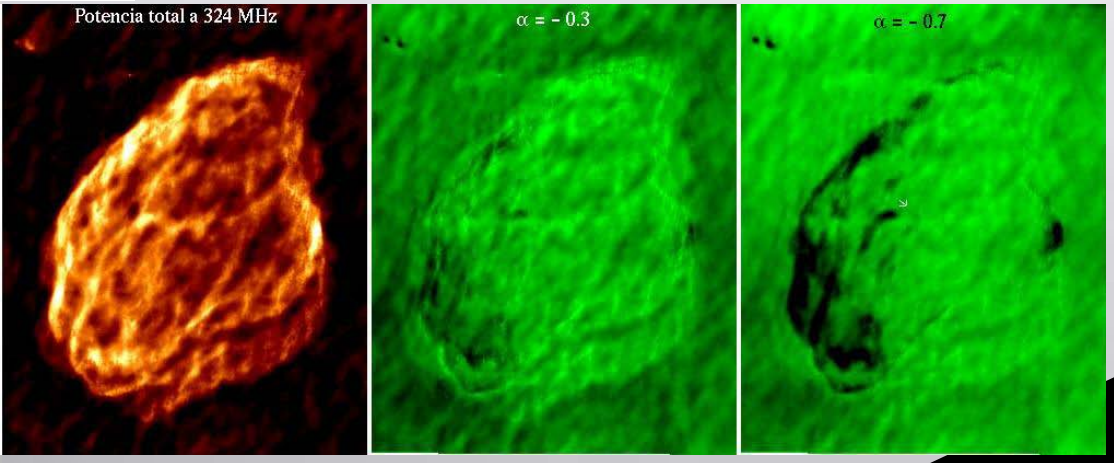

Tycho

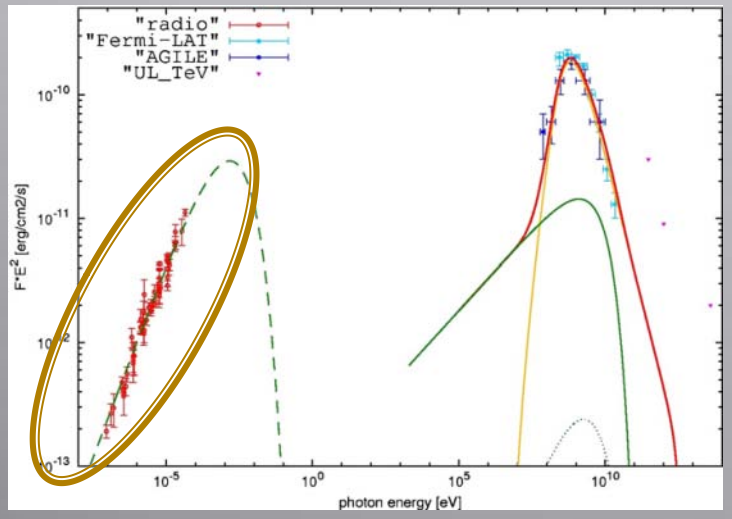

SN1006


W 28

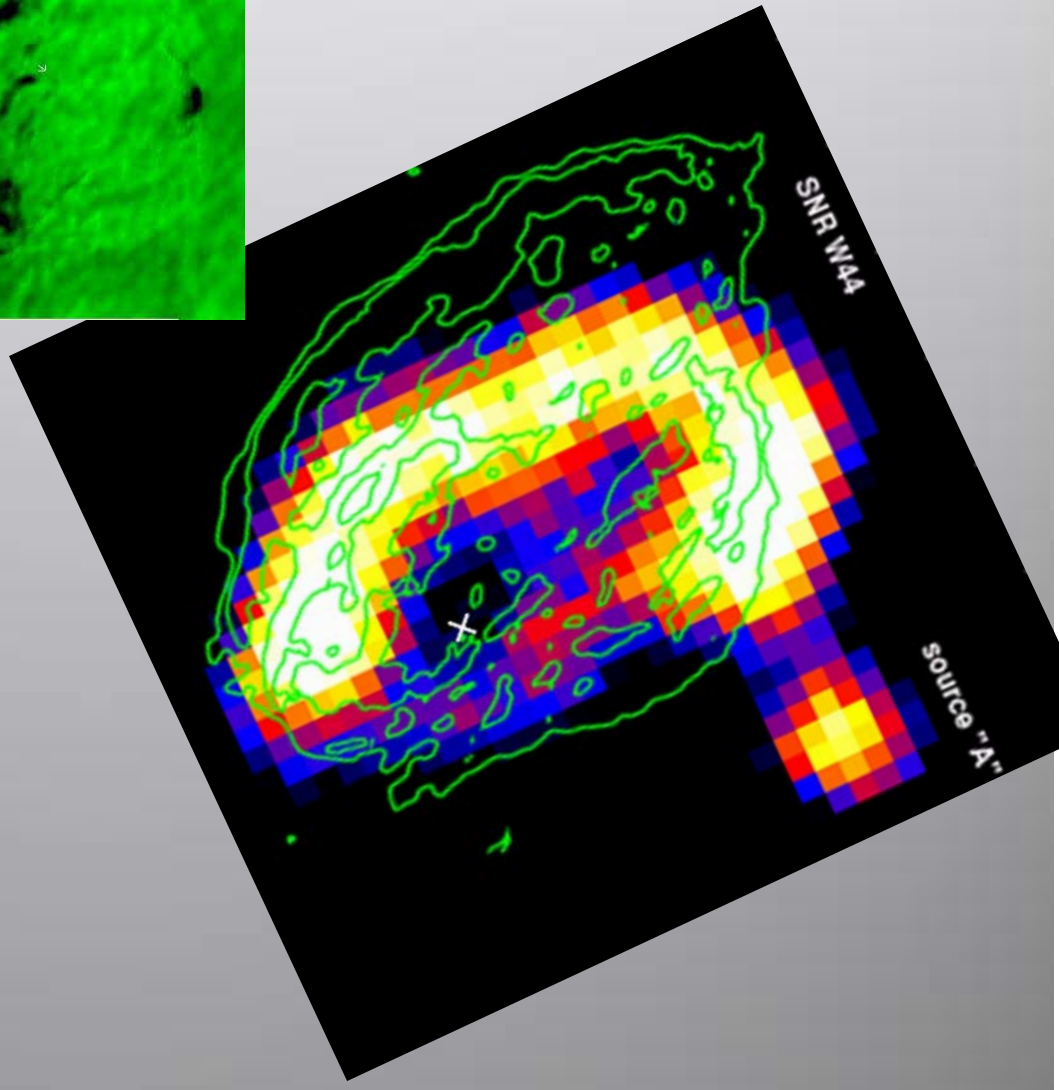

W 50 / SS433

Castelletti et al. 2007



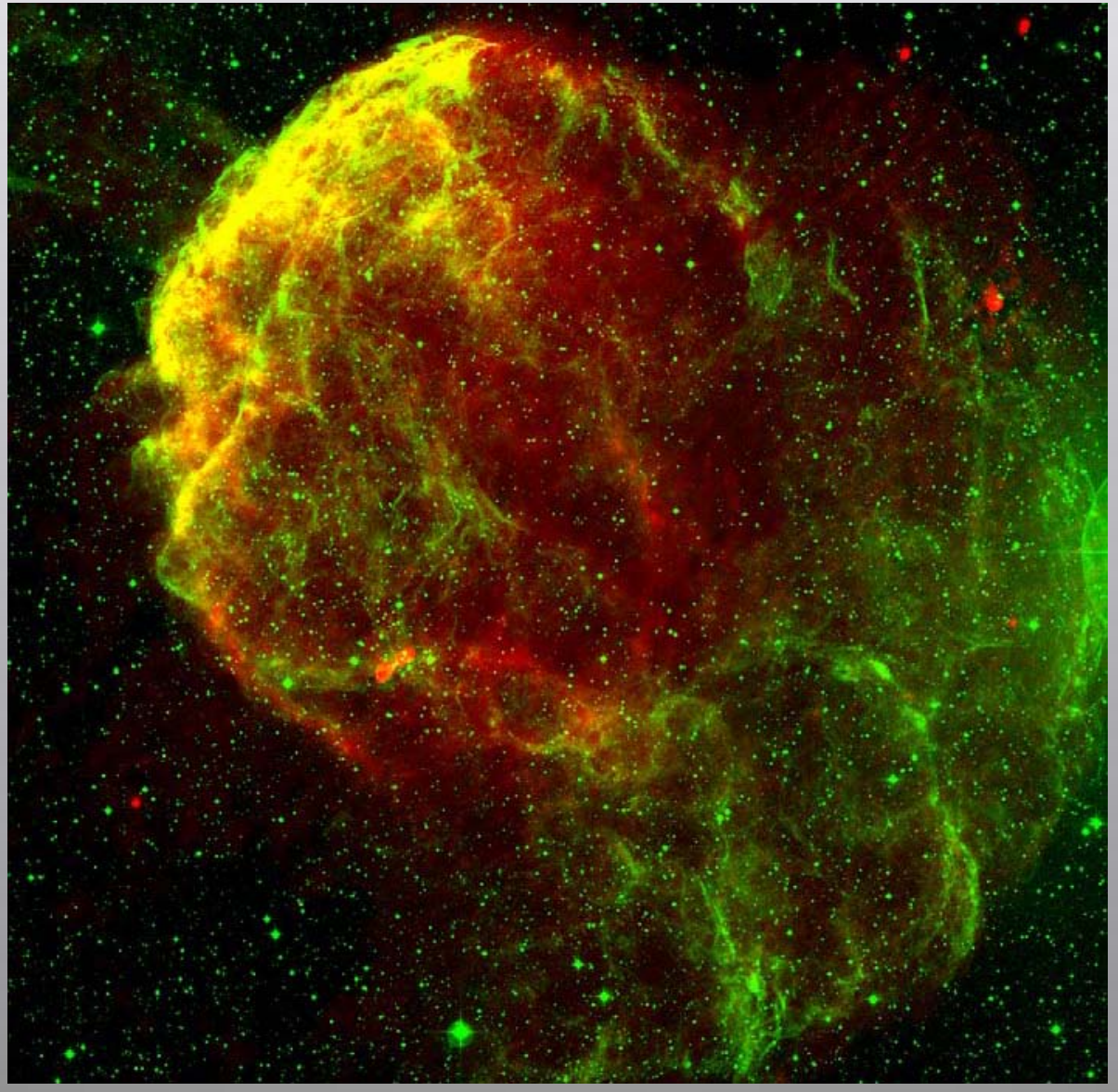


Giuliani et al. 2011

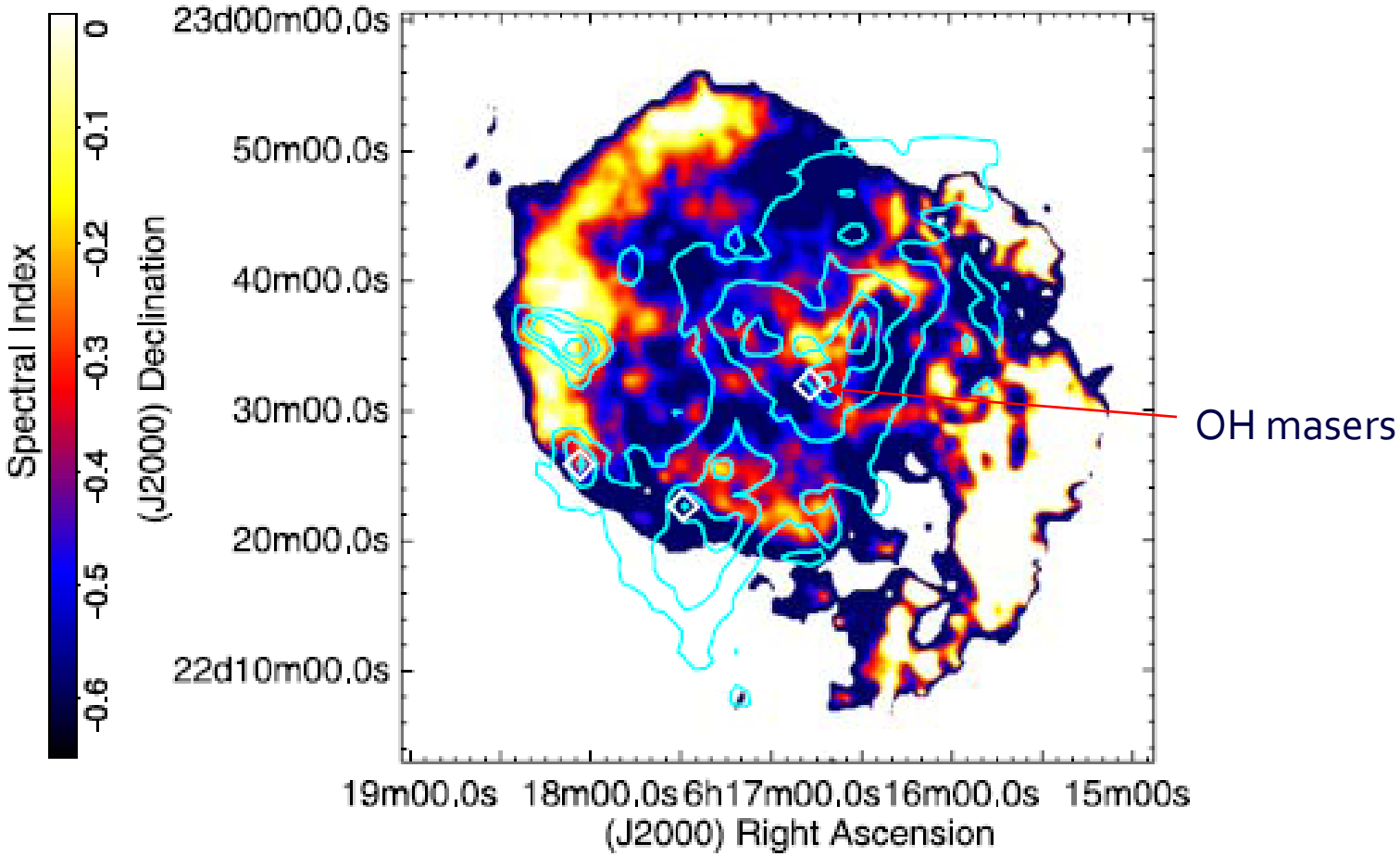


IC 443 - First high-resolution radio observations

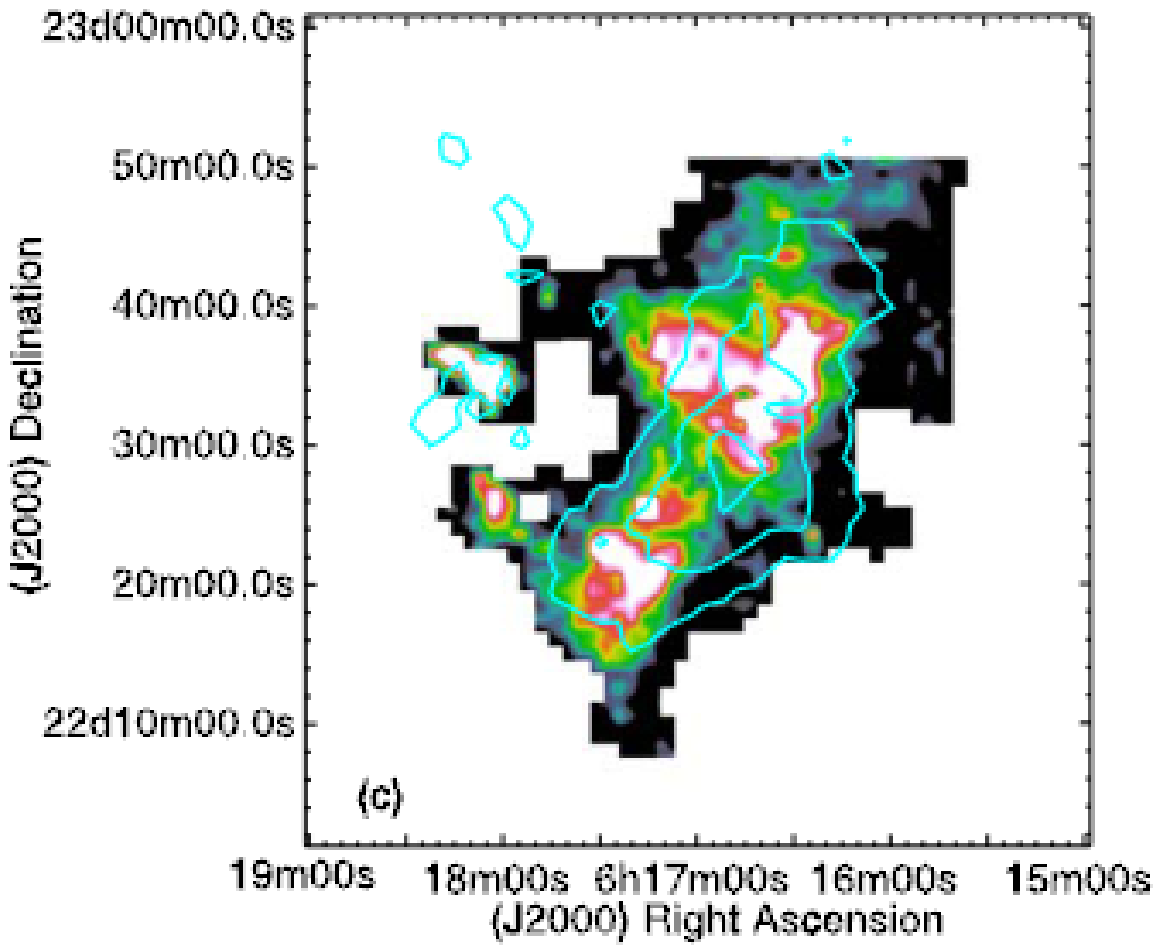
Castelletti et al. 2011 (See poster)



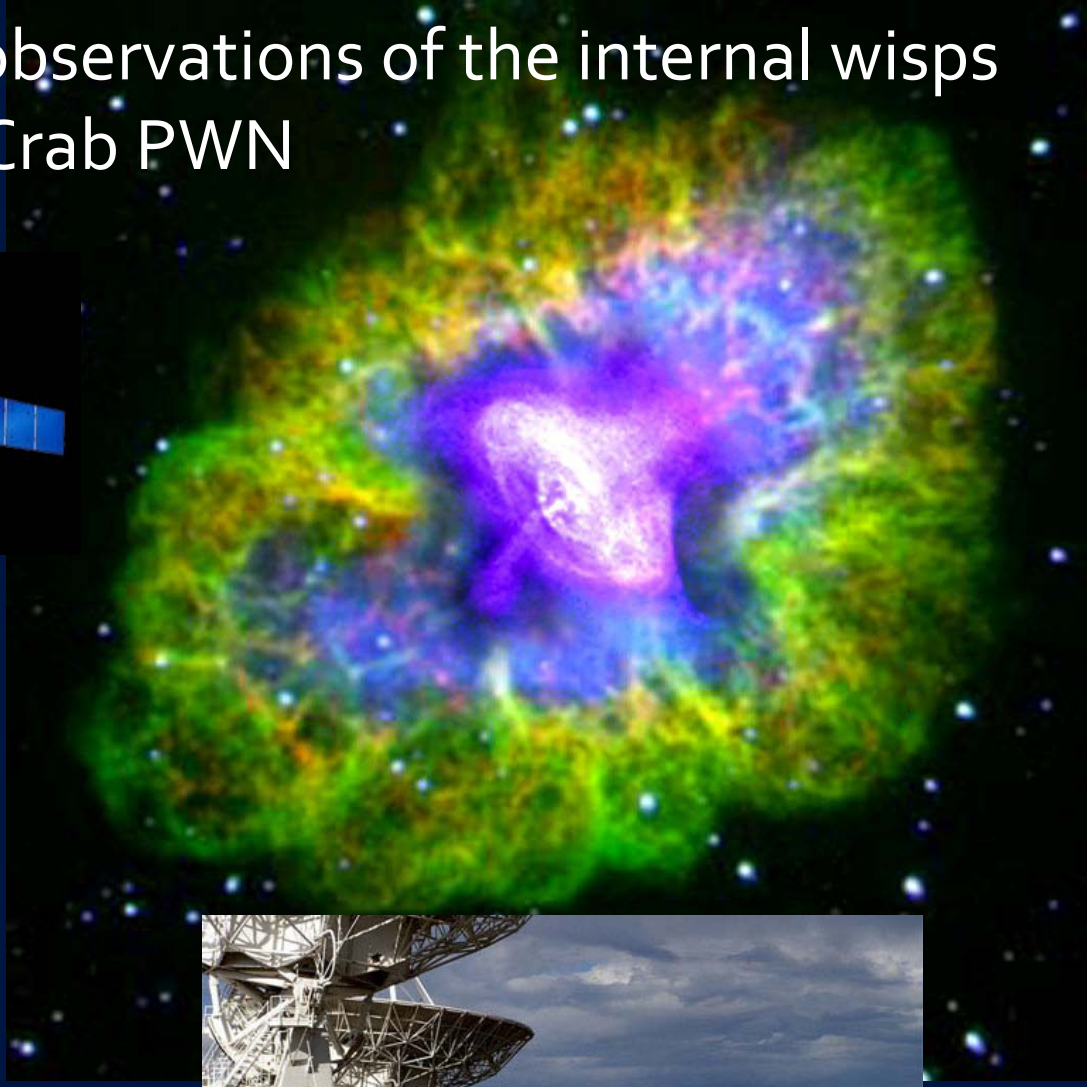
Radio spectral index and CO emission in IC443



TeV VERITAS (Acciari et al. 2009) source VERJ0616.9+2230 (contours) superposed to 12Co (J = 1–0) emission



Contemporaneous observations of the internal wisps and features of the Crab PWN



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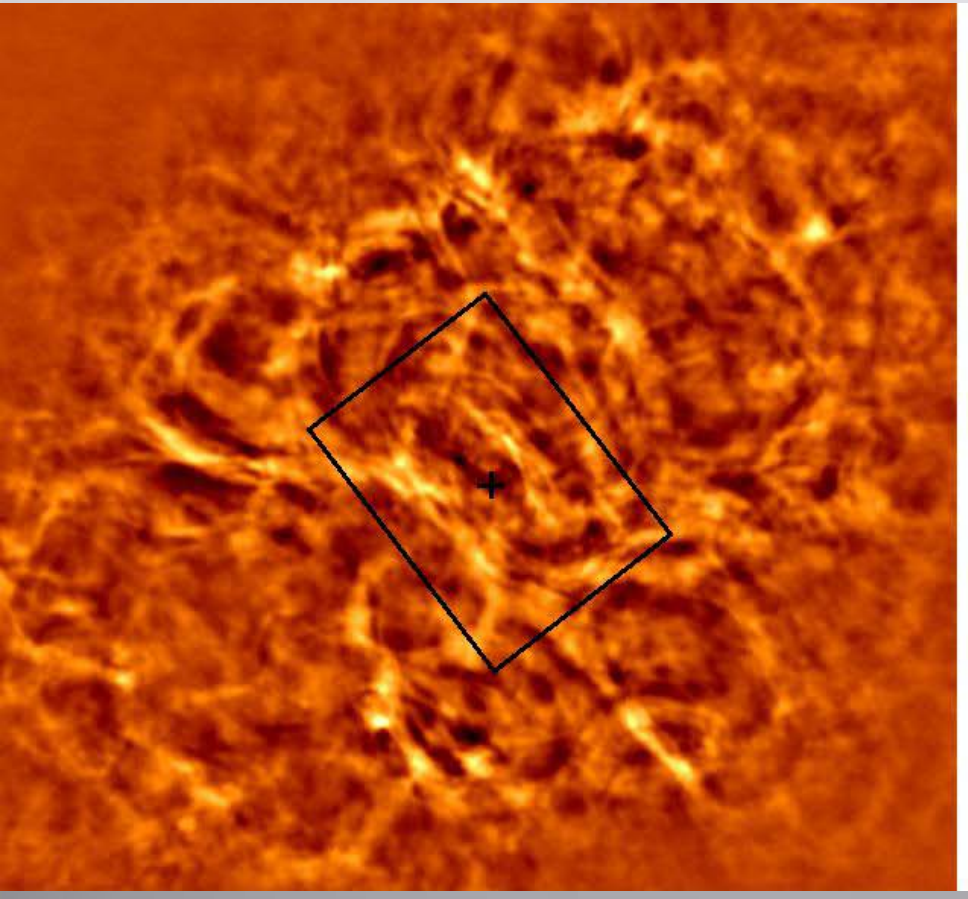
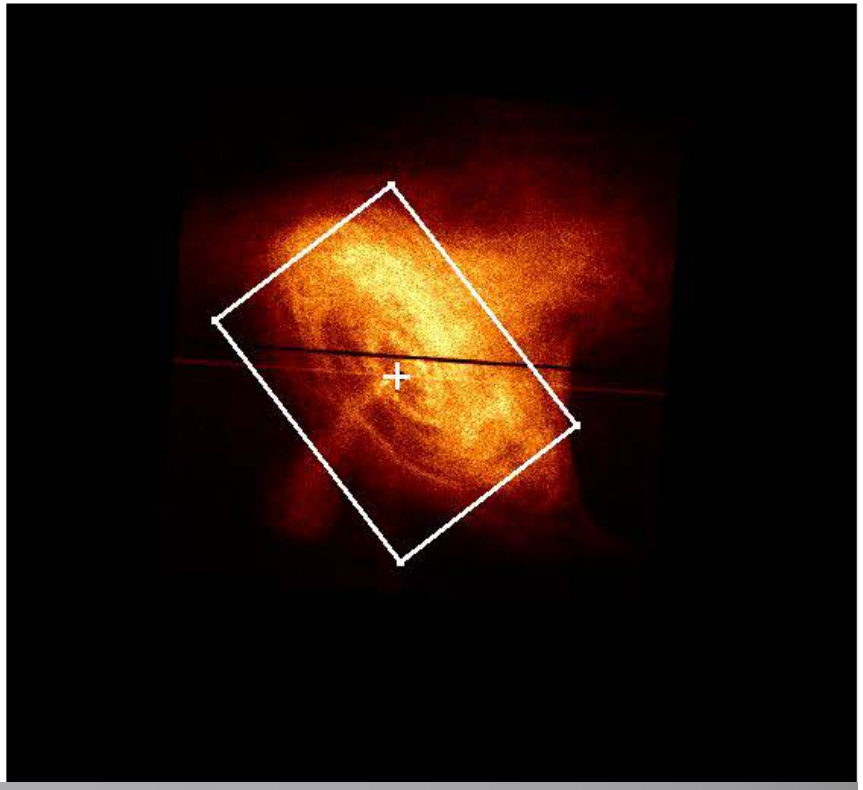
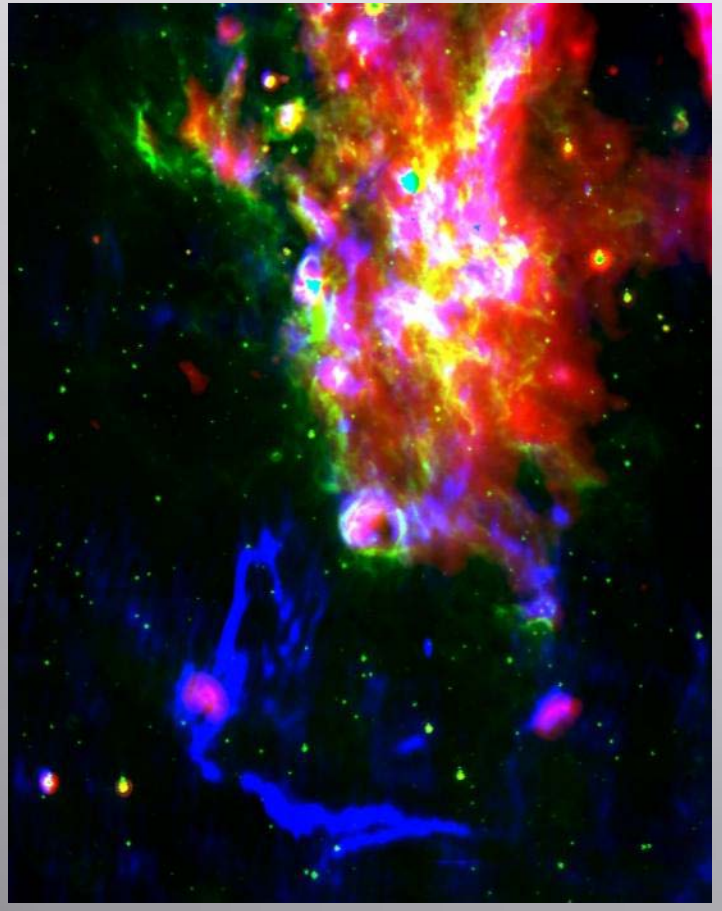
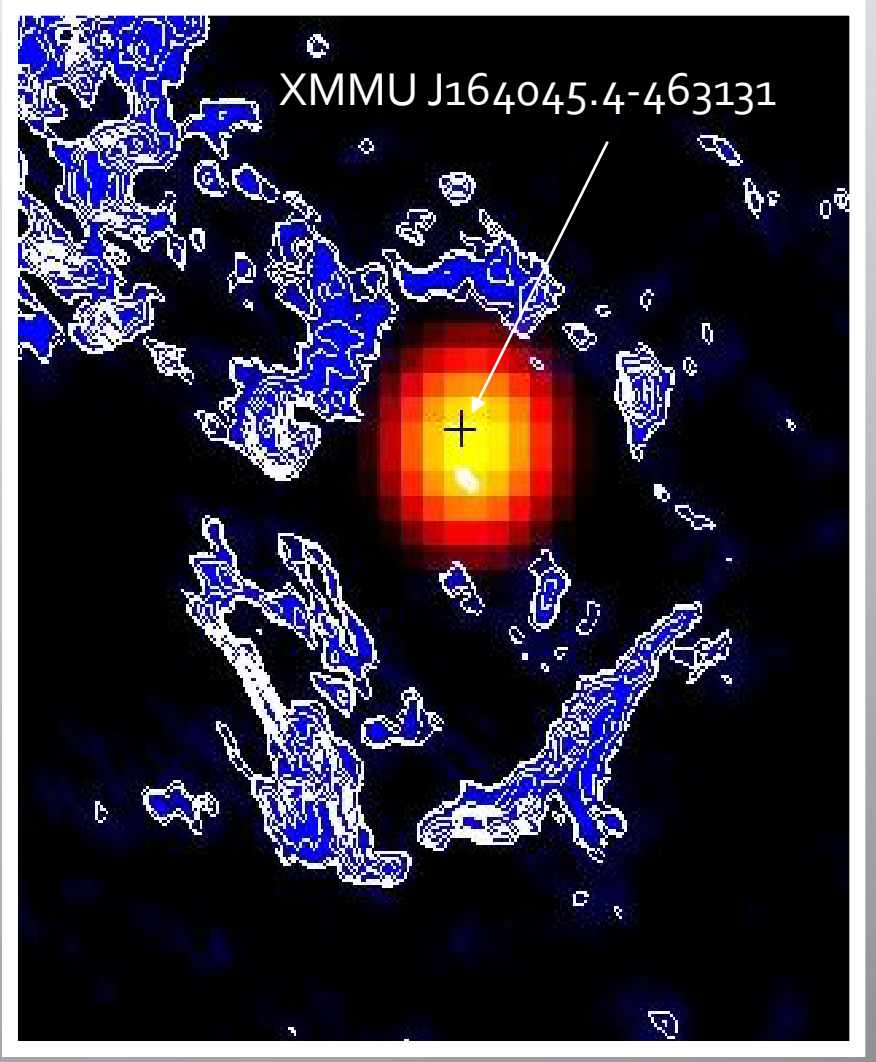




G338.3-0.0- HESS J1640-465 (Castelletti et al. 2011)



Spitzer 8 and 24 μm + radio



GMRT Observations at 610 MHz

High-energy sources investigated by our group

CTA1 (radio PWN RX J0007.0+7303 ?) *(Giacani et al. 2012)*

IC443 *(Castelletti et al. 2011)*

W44 *(Castelletti et al. 2007)*

W28 *(Dubner et al. 2000, 2002)*

HESS J1640-465 / G338.3-0.0 *(Castelletti et al. 2011)*

HESS J 1702-420 / G344.7-0.1 *(Giacani et al. 2011)*

HESS J1708-443 / G343.1-2.3/ B1706-44 *(with HESS col.)*

HESS J1713-397 / RX J1713.7-3946 *(Acero et al. 2009)*

HESS J1731-347 / G353.6-0.1 *(Dubner et al. 2010)*

HESS J1747-281 / G0.9+0.1 *(Dubner et al. 2010)*

HESS J 1858+020 *(Paron et al. 2011, see poster)*

HESS J1943+213 *(Gabanyi et al. 2012)*

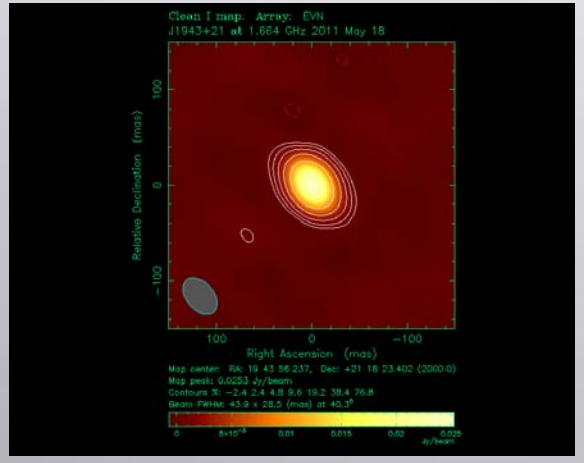
1AGL J2022+4032 *(Chen et al. 2011)*

HESS J1809-193 *(poster by Giacani)*

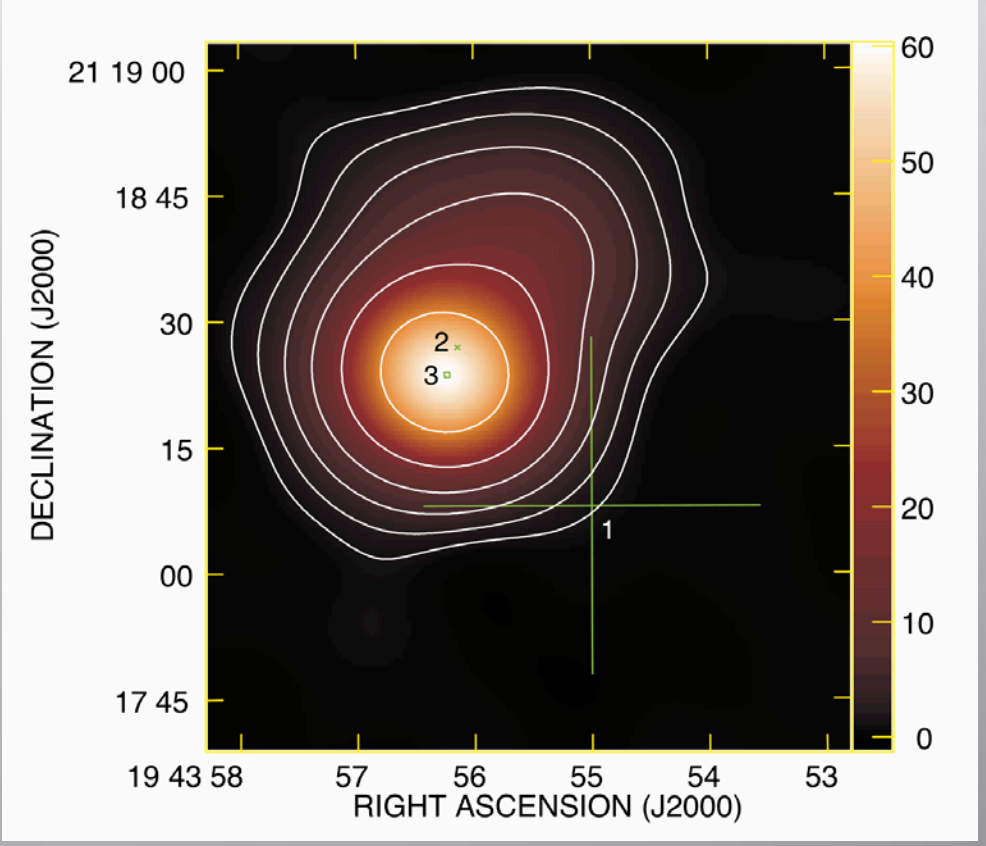
HESS J1825-137 *(poster by Giacani)*

HESS J1943+213

Observed with eEVLBI (Gabanyi et al. 2012)



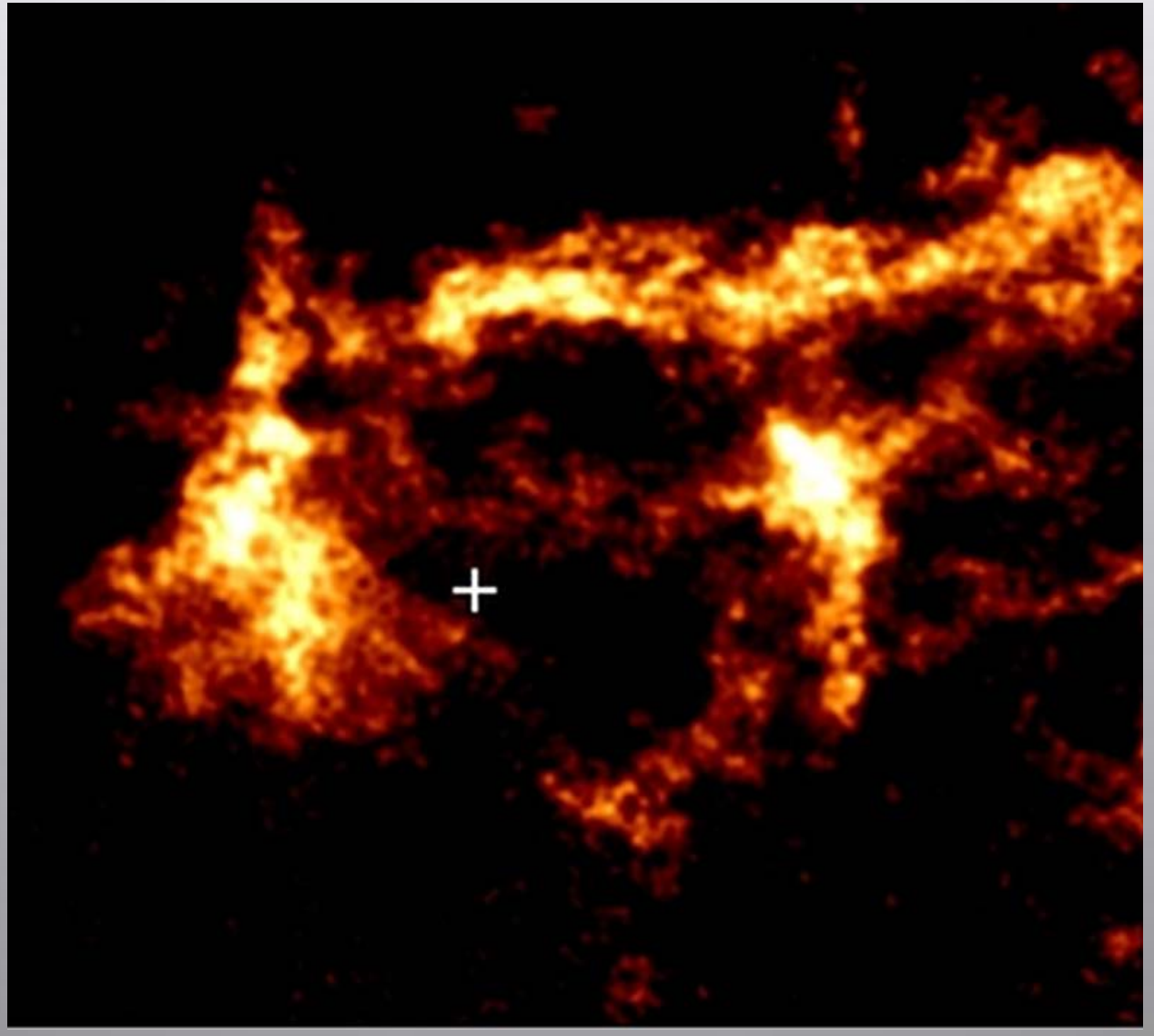
Point source - eEVLBI



VLA

If Crab or 3C58 were located at the distance of HESS J1943+213, their sizes would be comparable to the observed size

HESS J1943+213



How often a TeV source can be found associated with a large HI shell?

We confronted with catalogs of large HI shells (Mc Clure-Griffiths et al. 2002, over 2000 square degrees in the sky)

19 Galactic HI shells and **31** TeV gamma-ray sources

22 IDENTIFIED WITH GALACTIC OBJECTS (x-ray binaries, gal. clusters, pulsars, PWN, SNR)

9 UNIDENTIFIED

2 HI- TeV coincidences

7 HI – TeV coincidences

TeV sources - HI features associations

HESS J1018-589 → GSH 285-02+86

HESS J1427-608 -> GSH 316-00+65

HESS J1503-582 → GSH 319-01+13 (Renaud et al. 2008)

HESS J1626-490 → GSH 337+00-05

HESS J1634-472 → GSH 337+00-05

HESS J1702-420 → GSH 345+00+30

HESS J1708-410 → GSH 345+00+30

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