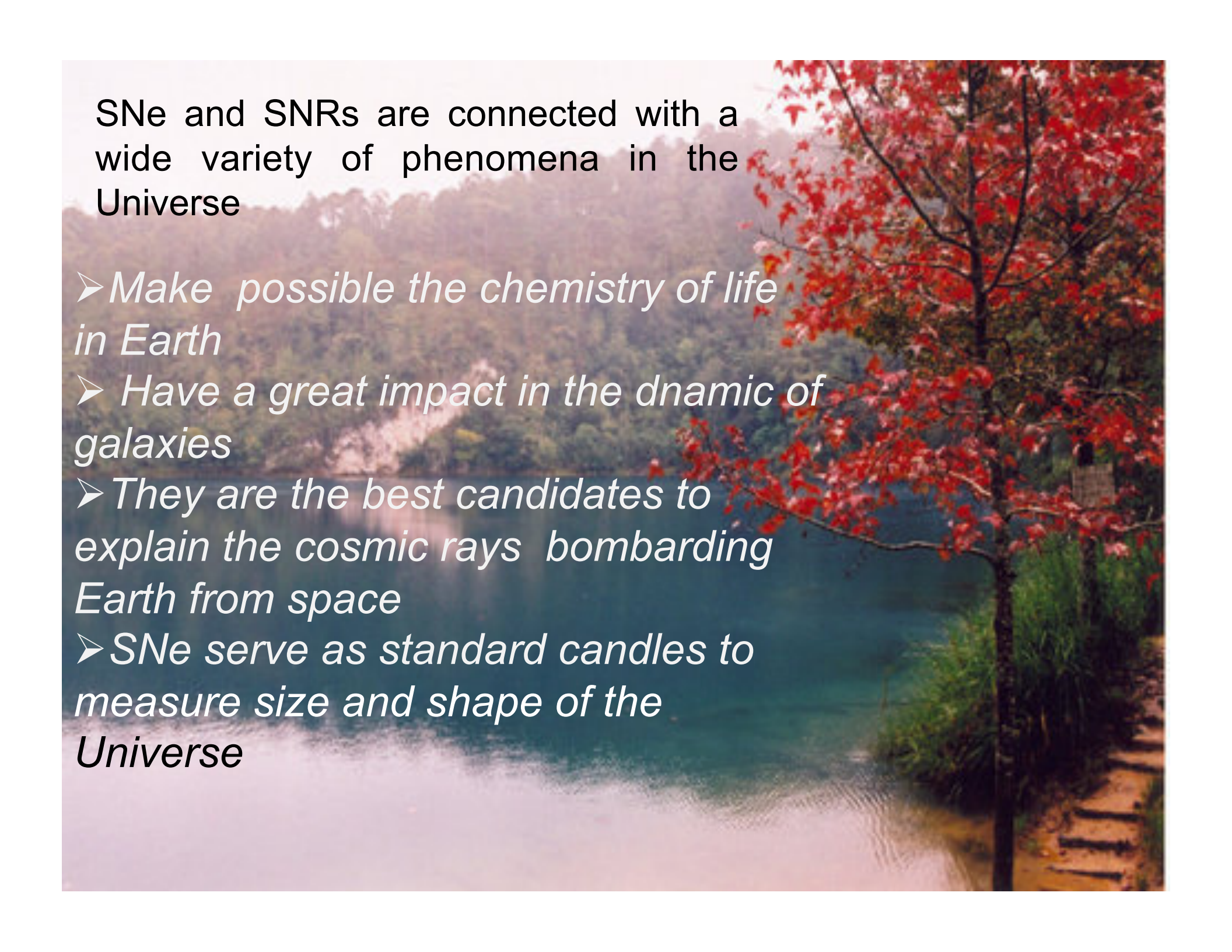




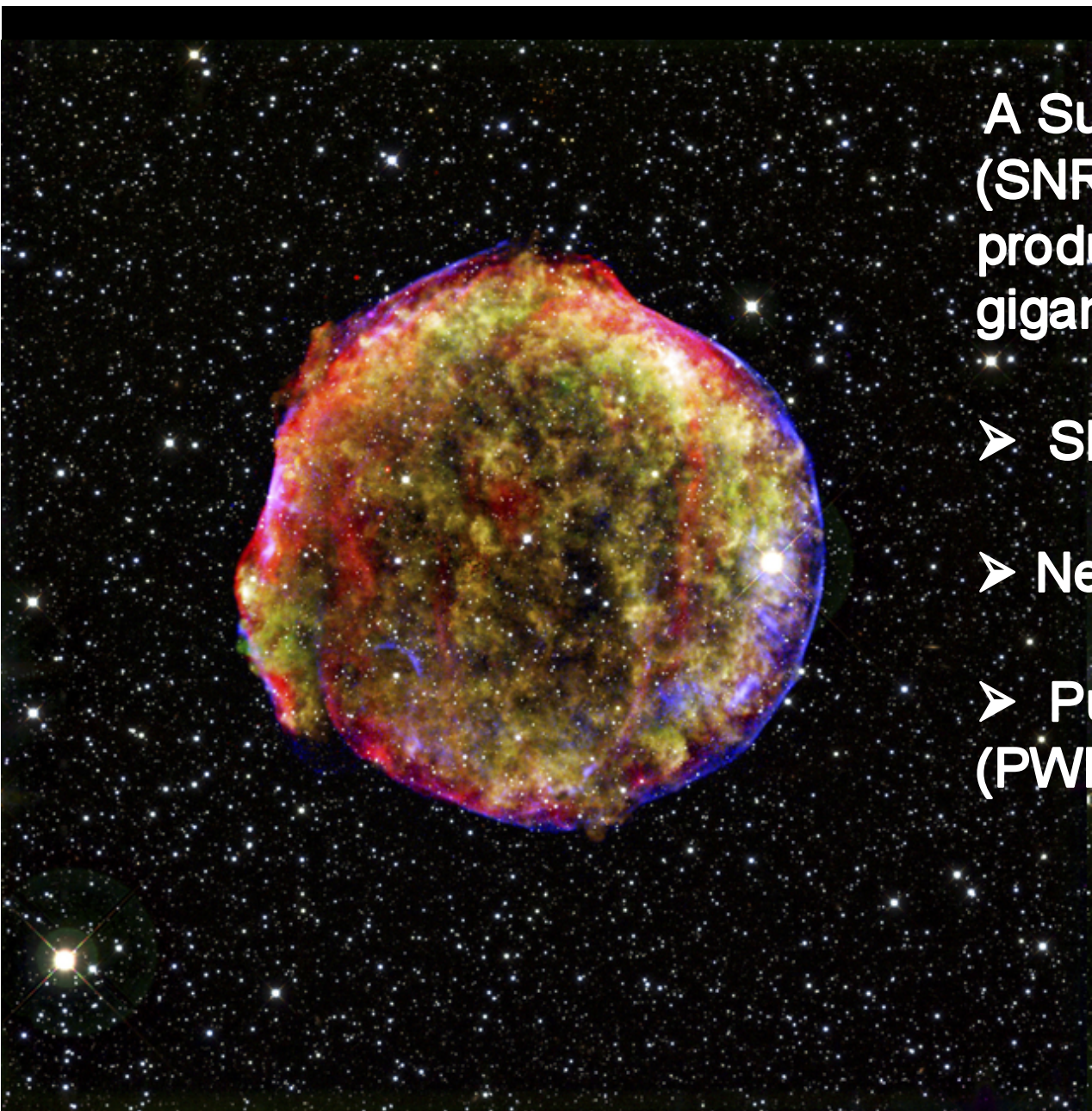
*Supernova Remnants
across the spectrum*

*A trip from Socorro to the space
guided by Miller Goss*

A scenic landscape featuring a calm lake in the foreground, a dense forest of green trees in the middle ground, and a prominent tree with vibrant red autumn leaves on the right side. The sky is hazy and light-colored.

SNe and SNRs are connected with a wide variety of phenomena in the Universe

- *Make possible the chemistry of life in Earth*
- *Have a great impact in the dynamic of galaxies*
- *They are the best candidates to explain the cosmic rays bombarding Earth from space*
- *SNe serve as standard candles to measure size and shape of the Universe*



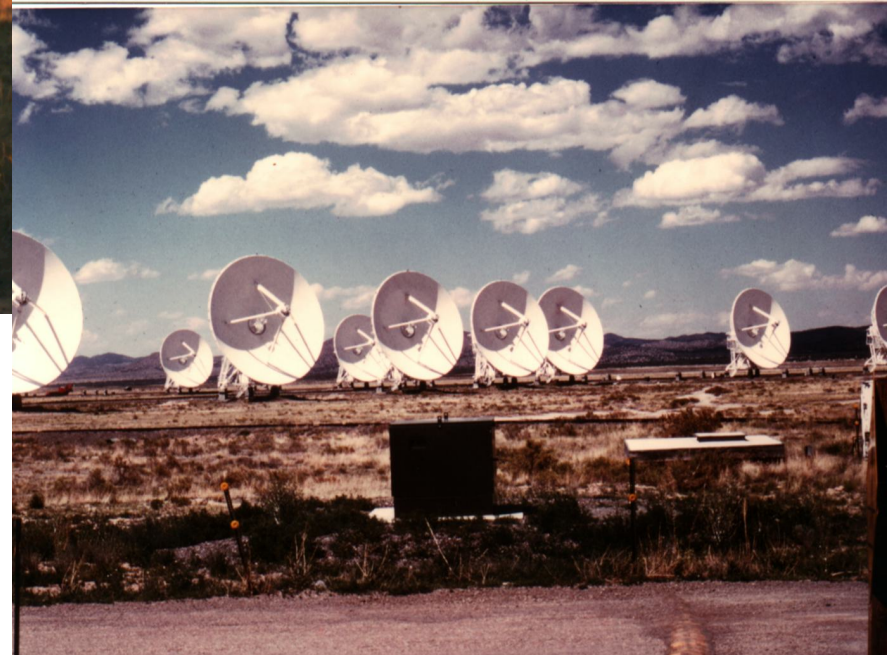
A Supernova Remnant (SNR) is the structure and products resulting from a gigantic stellar explosion.

➤ **Shell**

➤ **Neutron star**

➤ **Pulsar wind nebulae (PWN)**

In 1988, project AD220 was approved to observe with the VLA the SNR Puppis A



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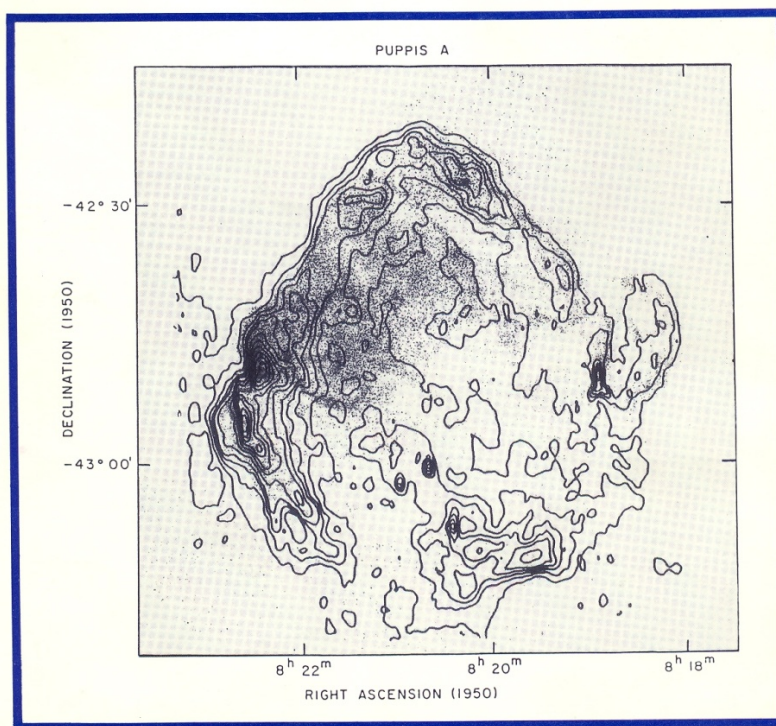
1991

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1849

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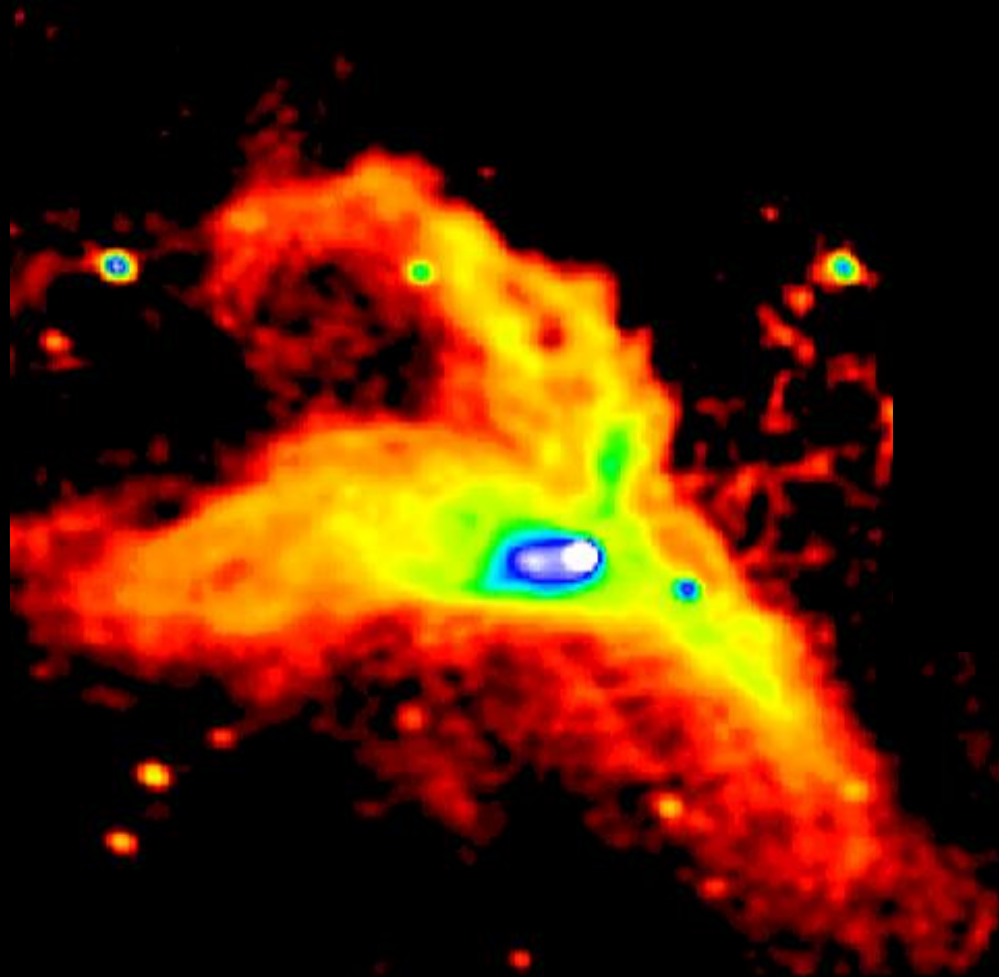
NUMBER 4



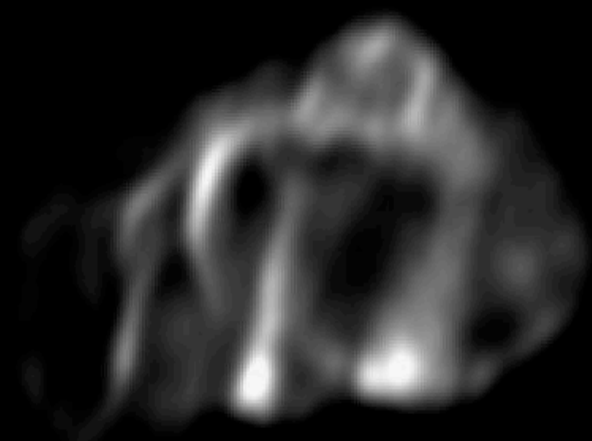
(See Page 1466)

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AMERICAN INSTITUTE OF PHYSICS

CTB 80



G340.4+0.4



W50 and SS433



1998

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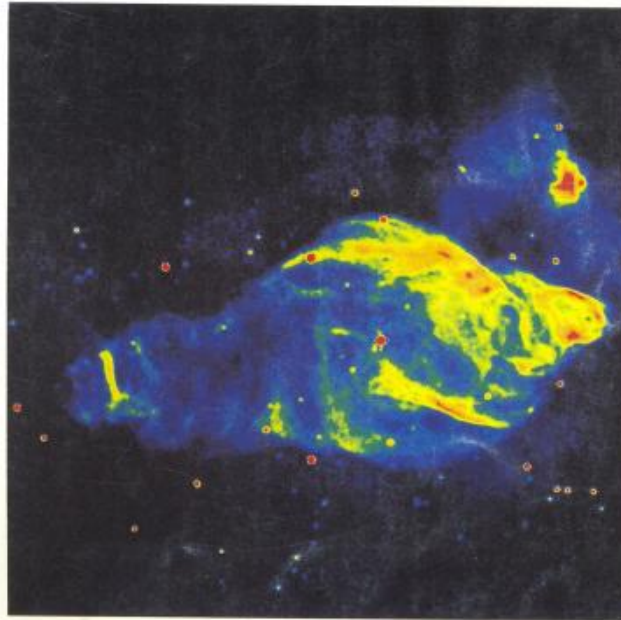
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NUMBER 4



(See Page 1845)

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2000

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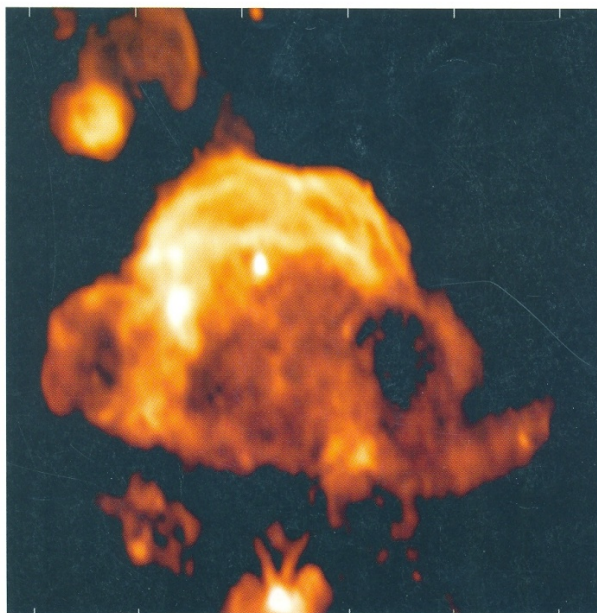
Instituto de Astronomía
Alca del Ecuador
4 DIC 2000
BIBLIOTECA

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VOLUME 120

October 2000 ~ No. 1738

NUMBER 4



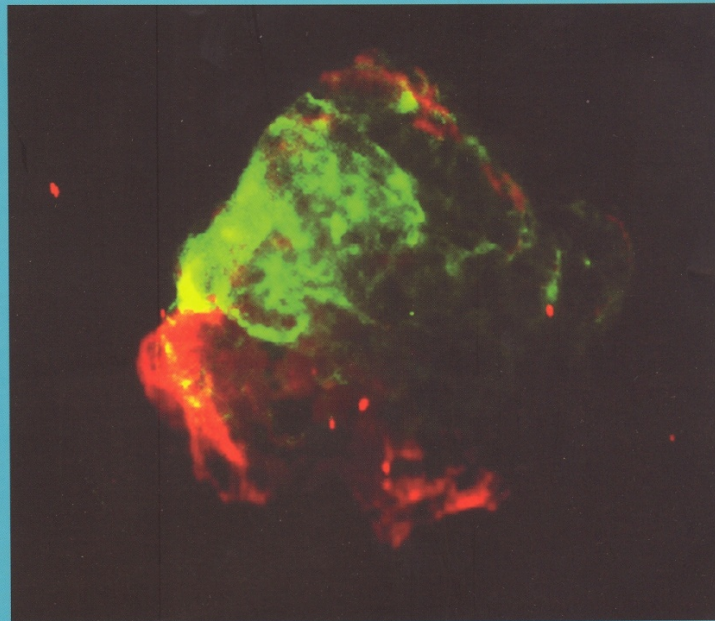
(See Page 1936)

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2006

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10 SEP 2006

Astronomy & Astrophysics



Vol. 459 • N° 2
NOVEMBER IV • 2006

A&A Online: <http://www.aanda.org> <http://www.edpsciences-usa.org> <http://aanda.u-strasbg.fr:2002>

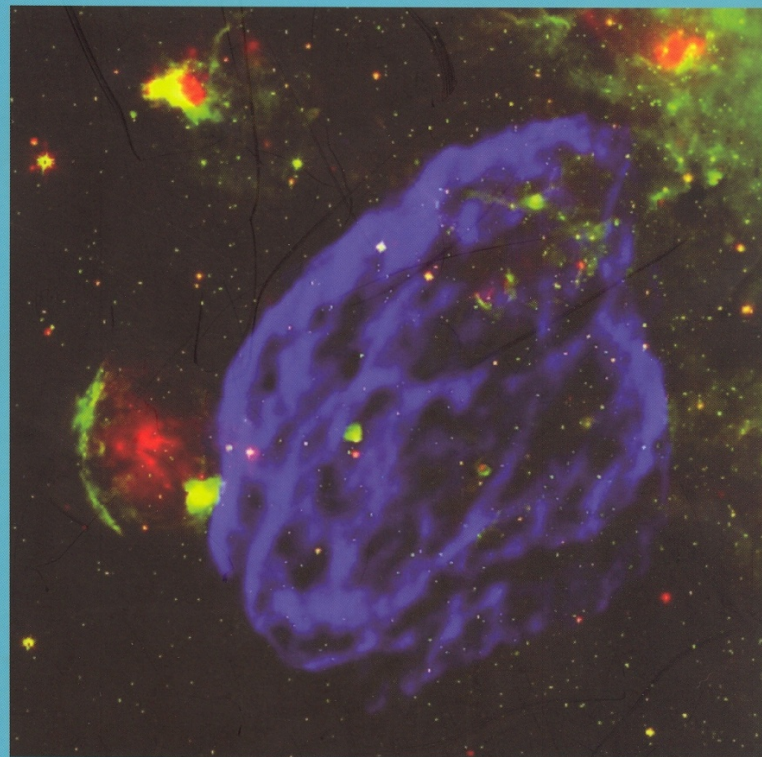
ISSN 0004-6361 • 459 (2) E3-E4/L25-L32/333-678 (2006) • Published four times per month • November IV 2006

2007



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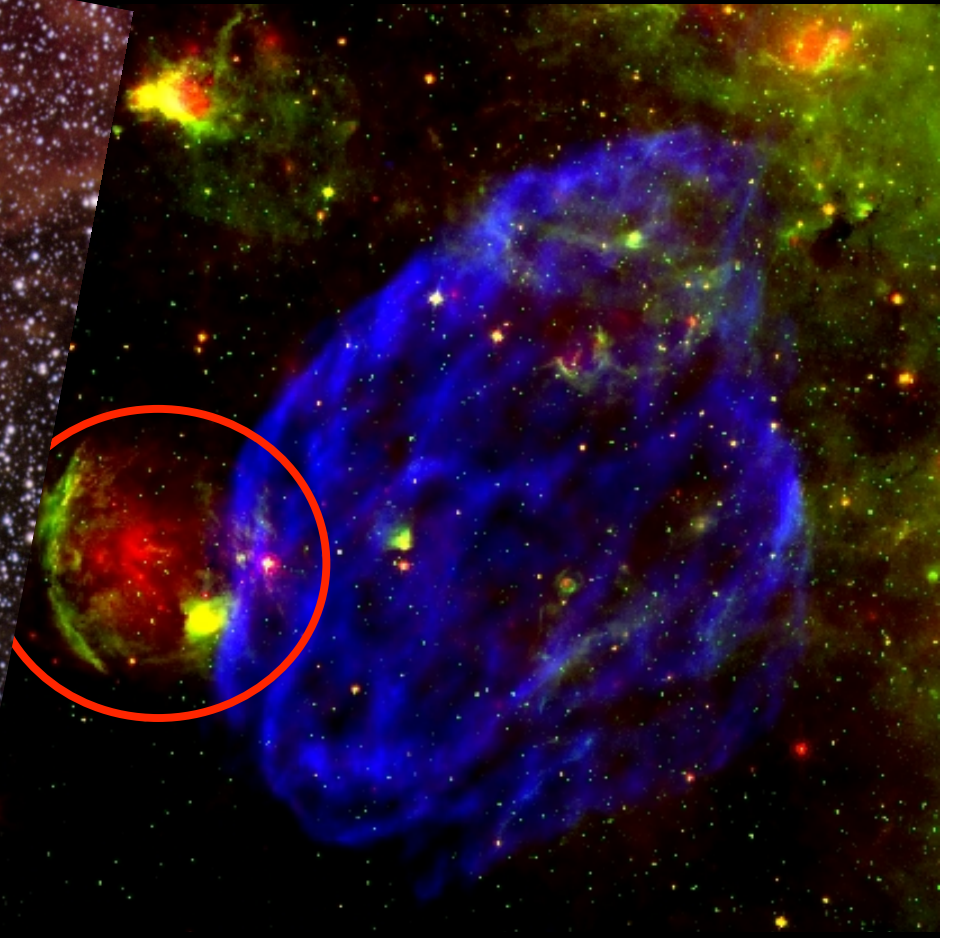
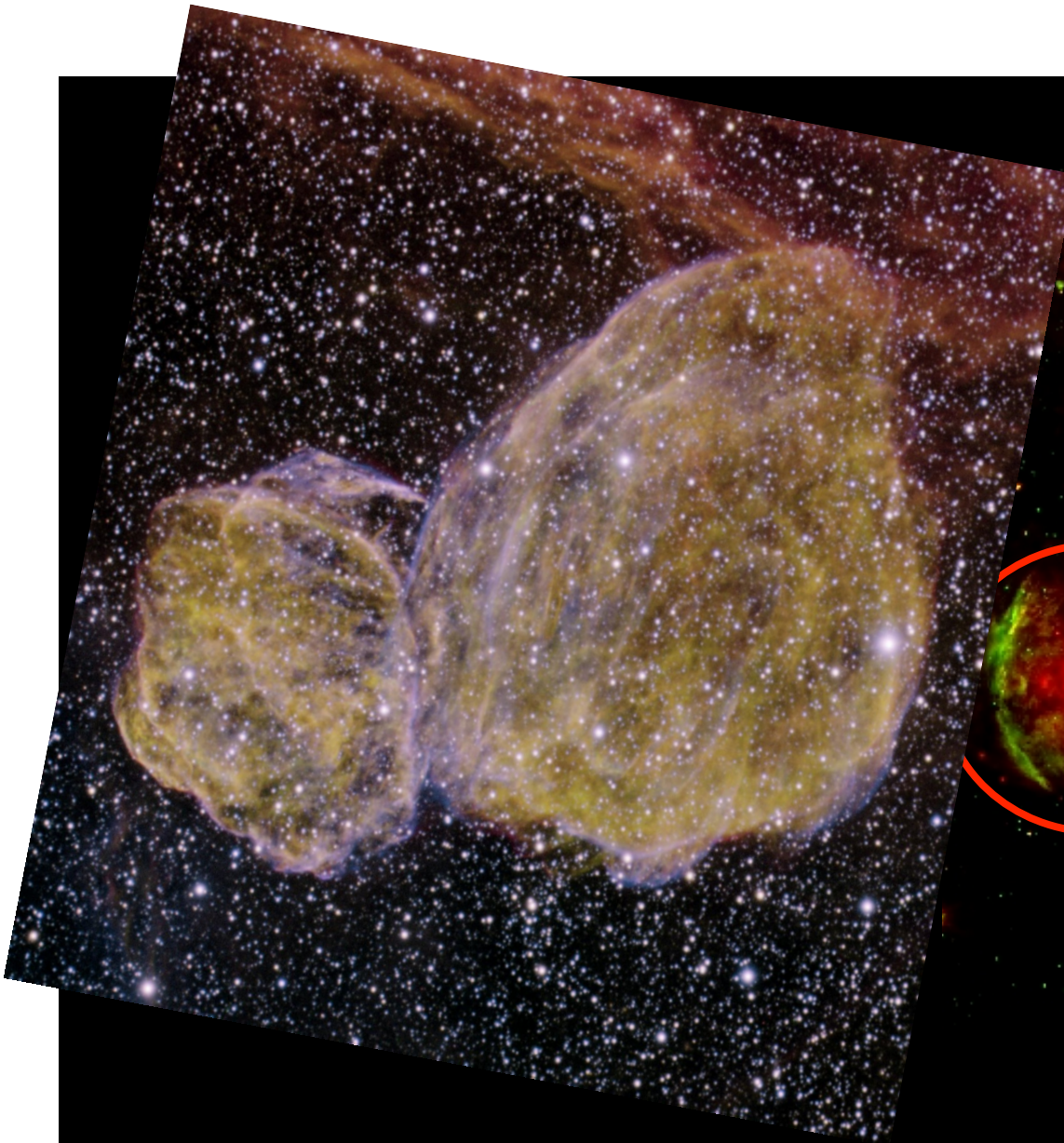


Vol. 471 • N° 2
AUGUST IV • 2007

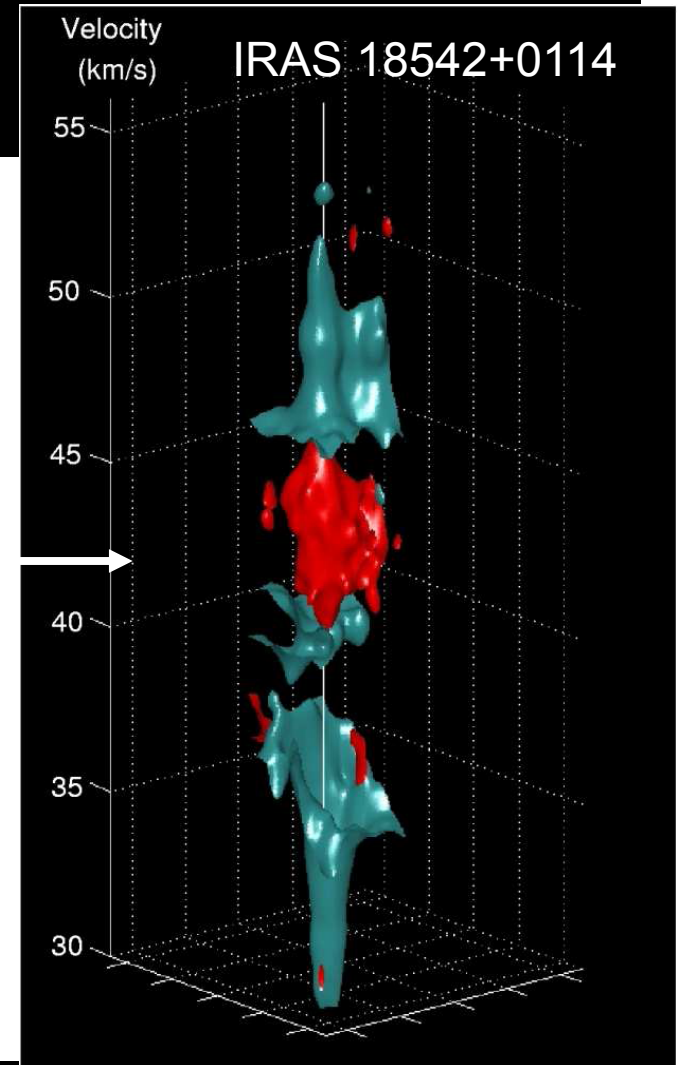
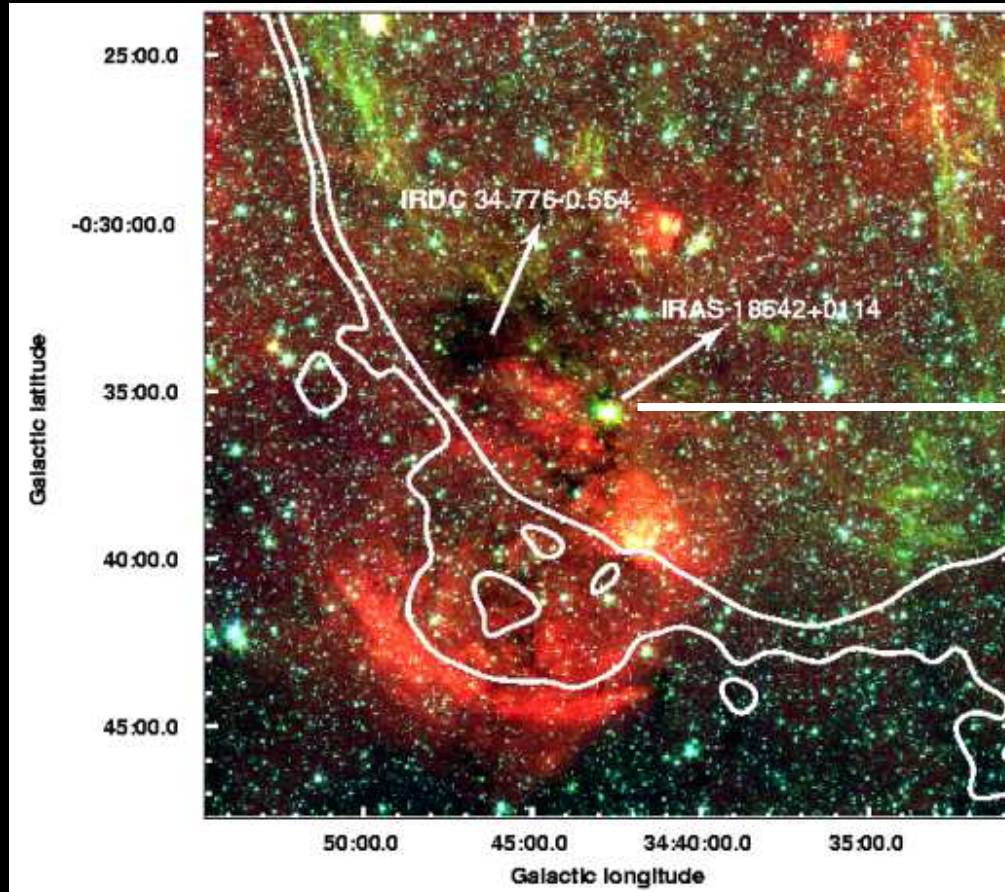
A&A Online: <http://www.aanda.org> <http://www.edpsciences-usa.org> <http://cds.aanda.org>

ISSN 0004-6361 • 471 (2) L21-L50/381-730 (2007) • Published four times per month • August IV 2007

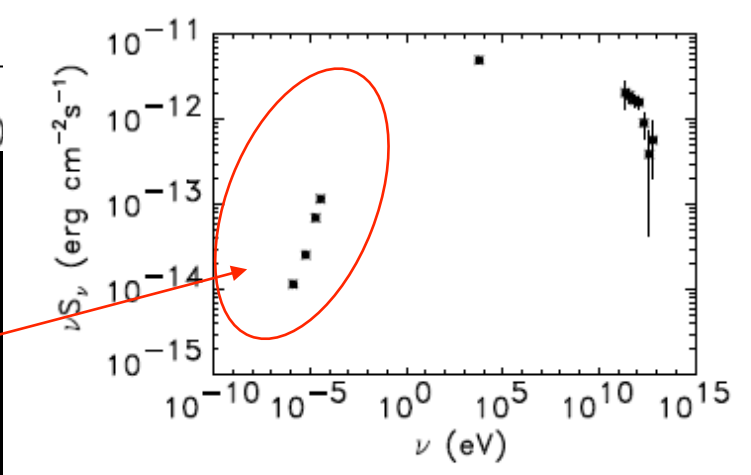
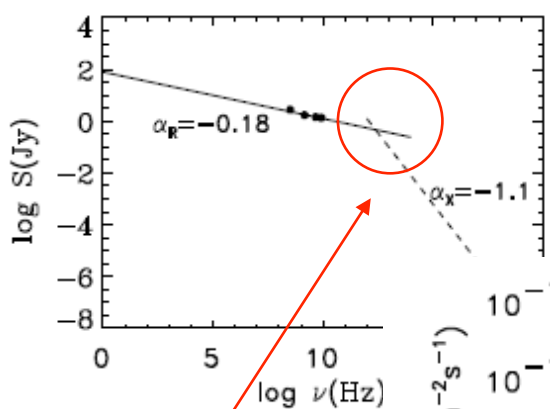
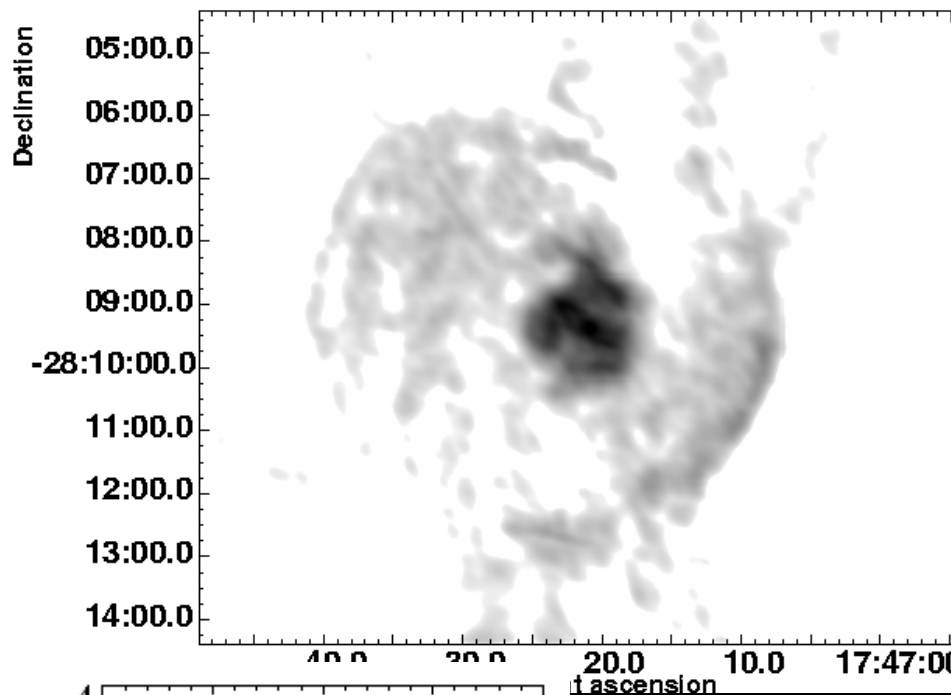
W 44



SNR W44



G0.9+0.1



B field

nature of emission

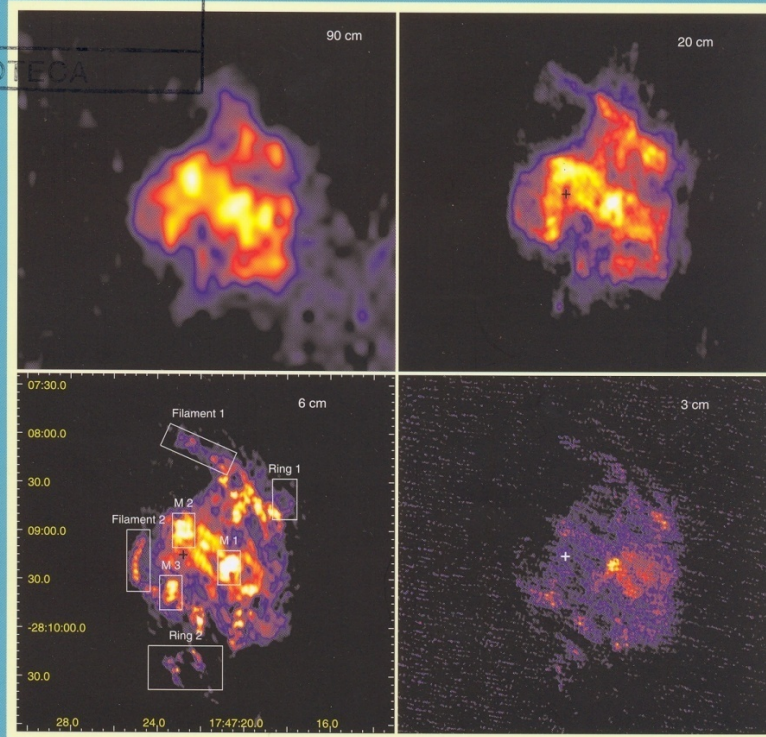
2008

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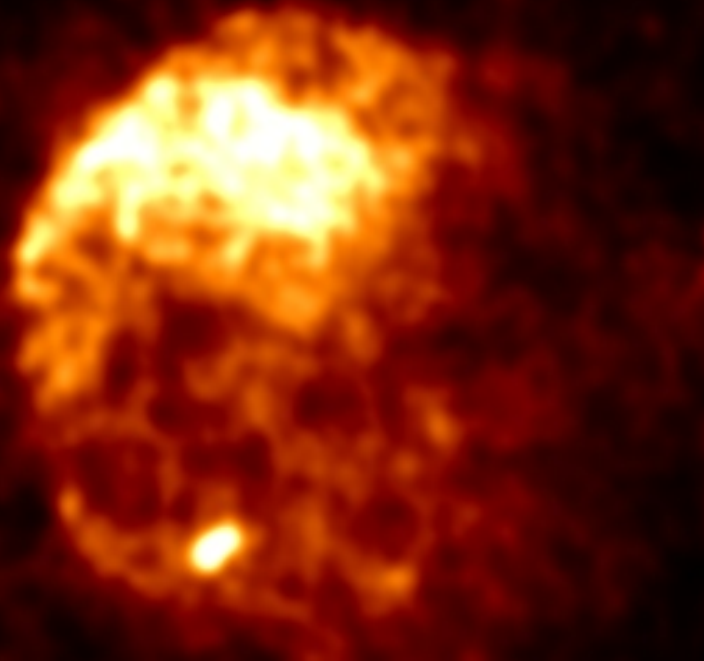


Vol. 487 • N° 3
SEPTEMBER I • 2008

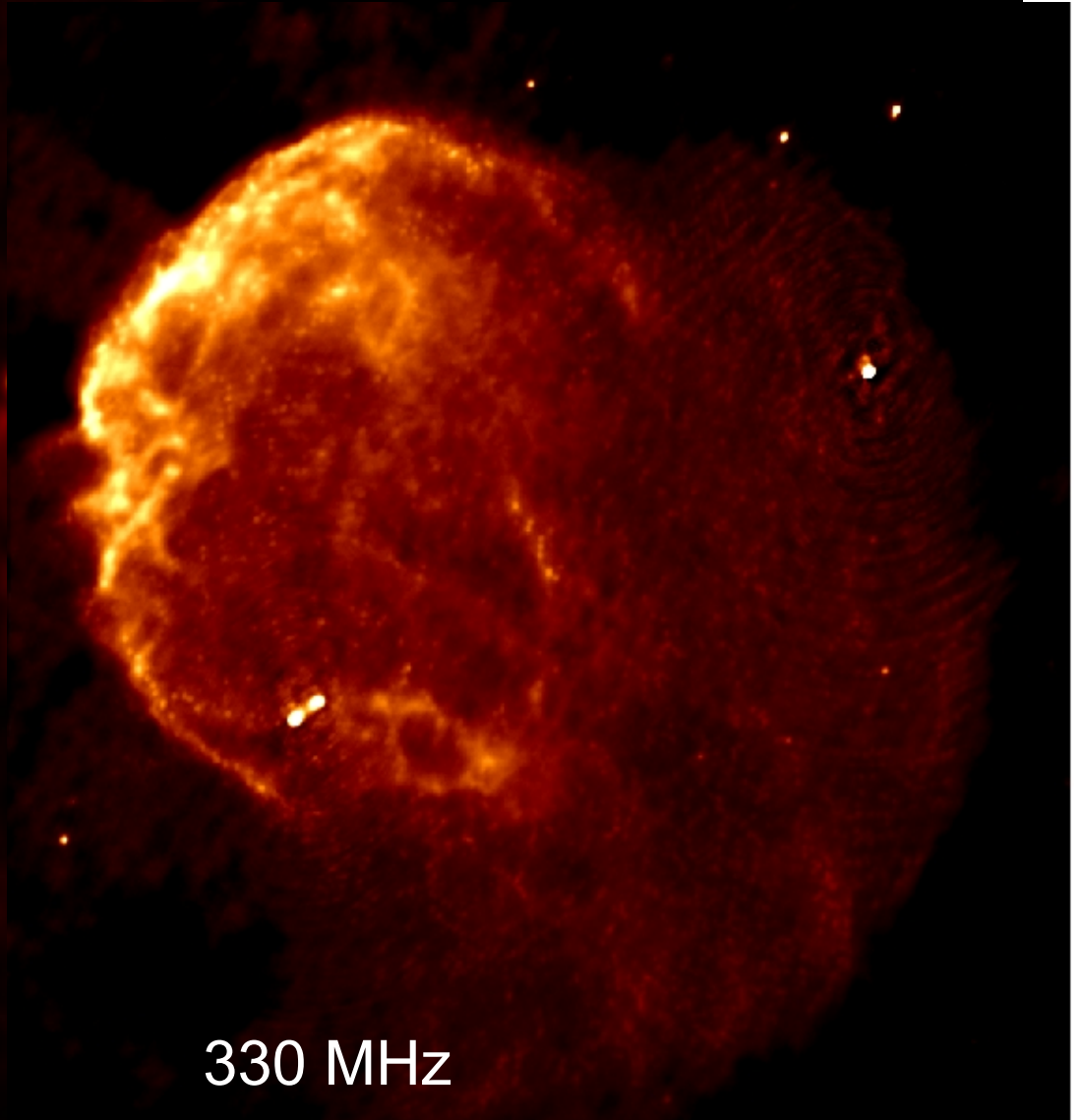
A&A Online: <http://www.aanda.org> <http://cds.aanda.org>

ISSN 0004-6361 • 487 (3) L49-L52/789-1220 • Published four times per month • September I 2008

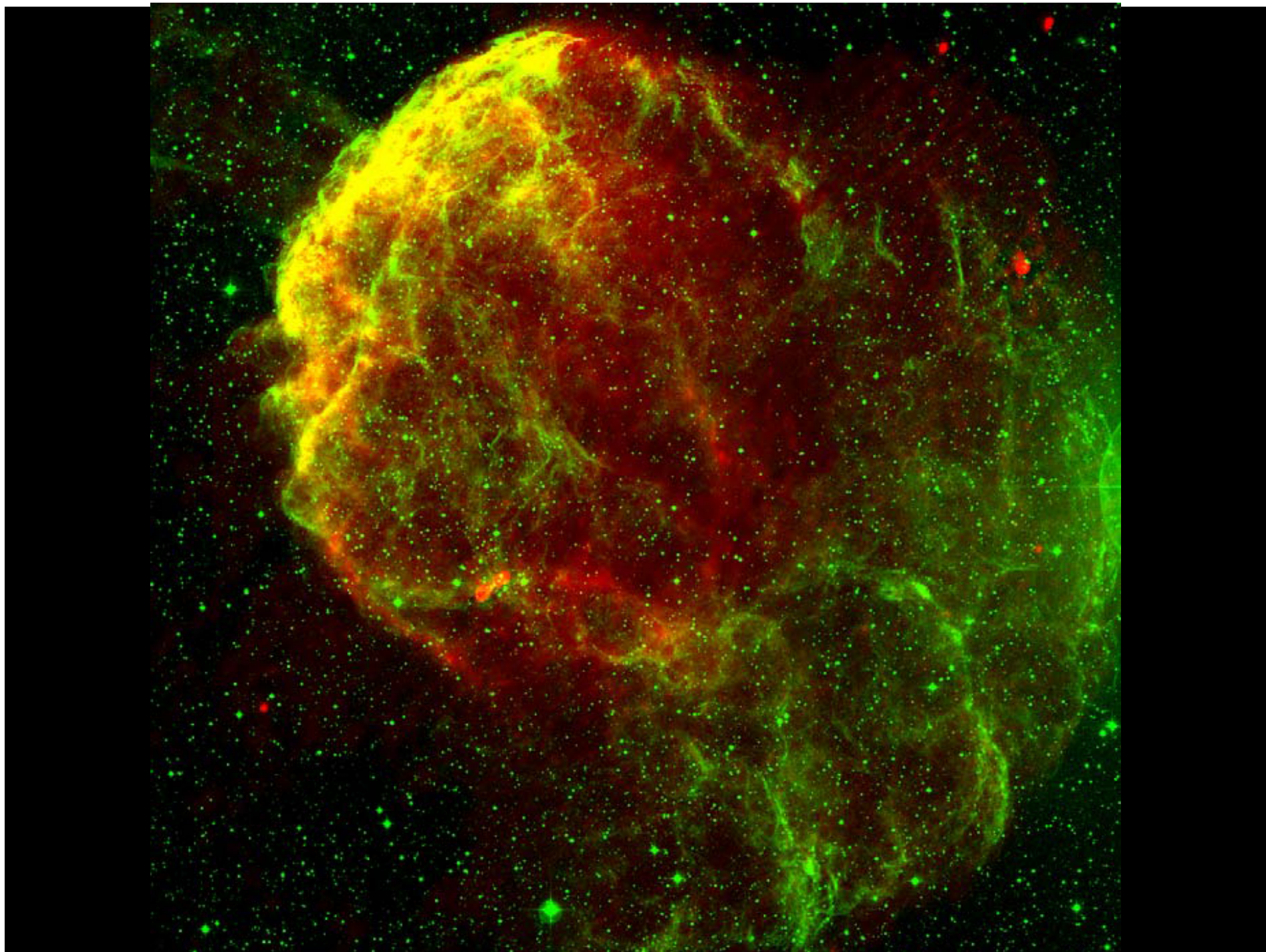
First images of IC443 at low radio frequencies



74 MHz



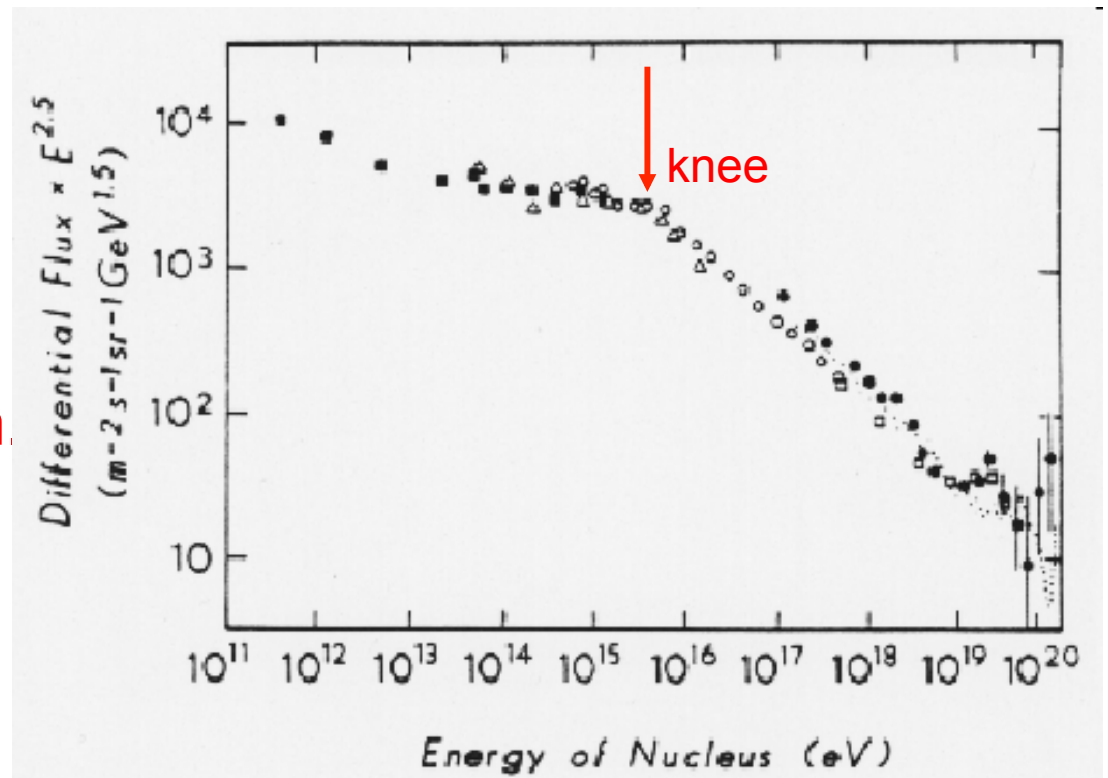
330 MHz



•SNRs as the factory of cosmic rays

Cosmic rays are made up of electrons, positrons and atomic nuclei and they constantly bombard the Earth

Back in July 1934, Baade and Zwicky proposed that most of CR observed at Earth may be generated in SNRs → **the SNR paradigm**.



However, there are still several issues that the proposed particle acceleration models cannot **explain** (like the non-detection of X-ray lines from SNR RX J1713-3946).

Also the standard calculations produce spectra at odds with multiwavelength observations.

Probably re-acceleration of pre-existing CRs can account for most SNRs

Or, acceleration can occur in previous stages, before explosion

Still an open question

Detection of Gamma-rays

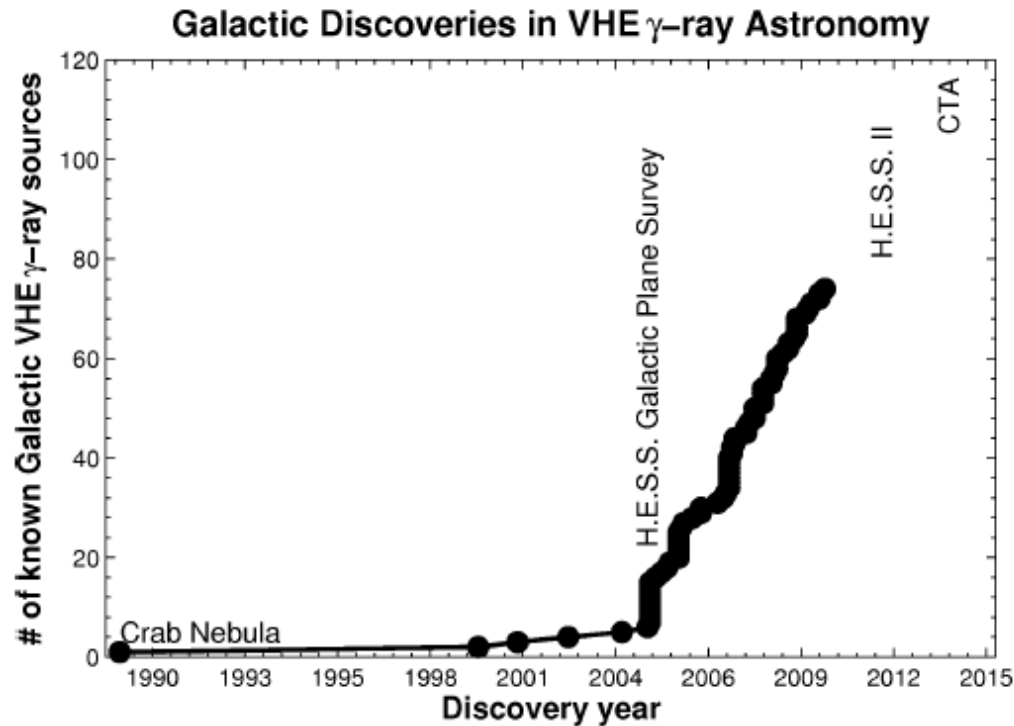
The production of gamma rays in a supernova shock wave tells us that it is acting like a giant particle accelerator in space, and thus a likely source of the cosmic rays in our galaxy.

A crucial step towards confirming or rejecting the SNR paradigm might be made through gamma-ray observations.

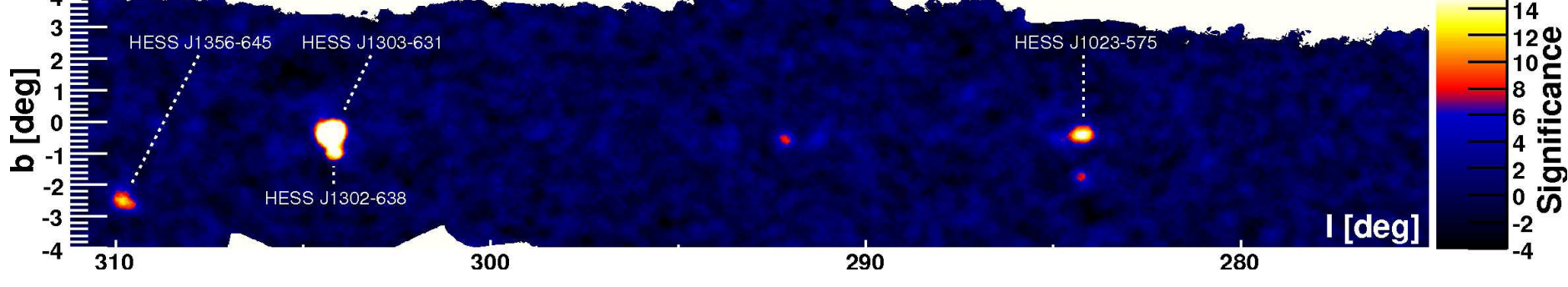
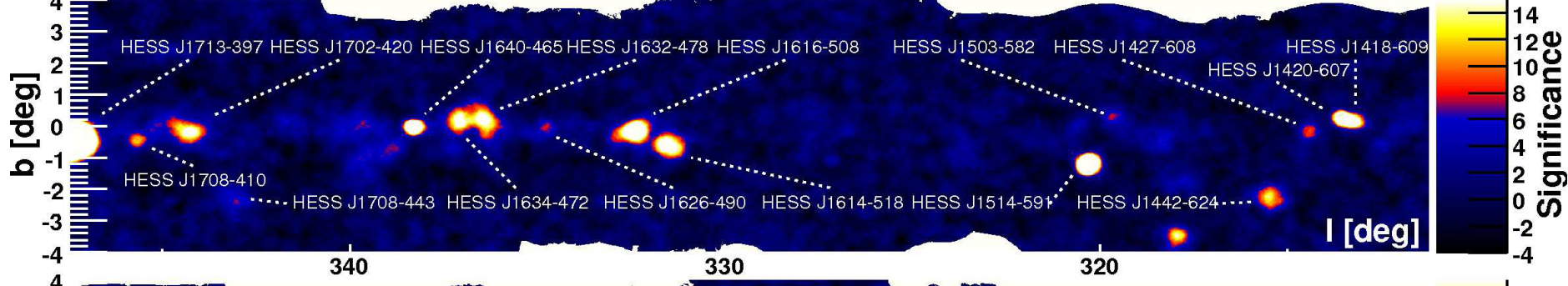
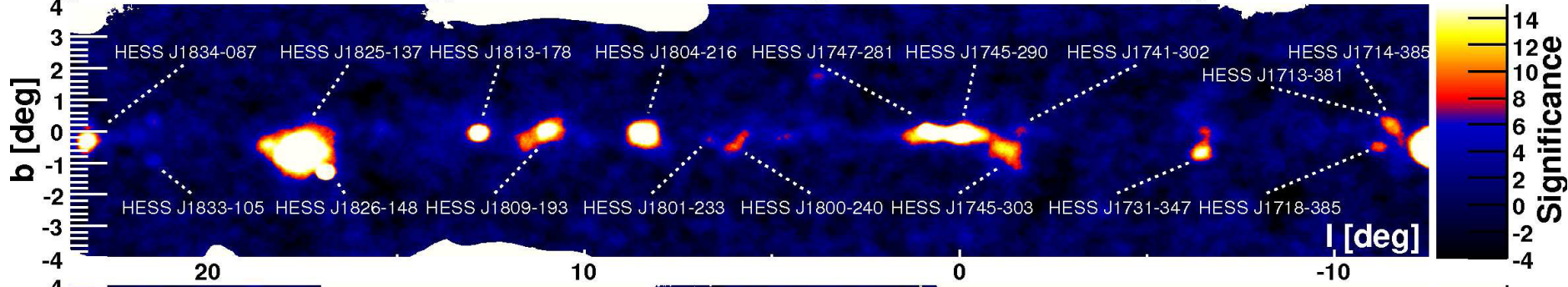
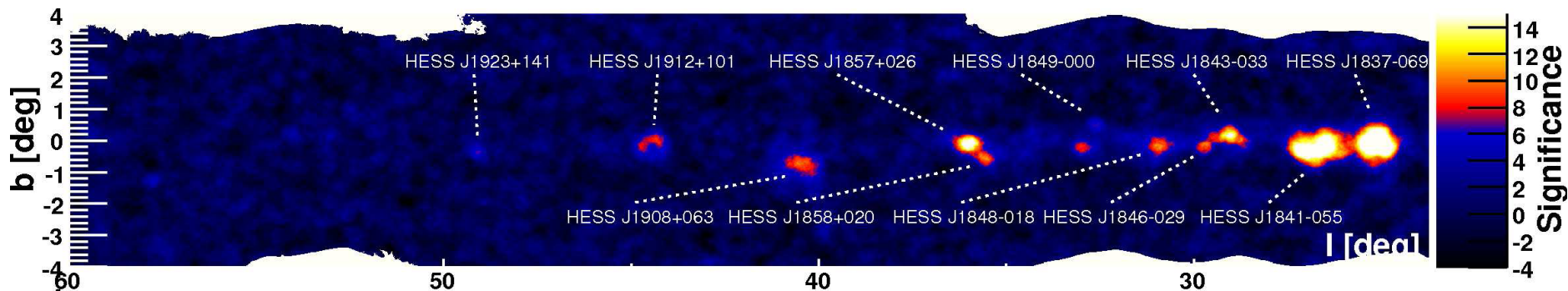
H.E.S.S. Cerenkov telescopes



The recent and rapid progress in the emerging field of galactic VHE γ -ray astronomy

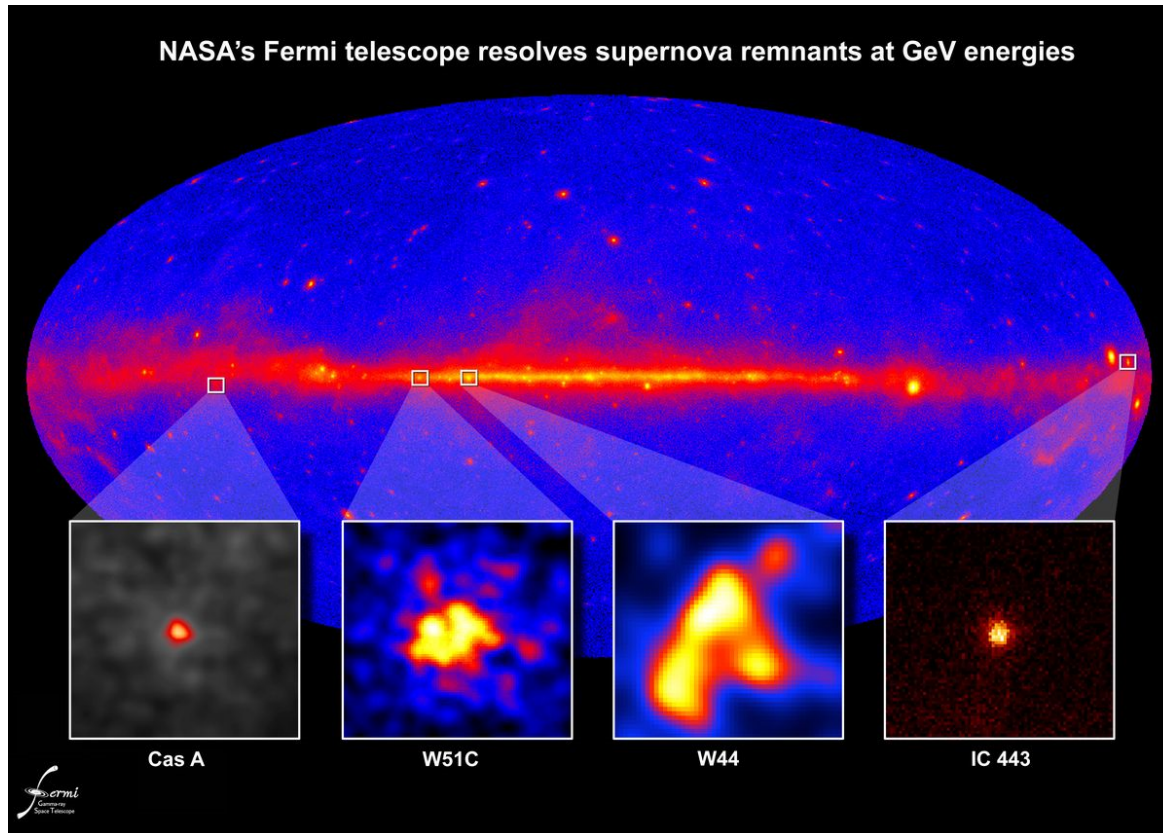


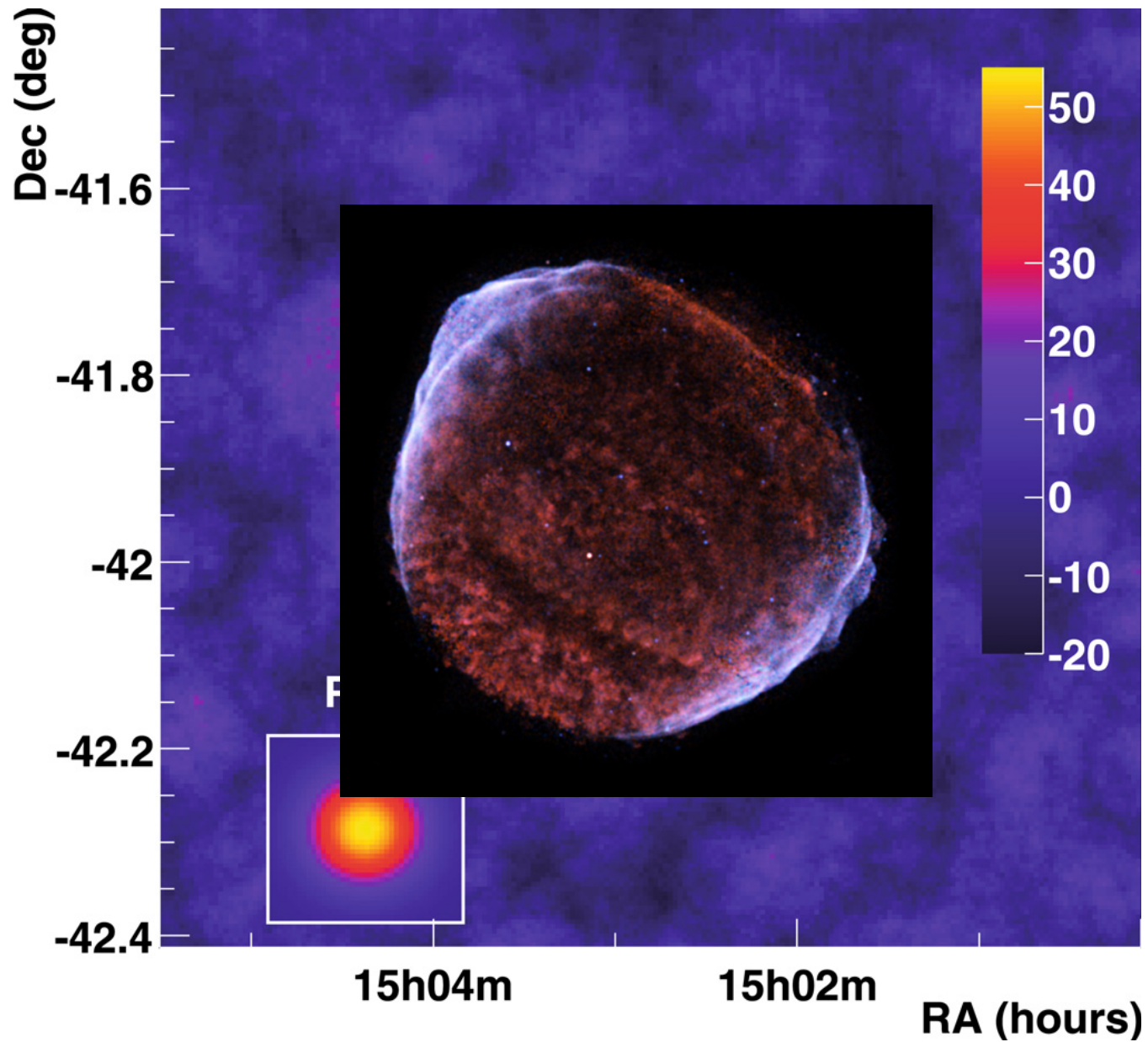
Surveys by the atmospheric Cerenkov telescopes HEGRA, HESS, MAGIC, and VERITAS, have revealed almost 60 Galactic TeV sources, the majority of which are supernova remnants (SNRs) or pulsar wind nebulae (PWNe), the latter being the largest class.



Fermi LAT

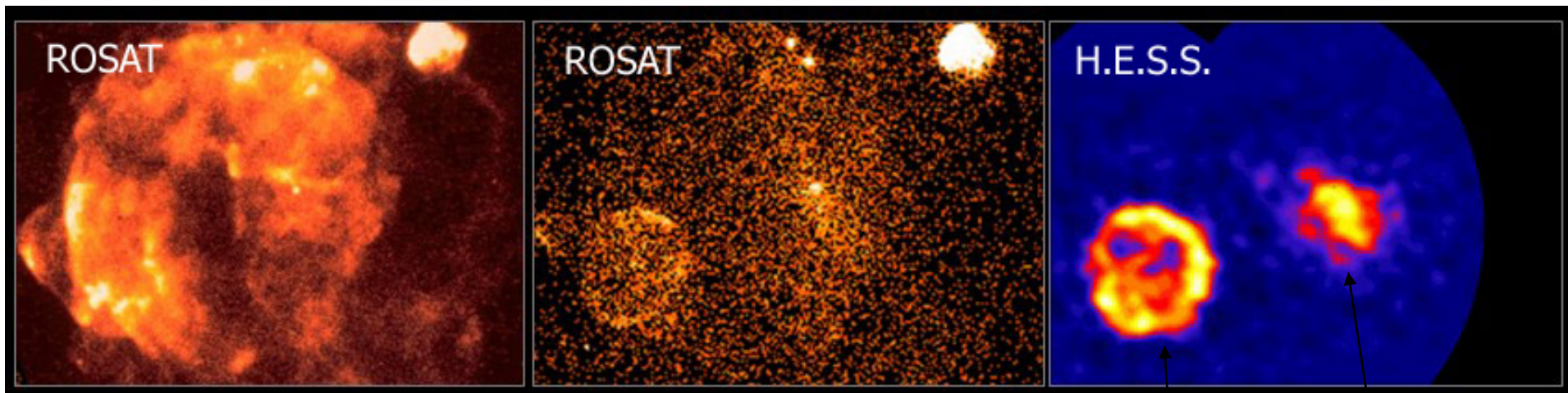
8keV – 300 GeV





HESS Gamma-ray map of the region of SN 1006, based on 103 h of H.E.S.S. data.
(Acero et al. 2010)

RX J0852.0-4622 (G266.2-01.2) "Vela Jr."



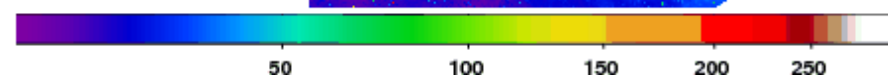
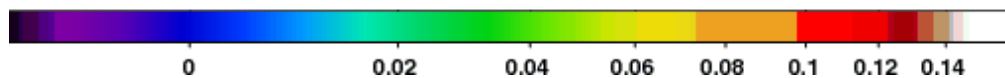
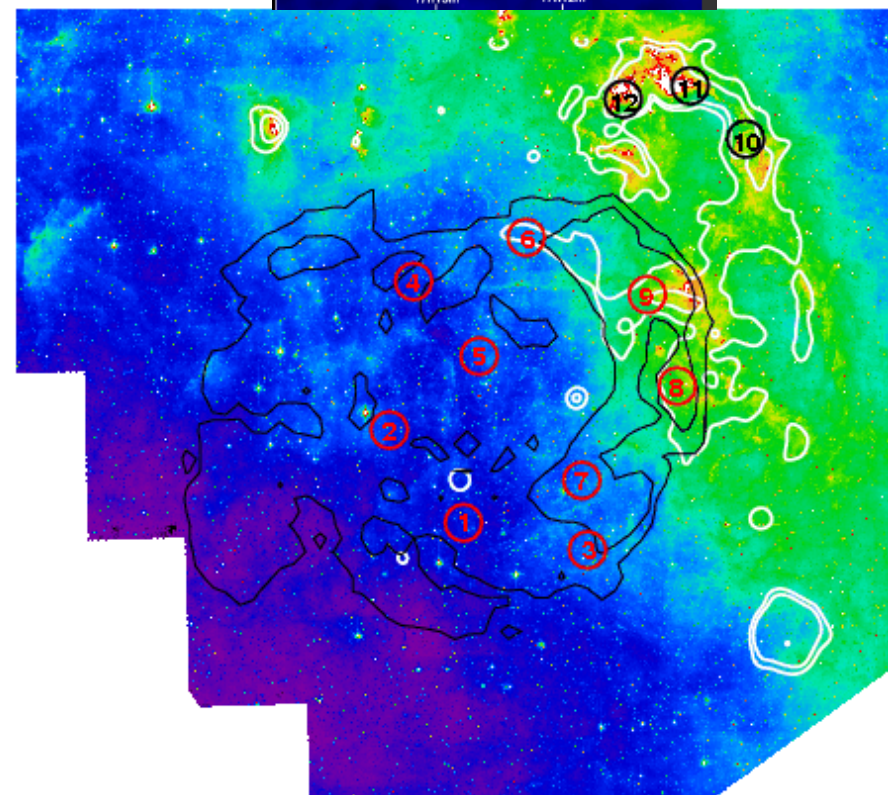
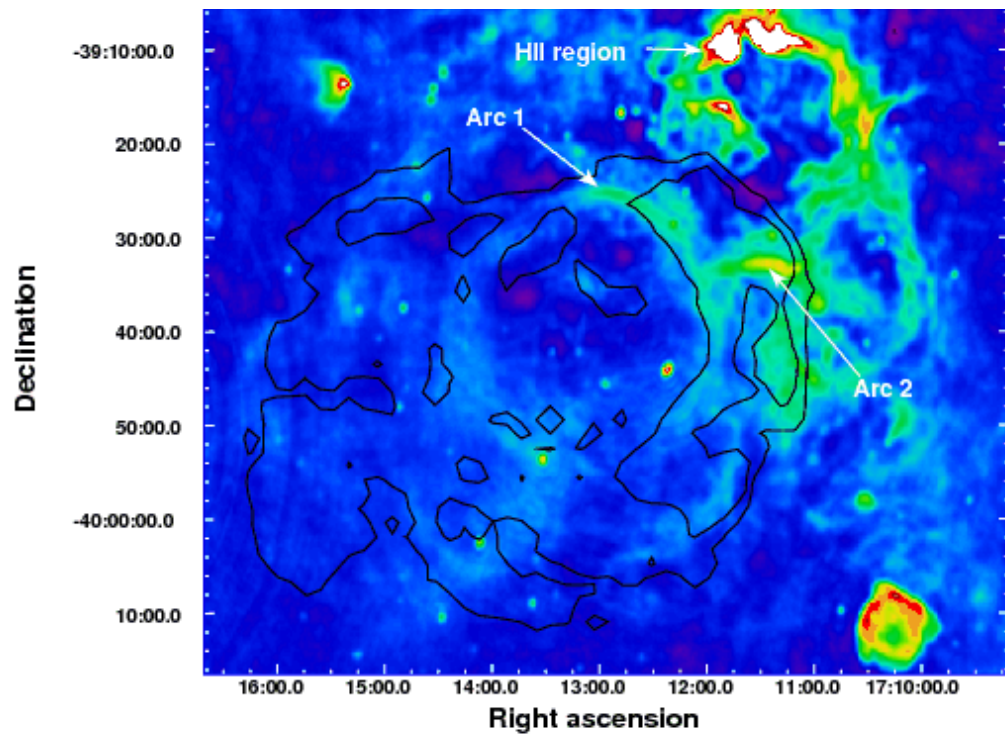
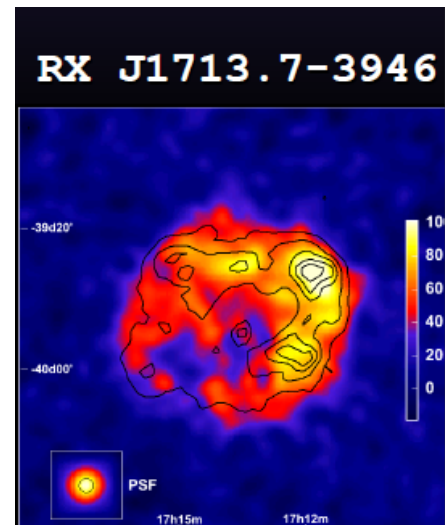
$0.1 < E < 2.4 \text{ keV}$

$E > 1.3 \text{ keV}$

Vela Jr

Vela X

HESS J1713-397 / RX J1713.7-3946



The precise mechanism for producing the detected TeV photons in an astronomical environment is still not entirely understood.

Gamma radiation can have two different origins:

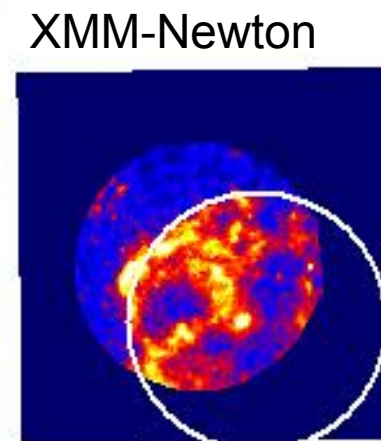
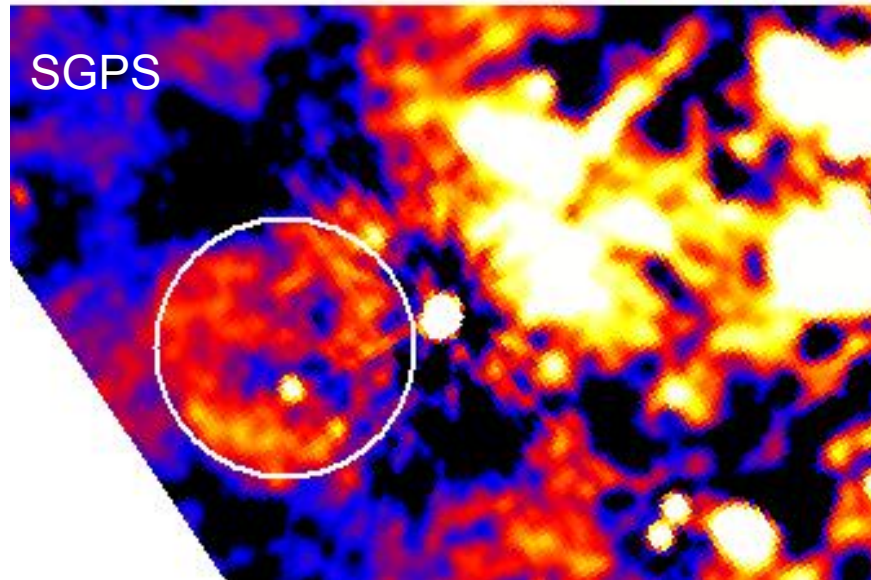
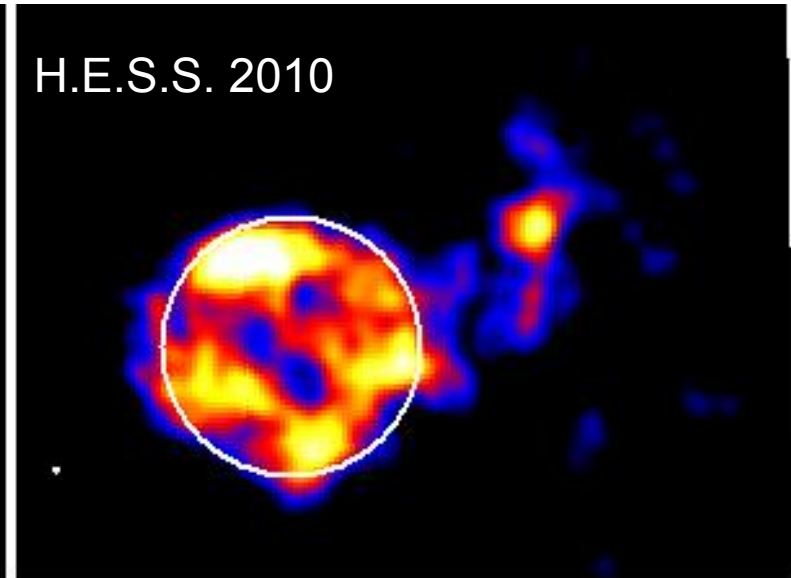
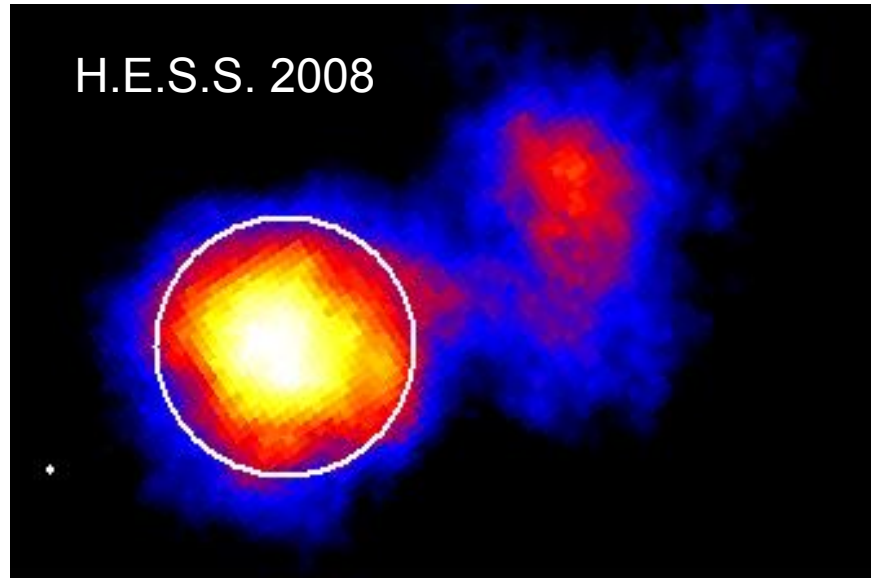
LEPTONIC: Inverse Compton scattering of relativistic electrons on the photon background

HADRONIC: inelastic proton-proton scatterings with production and decay of neutral pions

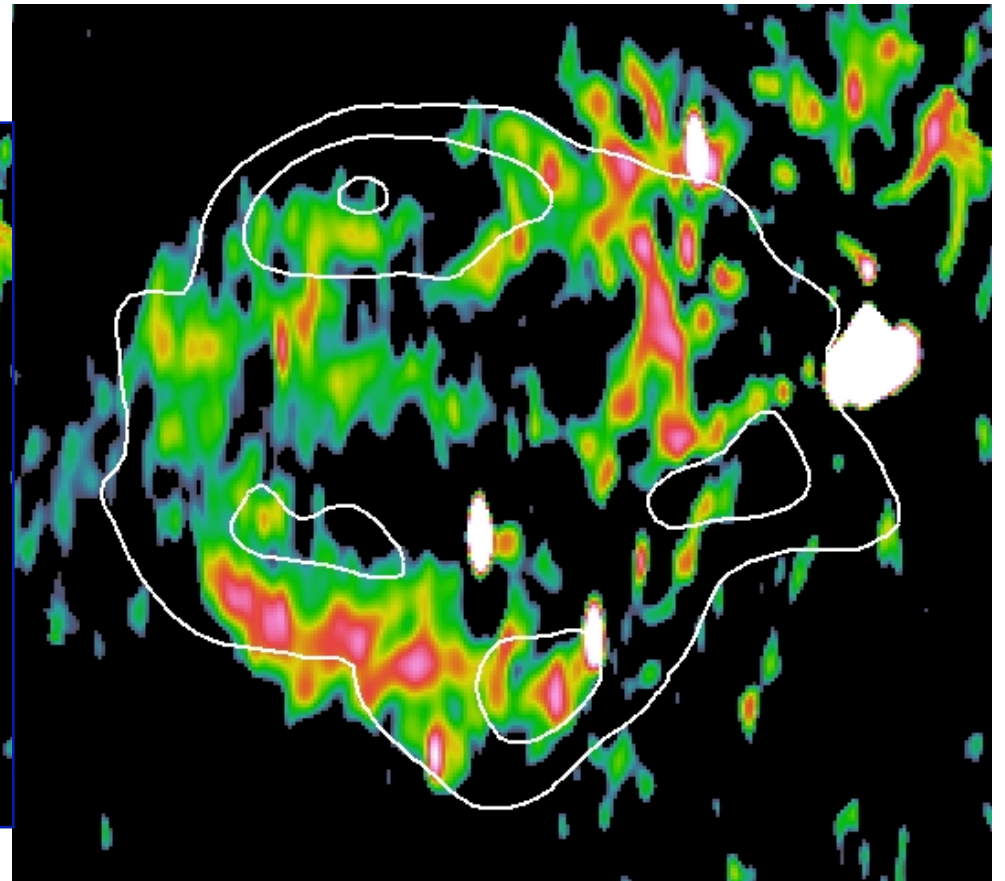
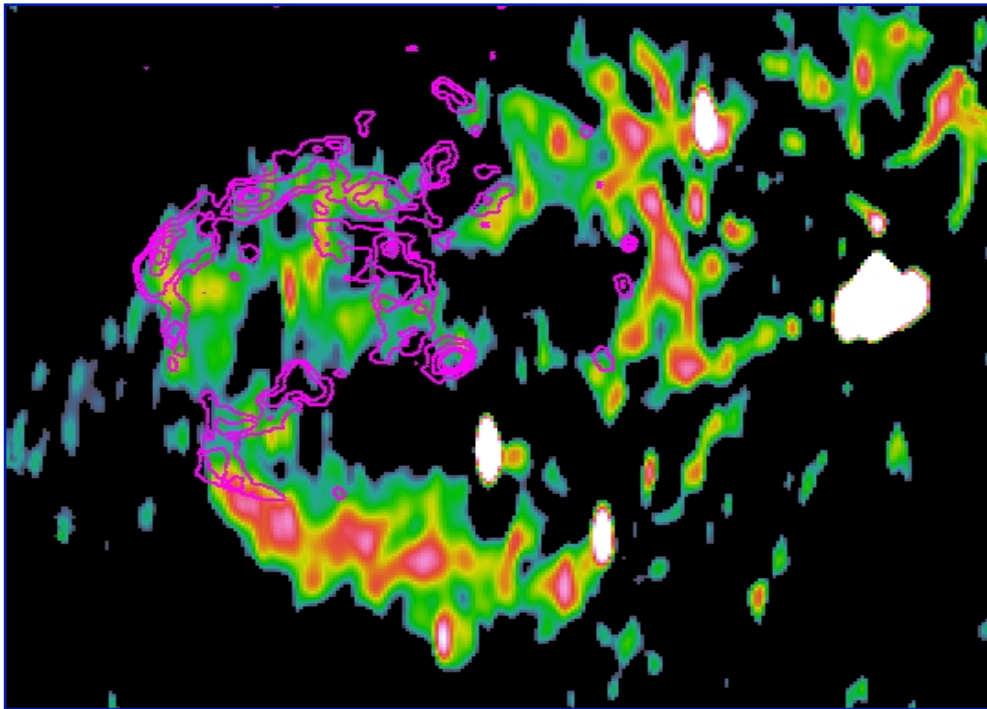
High-energy sources investigated by our group

HESS J1640-465 → G338.3-0.0	IC443
HESS J 1702-420 → G344,7-0.1	W44
HESS J1708-443 → G343.1-2.3/ B1706-44	W28
HESS J1713-397 → RX J1713.7-3946	SN1006
HESS J1731-347 → G353.6-0.1	
HESS J1747-281 → G0.9+0.1	
HESS J 1858+020	
1AGL J2022+4032	

HESS J1731-347 / G353.6-0.1

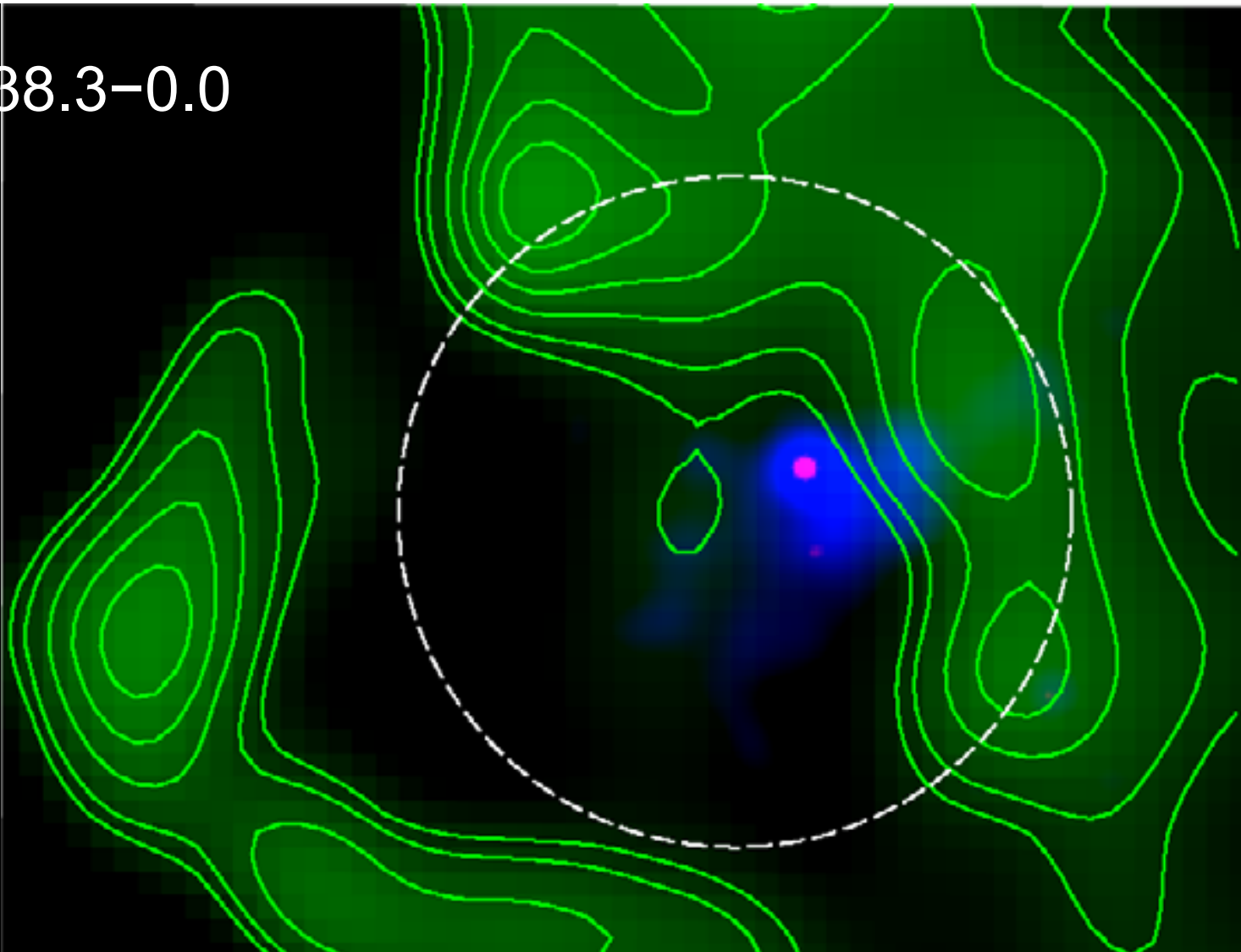


SNR G353.6-0.7 / HESS J1731-347



The contours traced at 4, 6 and 8 σ delineate the TeV emission

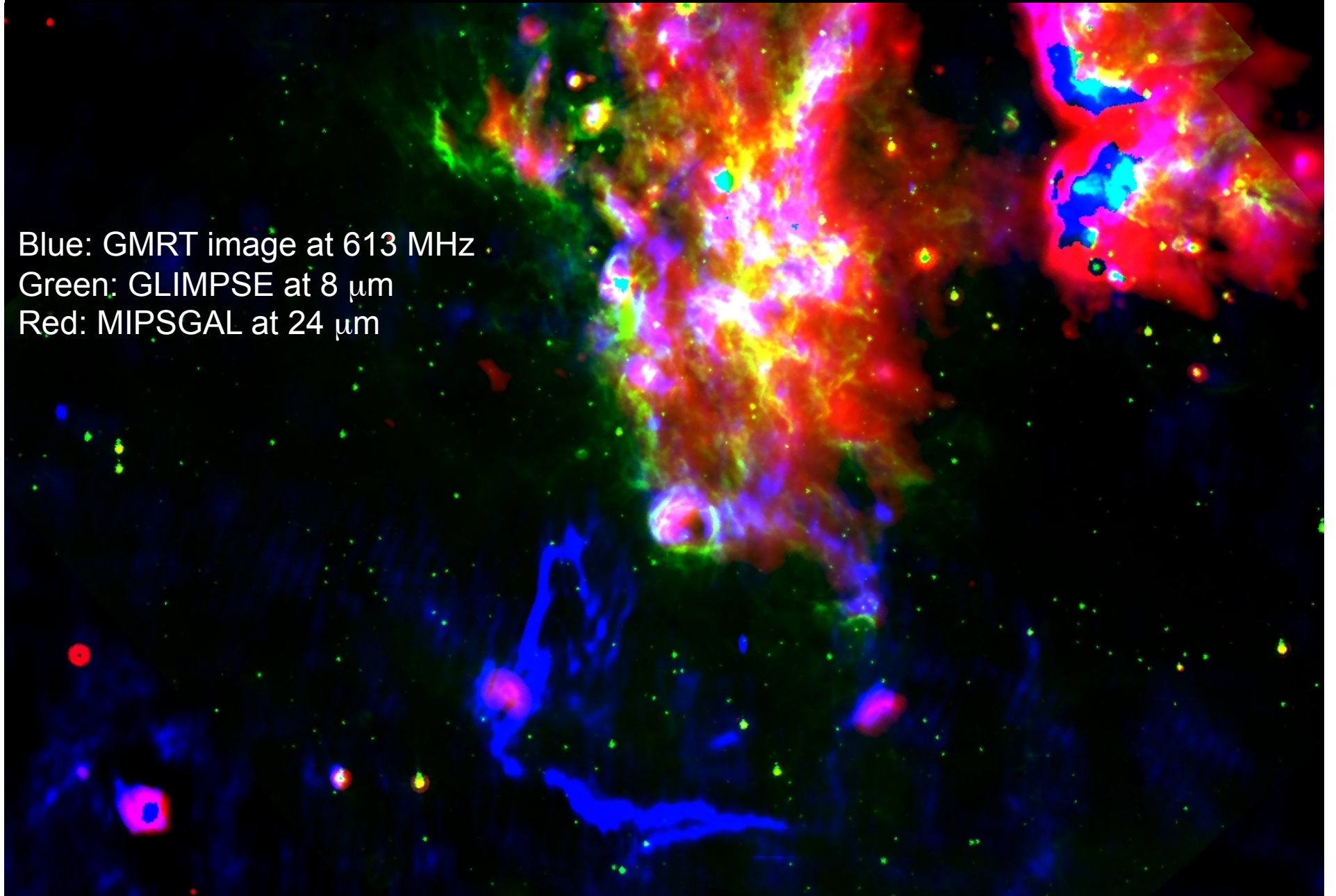
G338.3-0.0



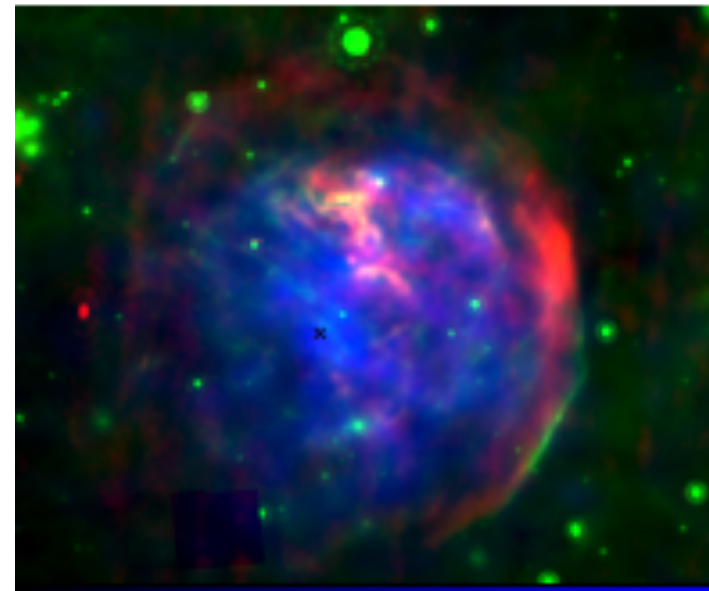
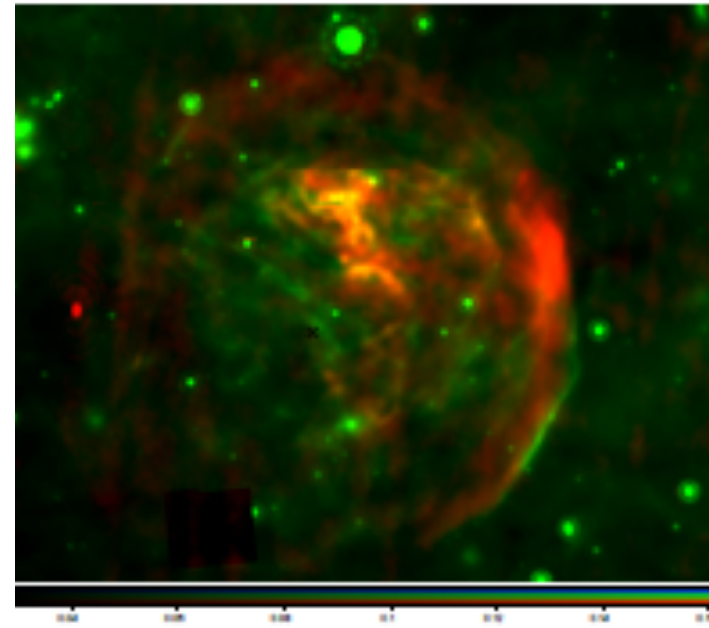
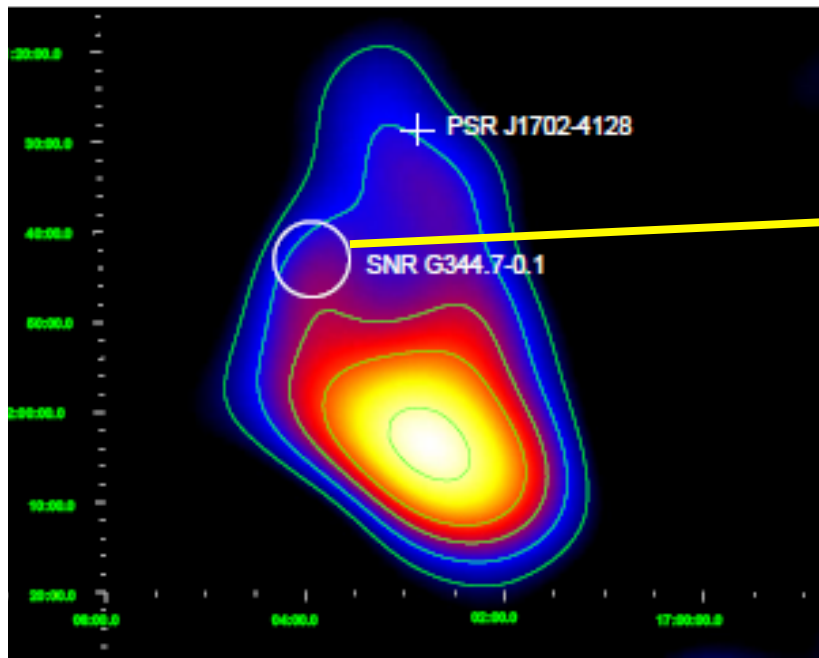
Multi-wavelength view of the field of G338.3-0.0: *Chandra* emission is shown in red ([4.5-8] keV band, and blue ([2.5-4.5] keV band, and the radio emission from 843 MHz MOST is shown in green. The intrinsic extent of HESS J1640-465 is shown as a white dashed circle.

G338.3-0.0- HESS J1640-465

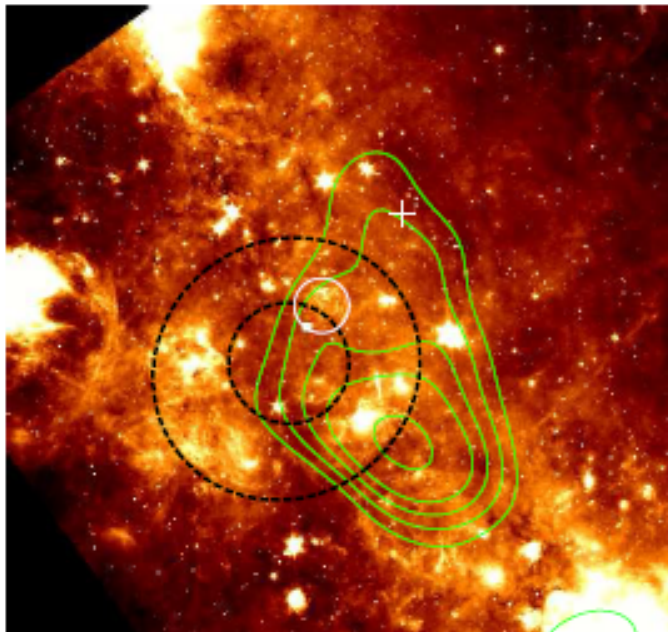
Blue: GMRT image at 613 MHz
Green: GLIMPSE at 8 μm
Red: MIPS GAL at 24 μm



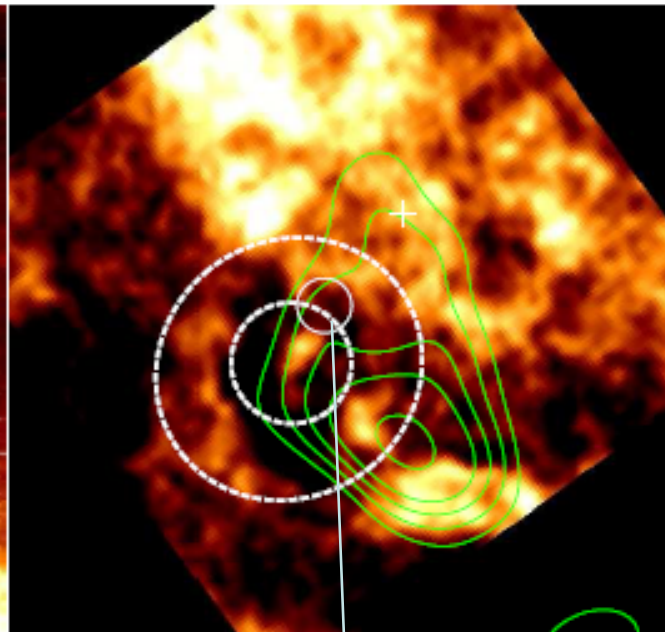
G344.7-0.1 and HESS J1702-420



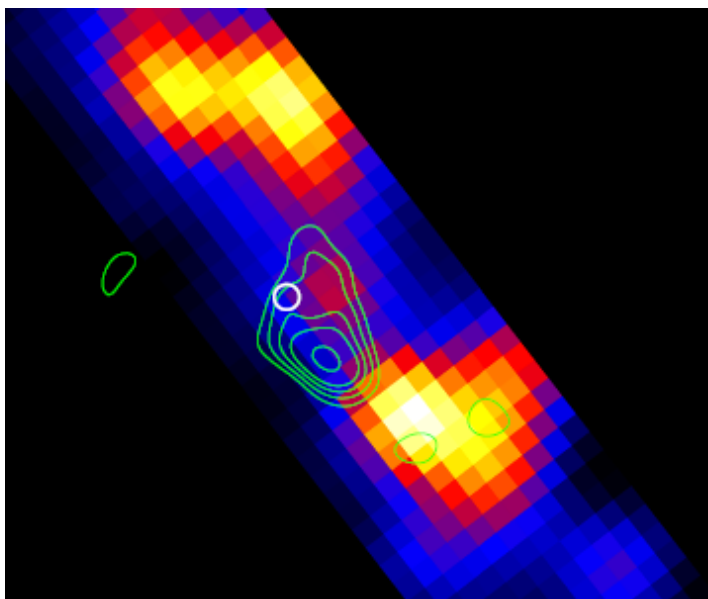
IR



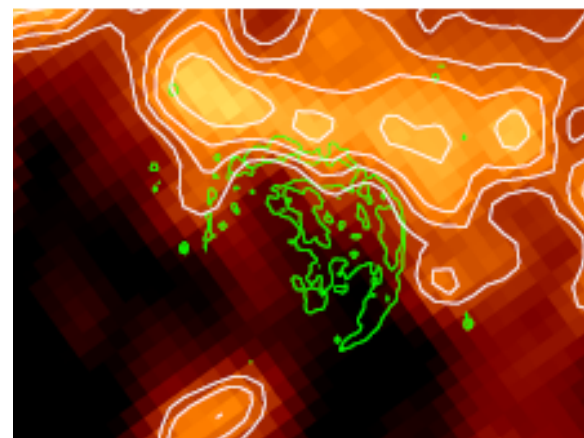
HI



CO



HI



After 24 years working with Miller Goss, his strong influence resulted in :

- 7 people group in IAFE
- 6 PhD thesis based on interferometric radio data
- Successful observing proposals at VLA, EVLA, ATCA, GMRT, DRAO, eVLBI, ASTE, APEX, NANTEN, XMM-Newton and Chandra
- Works with the high-energy collaborations HESS and AGILE



Thanks Miller!!

