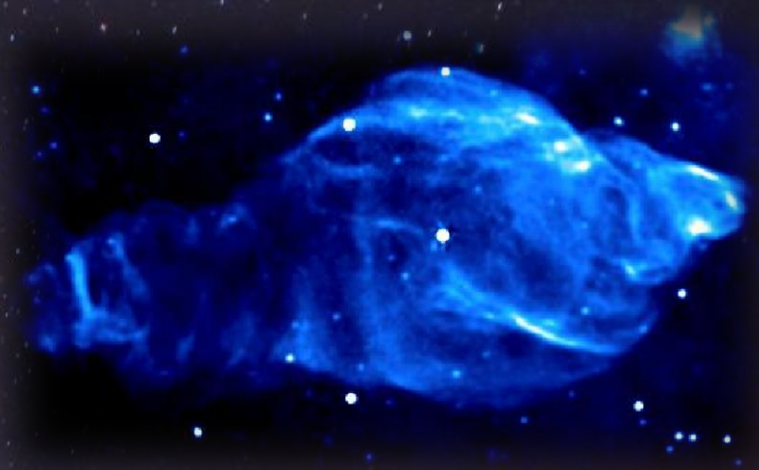
Restos de supernovas vistos con radiotelescopios



Gloria Dubner

IAFE

Buenos Aires, Argentina

• La explosión de una SN representa la inyección súbita de ~10^{51} ergs y varias masas solares de material estelar procesado en una región prácticamente puntual del espacio.

• Se generan ondas de choque con velocidades iniciales de f ~5000 a ~10000 km/s que barren y comprimen el material circundante (CSM e ISM)

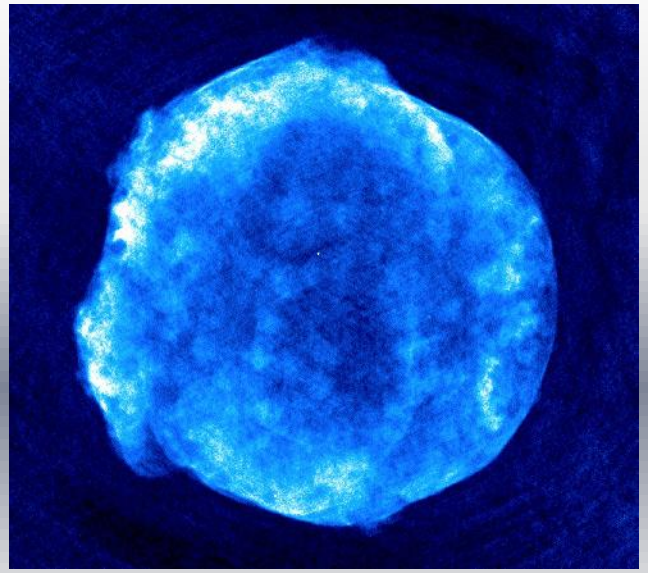
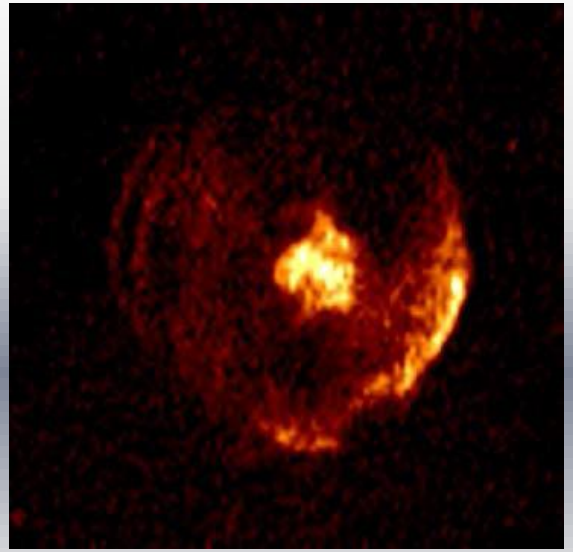
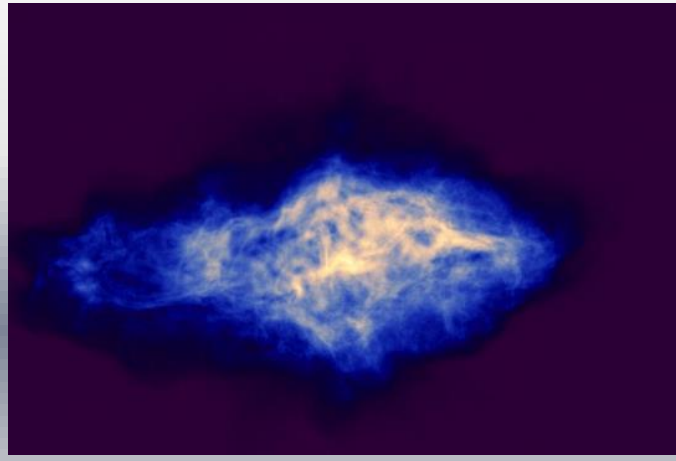
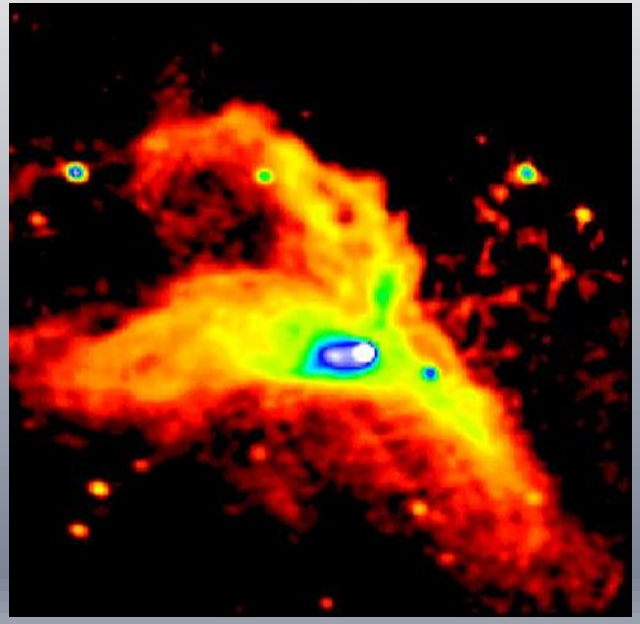
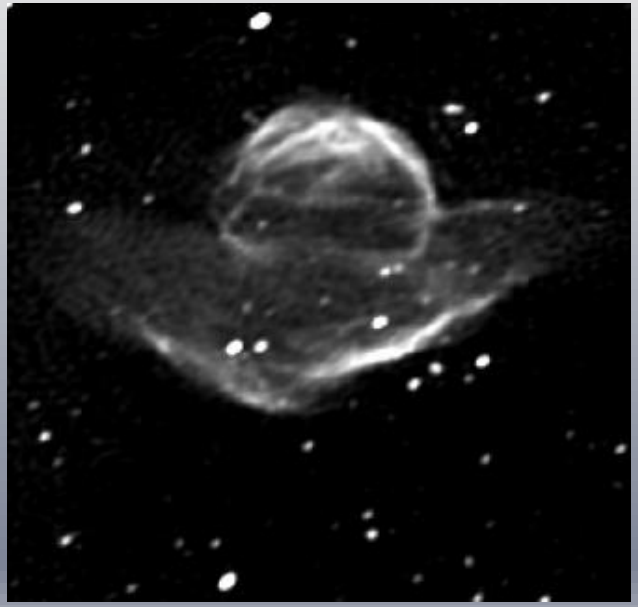
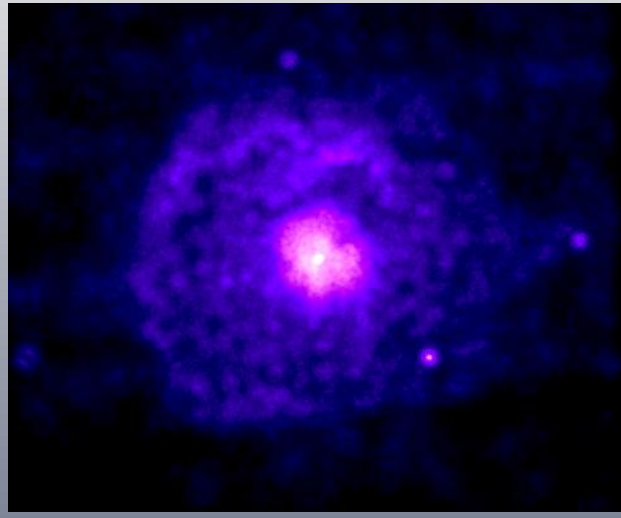
• En ~80% de los casos el RSN evoluciona en un ambiente fuertemente modificado por la acción de la estrella precursora.

Se denomina Remanente de Supernova (RSN) a la estructura y los productos creados durante y después de la explosión y a través de la interacción con el medio circundante.

El frente de choque en expansión barriendo y modificando el gas ambiente crea un CÁSCARA que emite radiación sincrotrónica.

Si queda una estrella de neutrones (EN), ésta puede soplar un viento relativista magnetizado creando una NEBULOSA DE VIENTO DE PULSAR (NVP).

Cuando ambos están presentes, se tiene un RSN COMPUESTO.

Por qué investigar los RSN en ondas de radio?

Antes de la existencia de la radioastronomía, se conociían sólo 2 RSN (Crab y Kepler´s).

Hoy en día hay 294 RSN firmemente clasificados en la Vía Láctea

95 % de ellos son radio fuentes. Sólo 20 RSN no han sido observados en radio o están muy pobremente definidos en radio.

- Los RSN pueden radiar su energía a través de todo el espectro electromagnético, pero son principalmente radio fuentes y las investigaciones con radiotelescopios son la herramienta más valiosa para:

  - *Delimitar la ubicación actual del fernte de choque en expansión,*
  - *Identificar sitios de aceleración de partículas*
  - *Inferir la orientación y el grado de orden de los campos magnéticos*
  - *Investigar el acoplamiento entre el viento relativista de la estrella de neutrones central y el plasma circundante .*

- Las observaciones en ondas de radio son una herramienta poderosa para descubrir nuevos RSN en nuestra Galaxia y en galaxias vecinas.

Los estudios en ondas de radio de RSN y NVP proveen información sobre:

- Morfología y distribución de brillo
- Espectro

Mecanismos de aceleración de partículas

- Polarización → Orientación y grado de orden del campo magnético
- Distancia → Parámetros físicos

Los inicios en el IAR

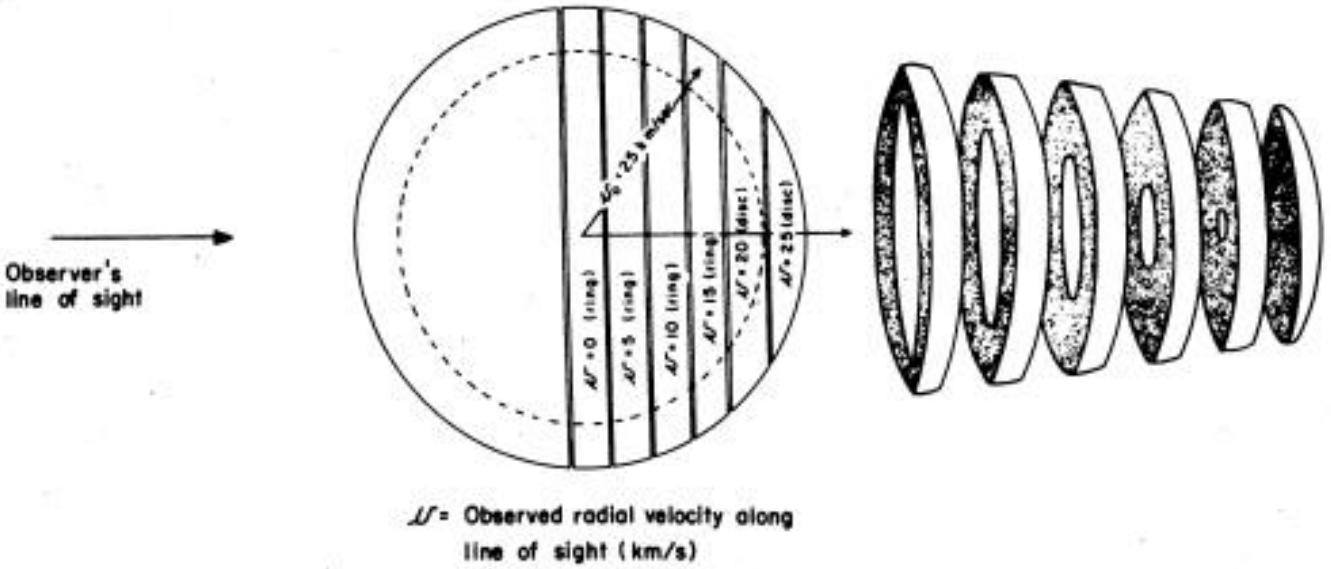


FIG. 2. A velocity diagram for an expanding shell model.

Assousa & Erkes, 1973, AJ 78, 885

Astron. Astrophys. 82, 244–248 (1980)

ASTRONOMY AND ASTROPHYSICS

Neutral Hydrogen Associated with Southern Supernova Remnants

I. "G 261.9, +5.5"

F. R. Colomb* and G. M. Dubner**

Instituto Argentino de Radioastronomía, Casilla de Correo No. 5, RA-1894 Villa Elisa (Prov. de Buenos Aires), Argentina

Summary. H I 21 cm observations have been made with the 30 m radiotelescope of the Instituto Argentino de Radioastronomía in the direction of the Supernova remnant G 261.9, +5.5. The observations strongly suggest the existence of neutral hydrogen clouds associated with the SNR. Mass, kinetic energy and expansion velocity are calculated.

Key words: neutral hydrogen – supernova remnants – interstellar medium

The results for G 261.9, +5.5 are reported here; in forthcoming papers we will discuss G 296.3, +10.0, Lupus Loop and SN 1006 AD.

G 261.9, +5.5 has been observed in the radio continuum at 2650 MHz by Hill (1967). Its distance has been estimated by several authors using $\Sigma - D$ relation; Milne (1970) derives a distance of 2.9 kpc; Downes (1971), 4.8 kpc; Ilovaisky and Lequeux (1972), 4.3 kpc; and Clark and Caswell (1976), 3.8 kpc. We will assume here an average distance of 3.9 kpc, which gives a linear diameter of 45 pc and $z = 365$ pc. As far as we know no optical identification exists for this object.

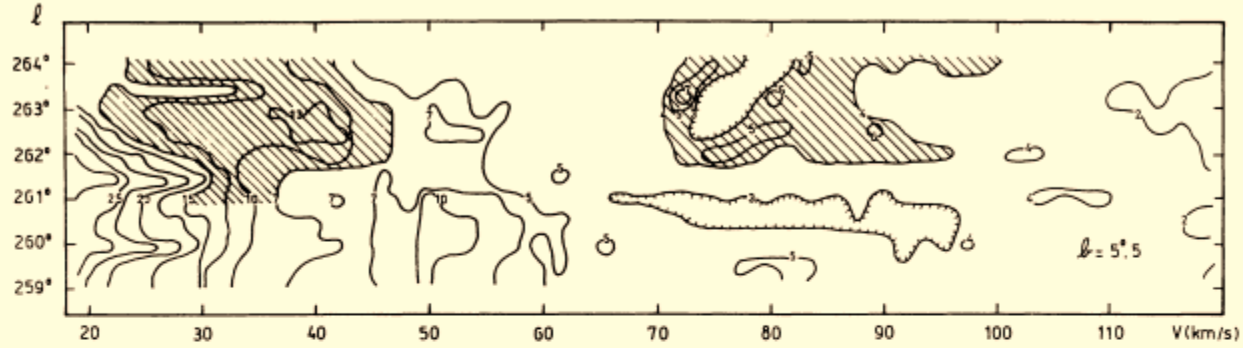


Fig. 1. Contour map of brightness temperature at $b = 5°.5$. Hatched areas are the H I feature probably related to G 261.9, +5.5

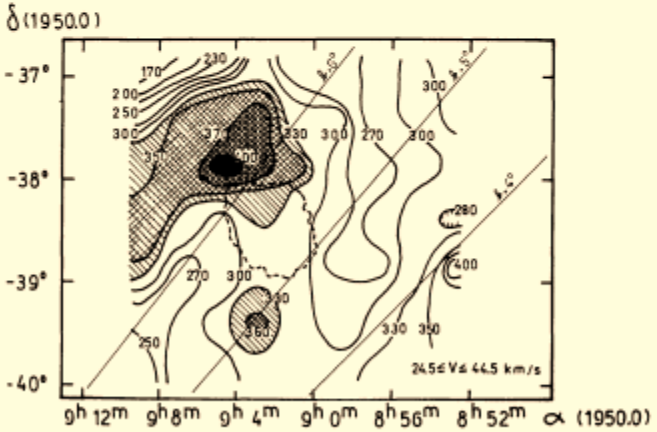


Fig. 2. Integrated H I over the velocity interval 24.5–44.5 km s^{-1}. Hatched areas show clouds related to G 261.9, +5.5. The dashed line represent the radio continuum at 2650 MHz

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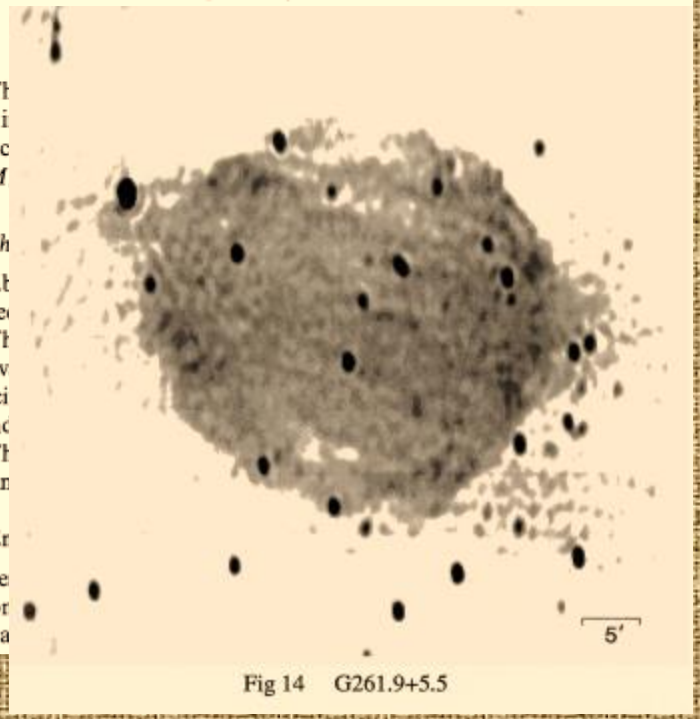

Fig 14 G261.9+5.5

Astron. Astrophys. 130, 294–300 (1984)

ASTRONOMY AND ASTROPHYSICS

1420 MHz continuum and H I line observations around the supernova remnant candidate H1538-32

F. R. Colomb*, G. M. Dubner*, and E. B. Giacani**

Instituto Argentino de Radioastronomía, P.O. Box 5, 1894 Villa Elisa (Prov. de B. A.), Argentina

Received July 11, accepted August 31, 1983

Summary. We report the observations in radio-continuum and H I emission, at 1420 MHz, in the direction of the soft X-ray source H 1538 – 32, proposed as a possible supernova remnant by Riegler et al. (1980). Our observational results provide further support to Riegler et al.'s contention. The radio-continuum emission is distributed around H 1538 – 32 forming an elliptical shell with an equivalent angular radius of 2°.6. A number of discrete sources have been detected immersed into the radio shell. The neutral gas associated with H 1538 – 32 shows the dynamical effects of an expanding shock front interacting with a cloudy surrounding medium. An inter-cloud preshock density of $\cong 0.02\,\mathrm{cm}^{-3}$, an initial energy of about $4\ 10^{50}$ ergs, an age of $2\ 10^{4}$ yr and a distance of about 950 pc, have been estimated. The H I features associated to this supernova remnant have no connection with the extended H I ring noticed by Riegler et al.

Key words: supernova remnants – radio continuum – neutral hydrogen – X-ray sources

ring-like feature. As will be discussed in the following sections, we think that this big ring is not associated to H 1538 – 32, because of the large size of the H I feature and the eccentricity of the X-ray source distribution.

In an attempt to observe the radio features that may possibly be associated with H 1538 – 32 and, thus, ascertain the nature of the object, we have observed the continuum at 1420 MHz and the H I distribution in the direction of the X-ray source.

II. Observations and results

The observations, both in the continuum and in the H I line, were made with the 30 m dish radiotelescope of the Instituto Argentino de Radioastronomia during 1982. At 1420 MHz, the antenna has HPBW of 34′. The system noise temperature is about 87° on cold sky.

The observations cover the region: from $15^{h}12^{m}$ to $16^{h}00^{m}$, in

THE ASTRONOMICAL JOURNAL VOLUME 91, NUMBER 2 FEBRUARY 1986

1410 MHz CONTINUUM AND H I LINE OBSERVATIONS TOWARDS THE SNR G296.5+10.0 AND NEARBY SOURCES. EVIDENCES OF TWO SNRs TUNNELING THROUGH THE INTERSTELLAR MEDIUM

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Received 16 May 1985; revised 10 October 1985

ABSTRACT

1410 MHz radio continuum and H I 21 cm line observations have been performed on an extended area that contains the SNR G296.5 + 10.0. Two additional radio-continuum sources have been identified in our 1410 MHz map, namely (1) G300.1 + 9.4, which we classify as a faint SNR, located at a distance comparable to that of G296.5 + 10.0, and (2) G300.8 + 11.7, with a broken spectrum and a possible double structure unresolvable with the present resolution. Our observations reproduce the theoretically expected outcome of two interacting supernova remnants. A peanut-shaped cold shell surrounding the SNRs G296.5 + 10.0 and G300.1 + 9.4 is observed in a range of kinematic velocities compatible with the distances of the SN remnants, a low-density tunnel connects both SNRs, and a set of H I features can convincingly be explained as part of the perpendicular ring predicted to form in the region where the two expanding shocks overlap. In addition, some small H I clouds accelerated to relatively high velocities are observed to be positionally coincident with the SNRs. In the case of G296.5 + 10.0 part of these accelerated cloudlets correlate with the associated optical filaments.

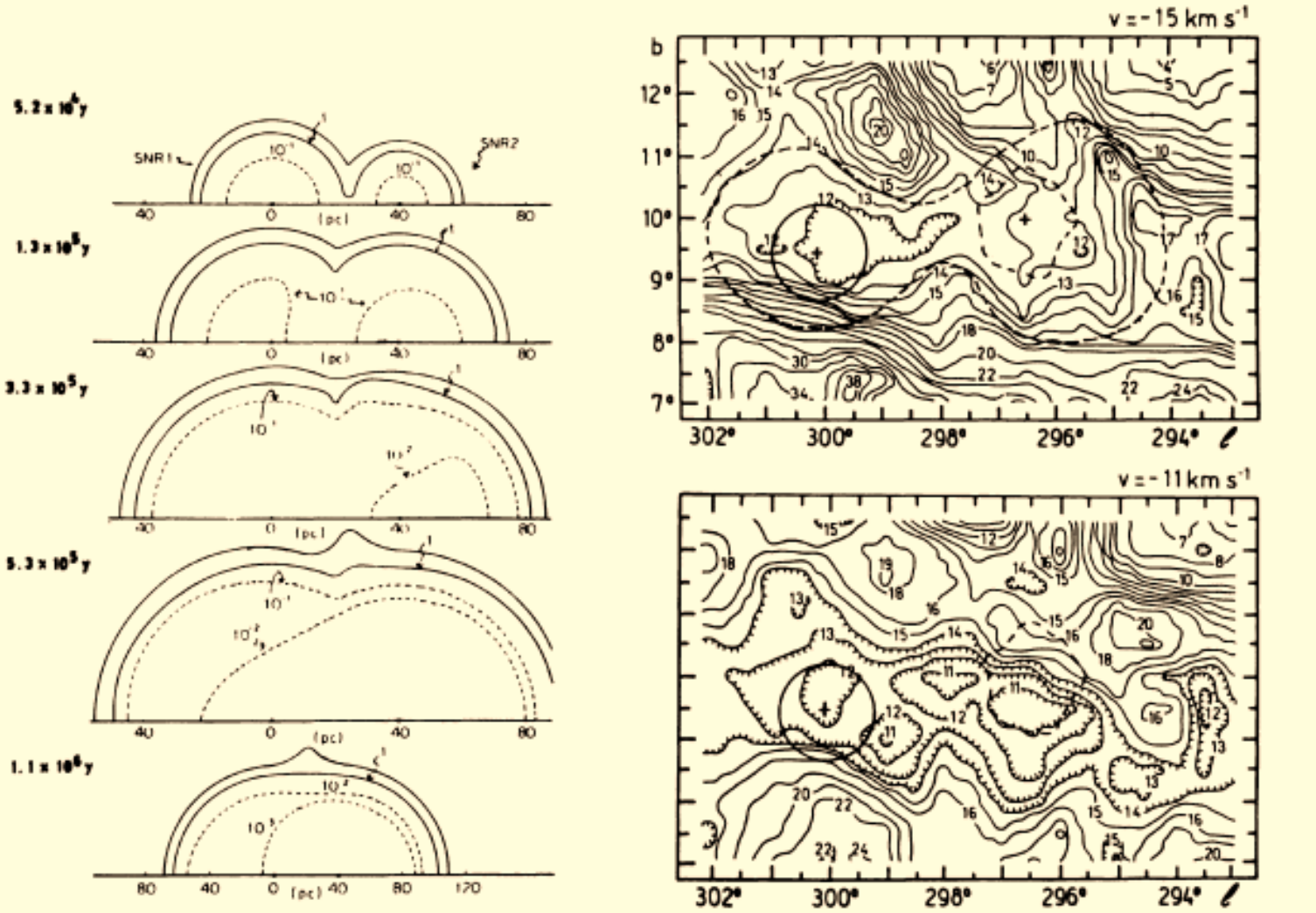
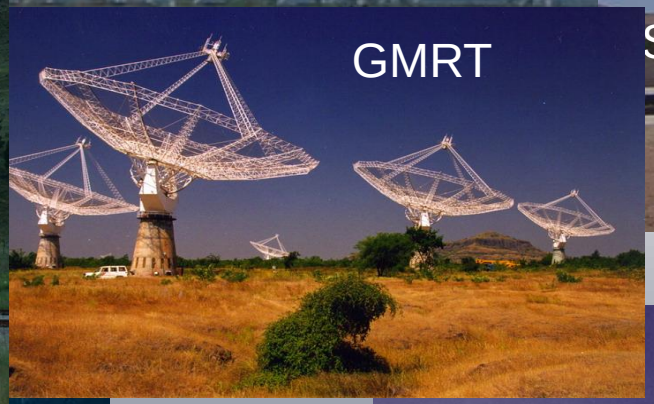
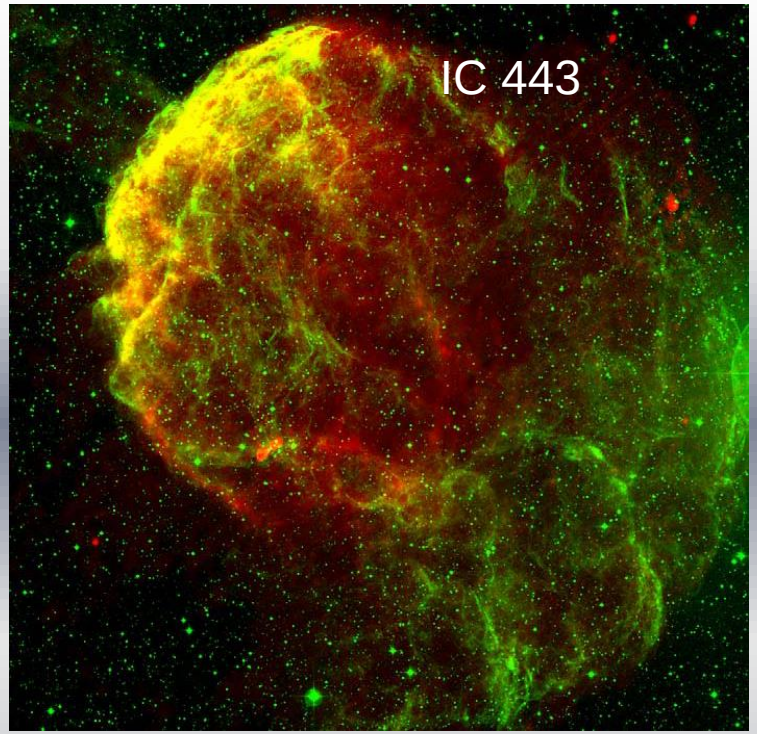
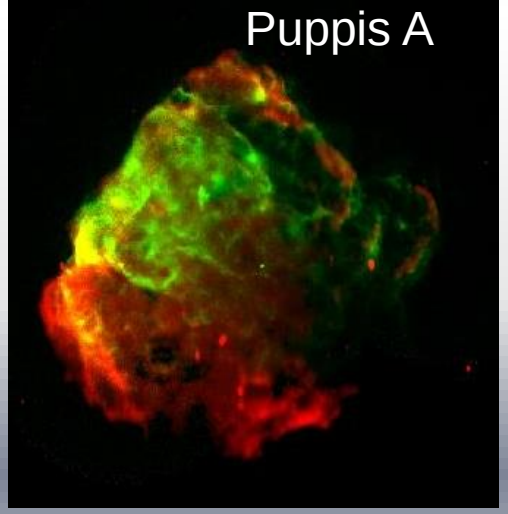


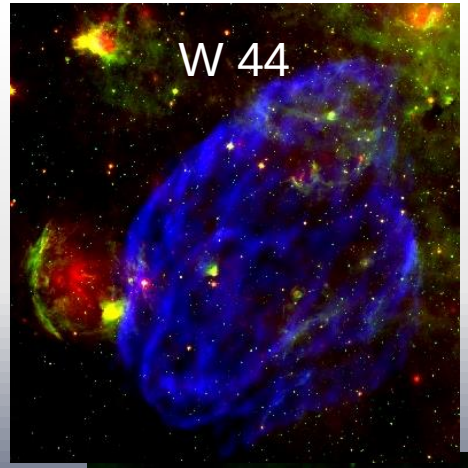
FIG. 5. Left: the theoretically predicted H I density contours in different stages, for two interacting SNRs, according to Ikeuchi (1978). Contours are labeled in units of H atoms per cm^{-3}. Right: observed H I column density distribution at -15 and -11 km/s, including the radio-continuum remnants limits; dashed surrounding shell has been included to emphasize the observed distribution.

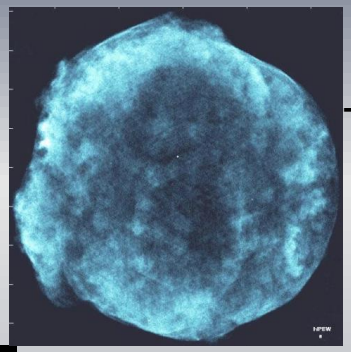
Estudios en el IAFE de RSN y MIE











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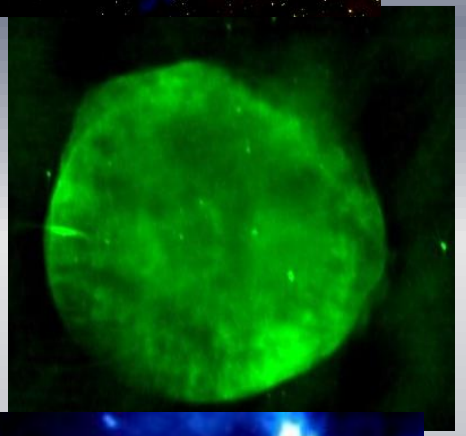

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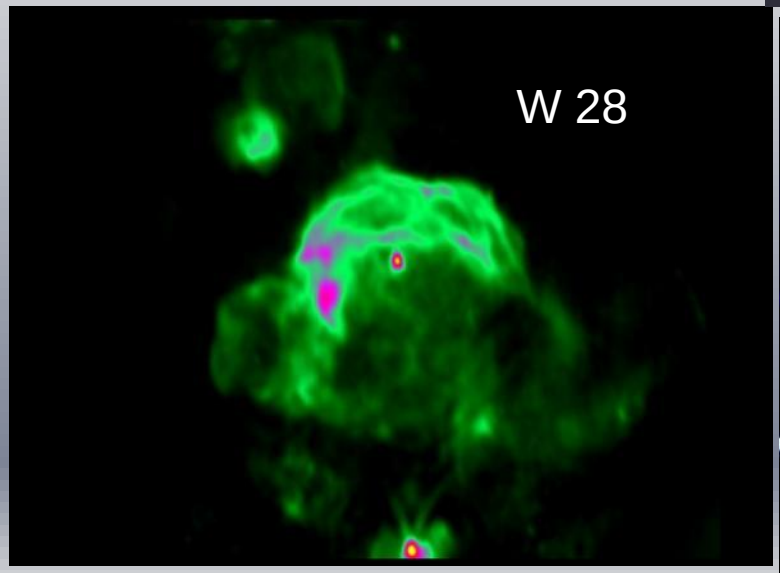

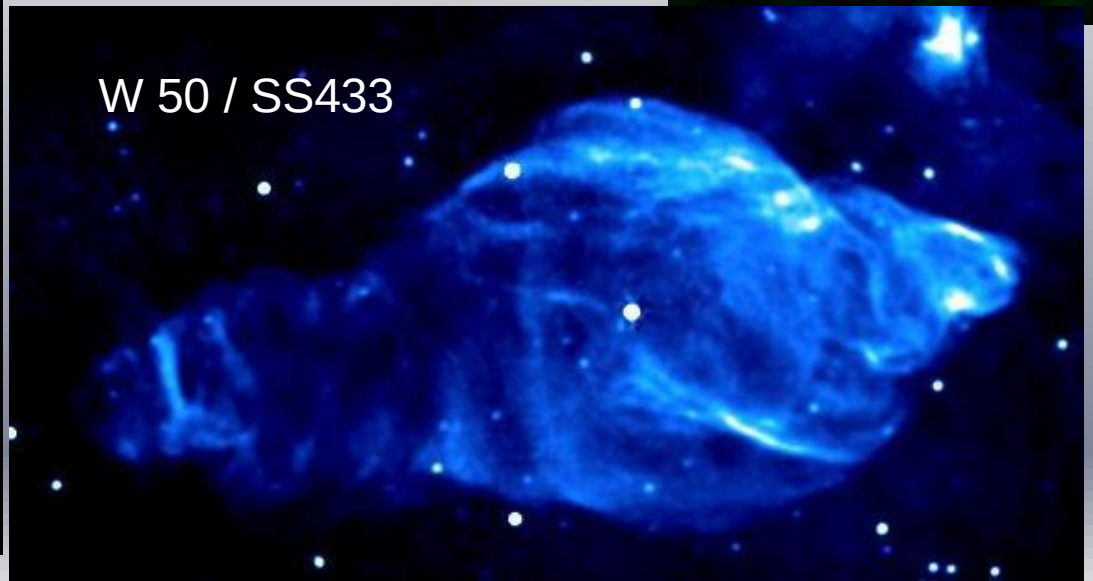

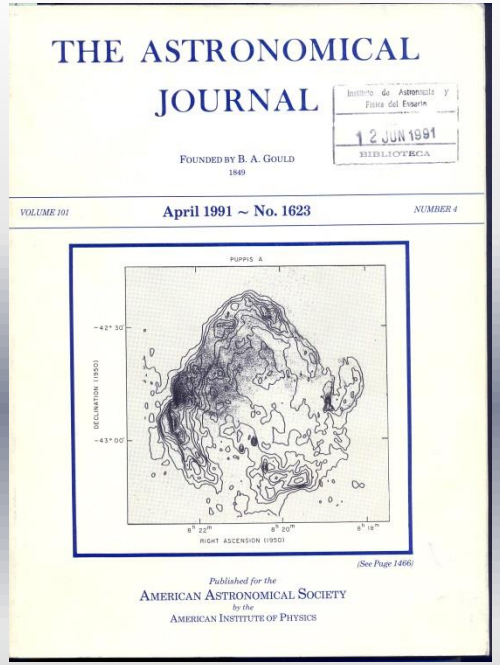
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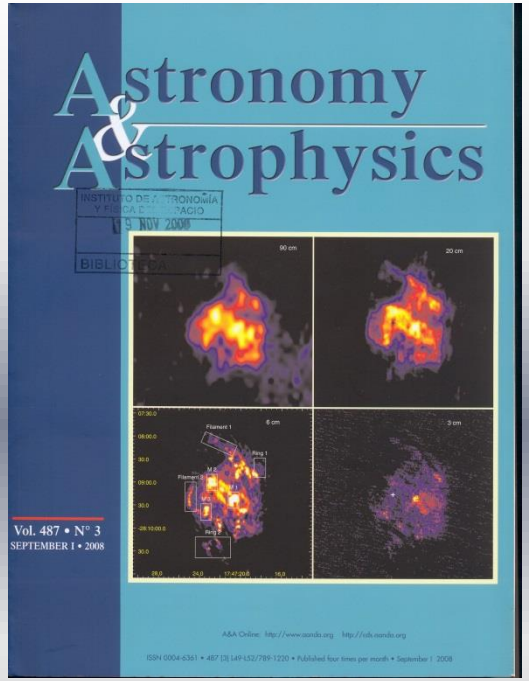
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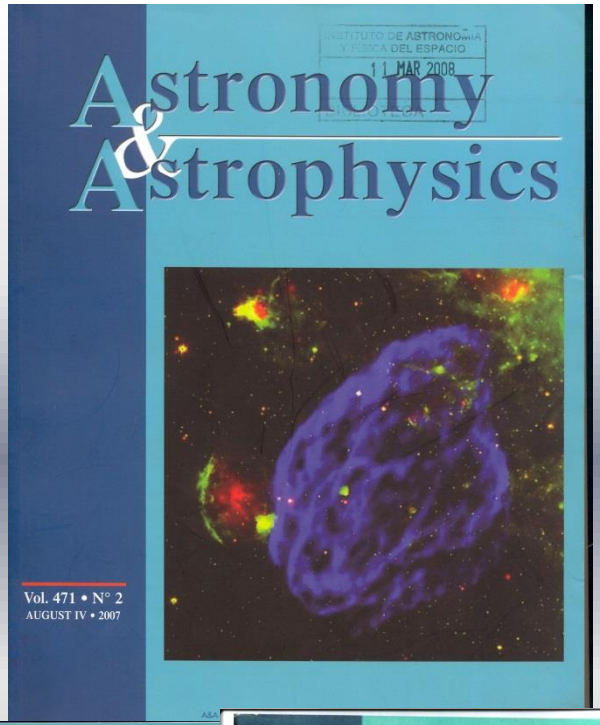
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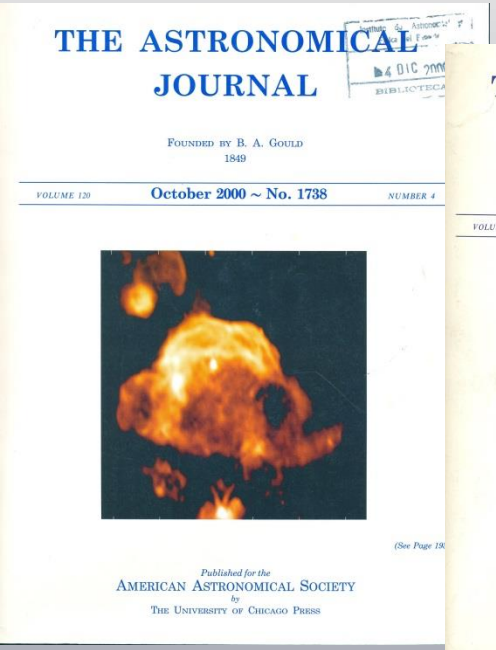
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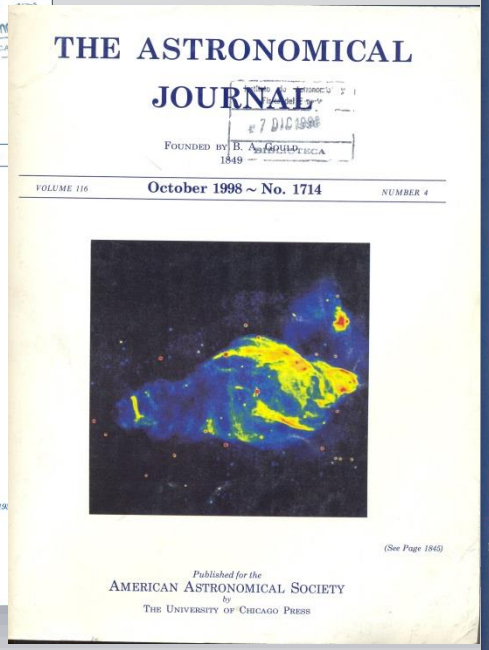
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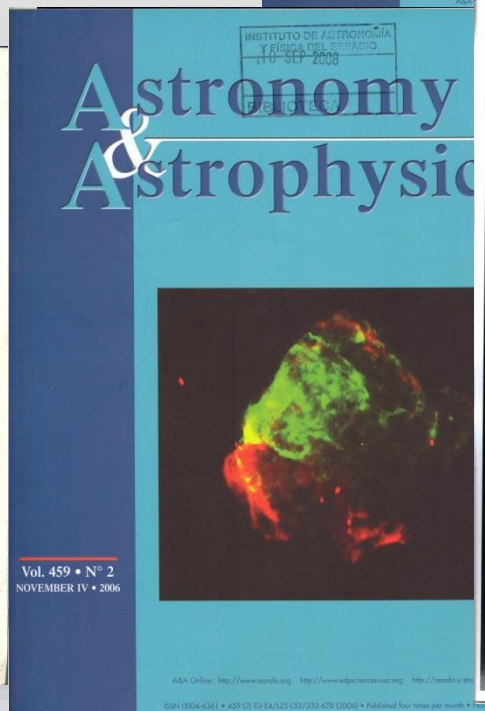
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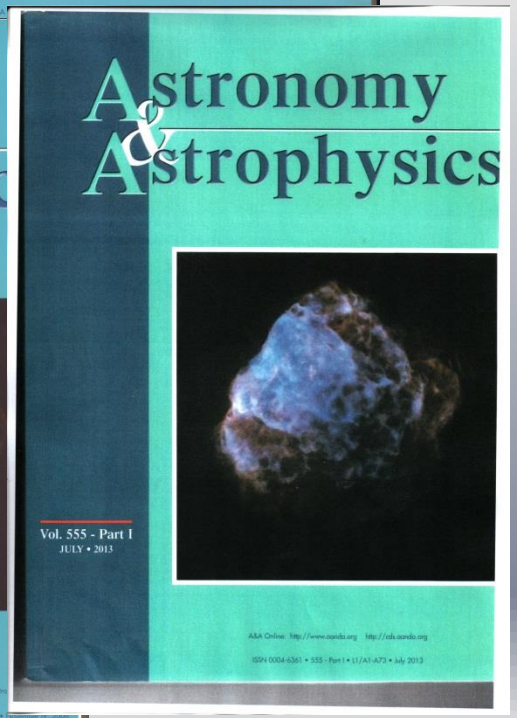
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Astronomy Picture of the Day

Discover the cosmos! Each day a different image or photograph of our fascinating universe is featured, along with a brief explanation written by a professional astronomer.

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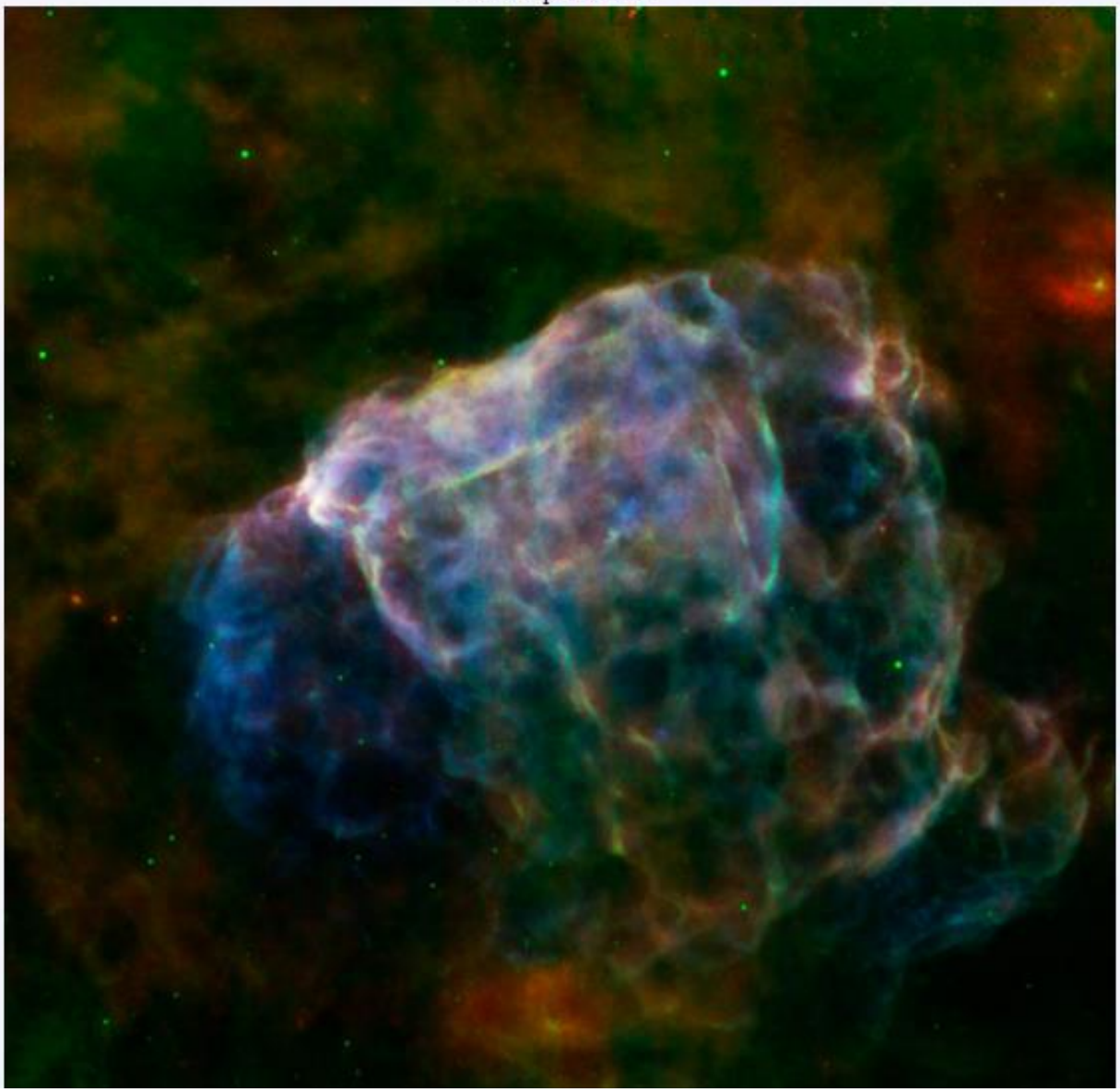

Chandra Calendar 2015

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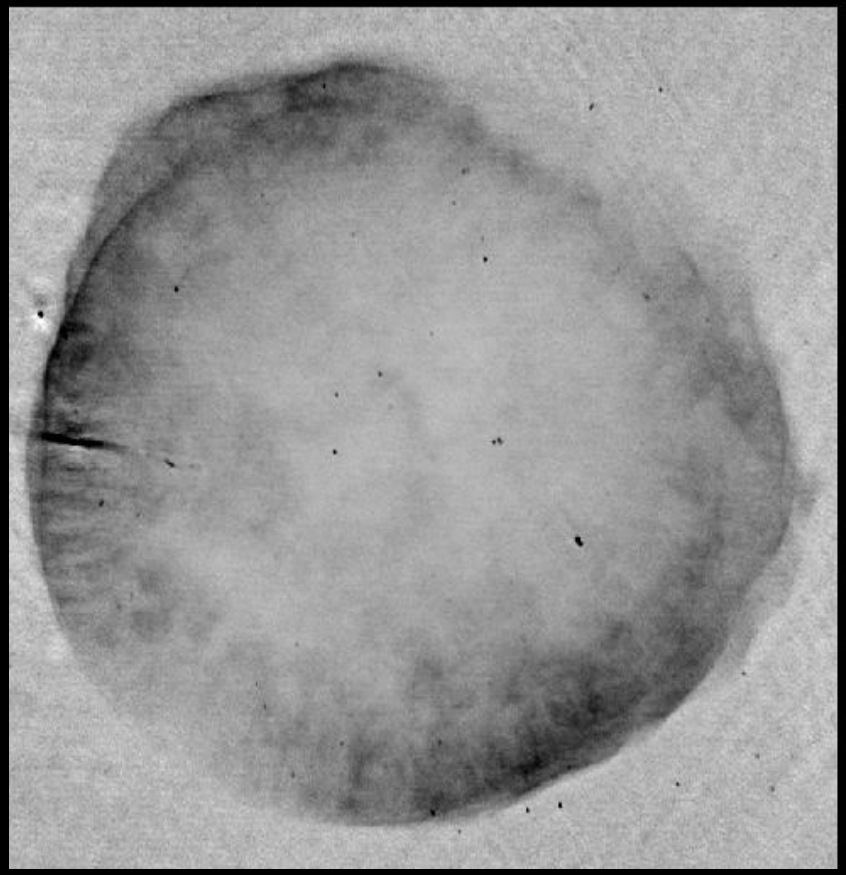
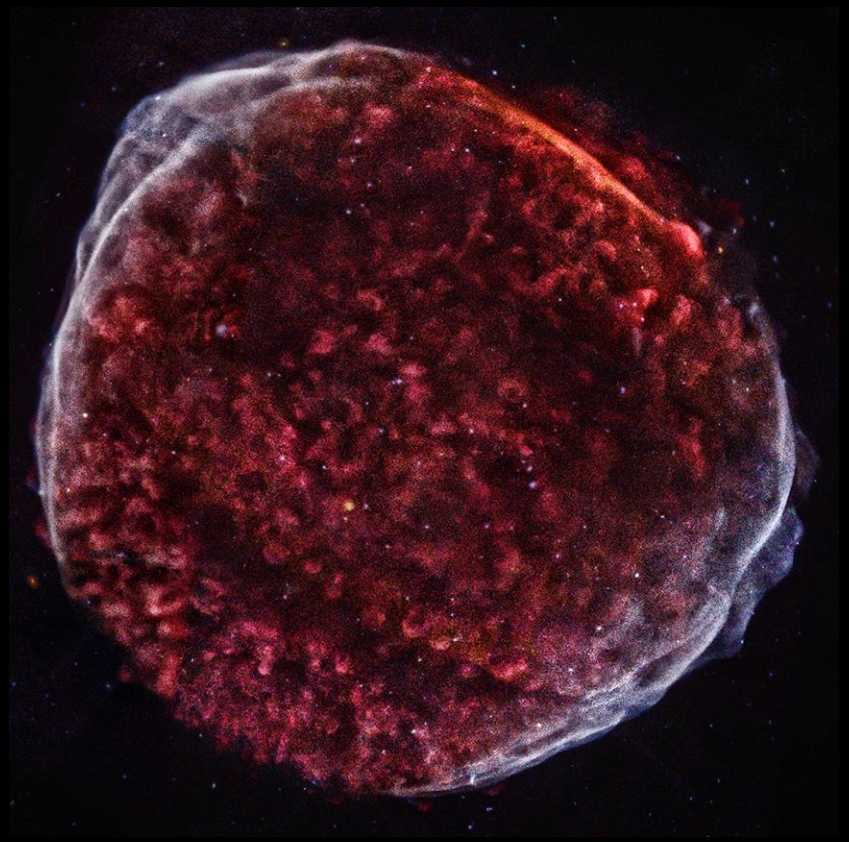
PUPPIS A

The destructive results of a powerful supernova explosion are seen in a delicate tapestry of X-ray light in this new image. The remnant is called Puppis A, which could have been witnessed on Earth about 3,700 years ago and is about 10 light years across. This image is the most complete and detailed X-ray view of Puppis A ever obtained, made by combining a mosaic of different Chandra and XMM-Newton observations. In this image, low-energy X-rays are shown in red, medium-energy X-rays are in green and high energy X-rays are colored blue.

Credit: Chandra: NASA/CXC/IAFE/G.Dubner et al.; XMM: ESA/XMM-Newton

SN 1006





A&A 387, 1047–1056 (2002)
DOI: 10.1051/0004-6361:20020365

Astronomy & Astrophysics

The neutral gas environment of the young supernova remnant SN 1006 (G327.6+14.6)

G. M. Dubner[1,*], E. B. Giacani[1,*], W. M. Goss[2], A. J. Green[3], and L.-Å. Nyman[4]

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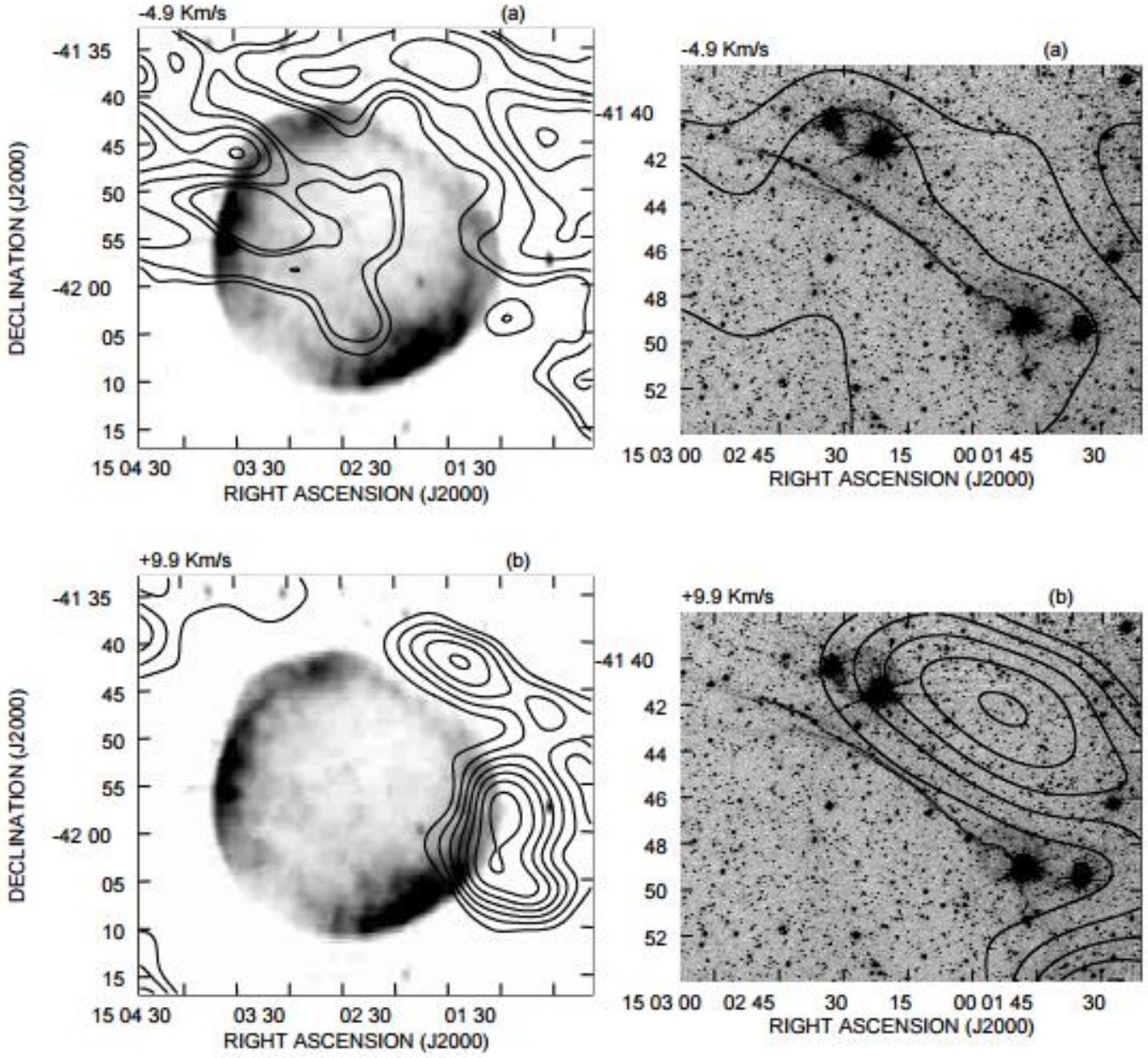
[4] Onsala Space Observatory, Chalmers University of Technology, 439 92 Onsala, Sweden and European Southern Observatory, Casilla 19001, Santiago 19, Chile
e-mail: lnyman@eso.org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DECLINATION (J2000)
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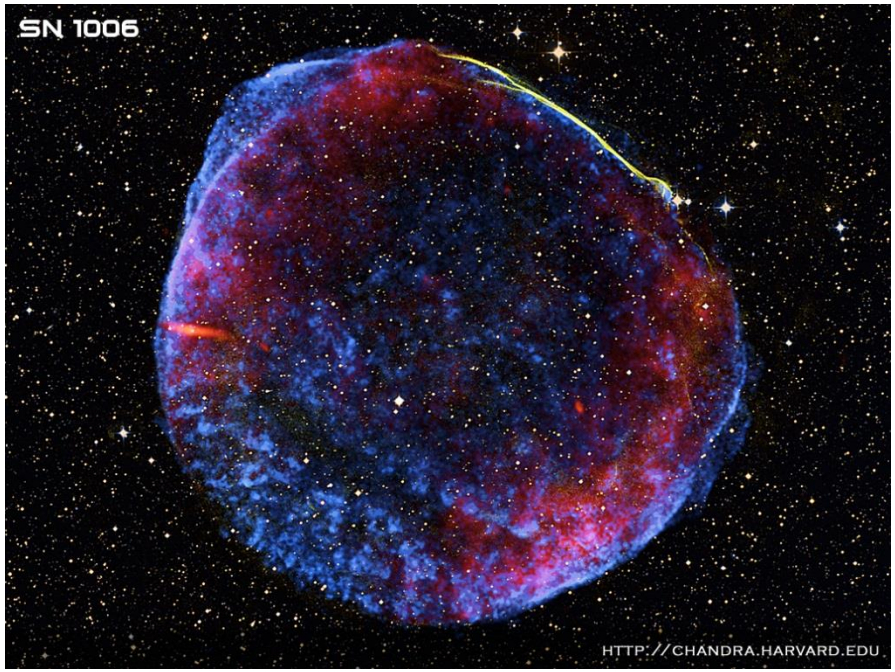
15
00 01 45
30
RIGHT ASCENSION (J2000)



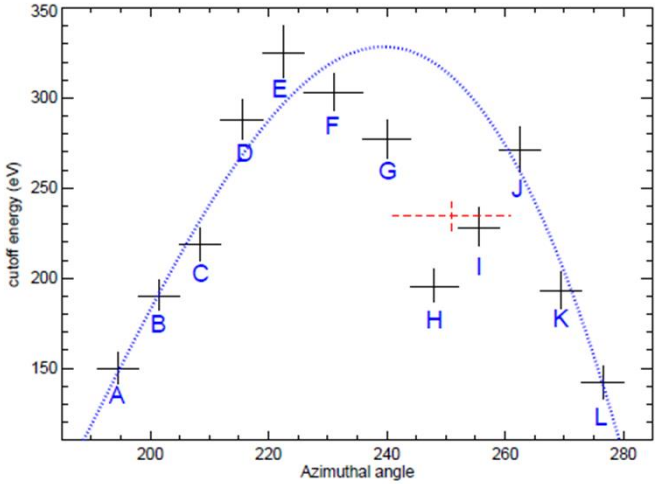
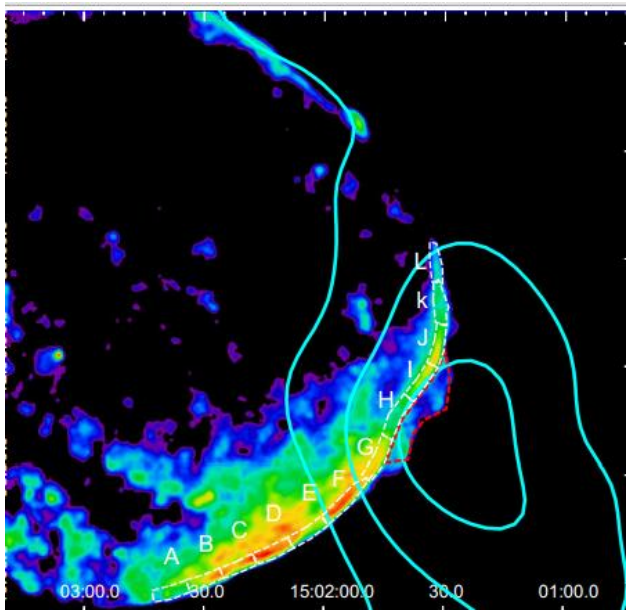


FIG. 3.— Best fit values of the synchrotron cutoff energy obtained from the X-ray spectral analysis of regions $A - L$ of Fig. 1. The red cross corresponds to the red dashed region of Fig. 1. Error bars are shown at the 90% confidence levels. The blue curve shows a 4th degree polynomial fit to all the points but G, H, and I.

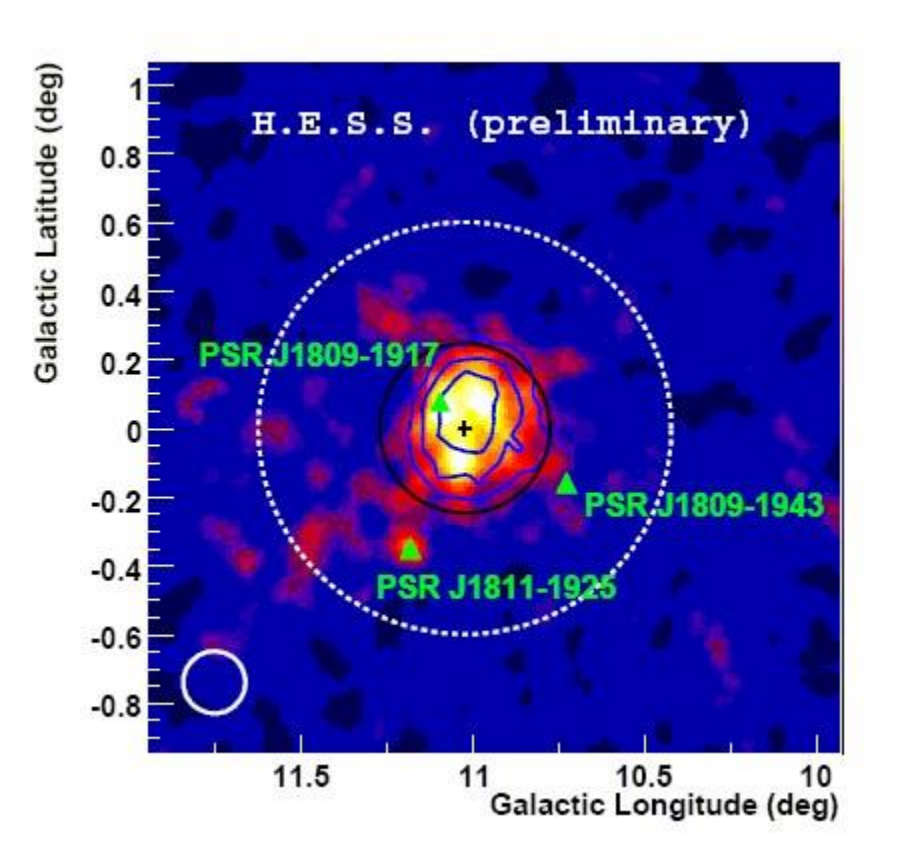


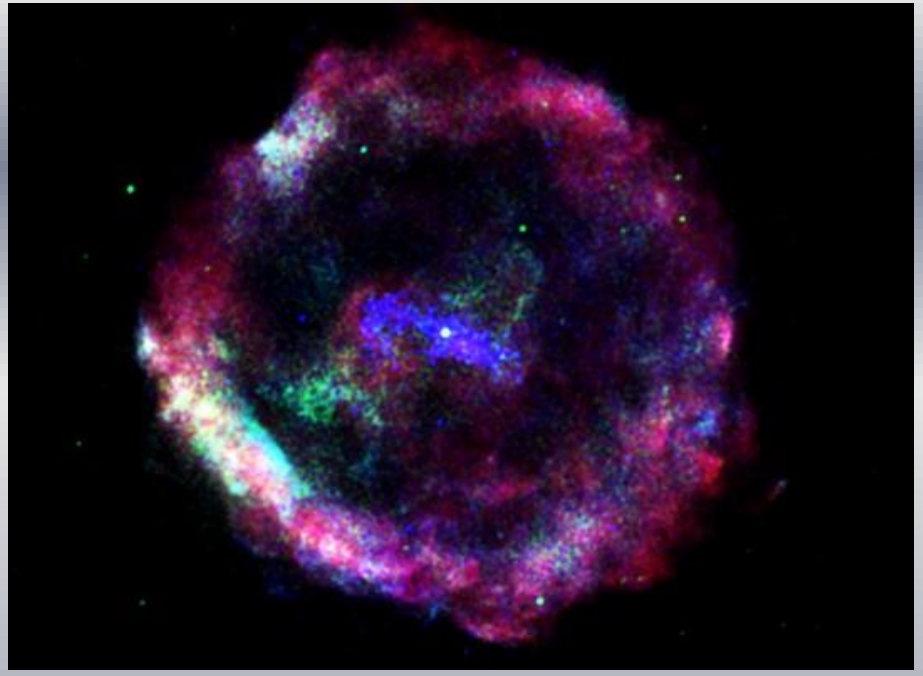
Miceli et al. 2014, 2016

El borde SW de SN1006 , caracterizado por aceleración de partículas altamente eficiente, resulta ser una región muy promisoria para detectar radiación gamma de origen hadrónico. emission in SN1006

Investigación de RSN y NVP que pueden estar asociadas con fuentes TeV y Gev de origen (aún) desconocido.

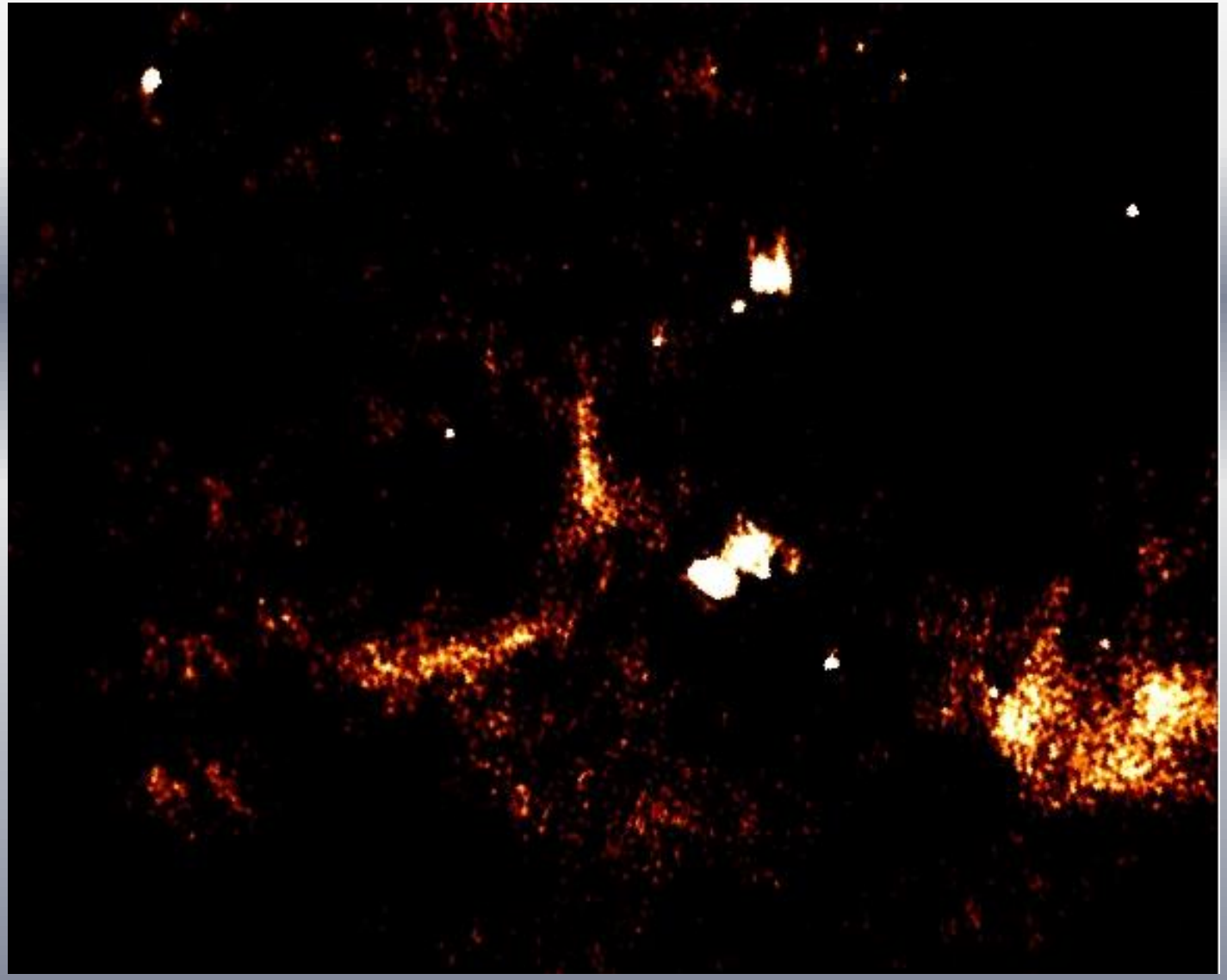
HESS J1809-193

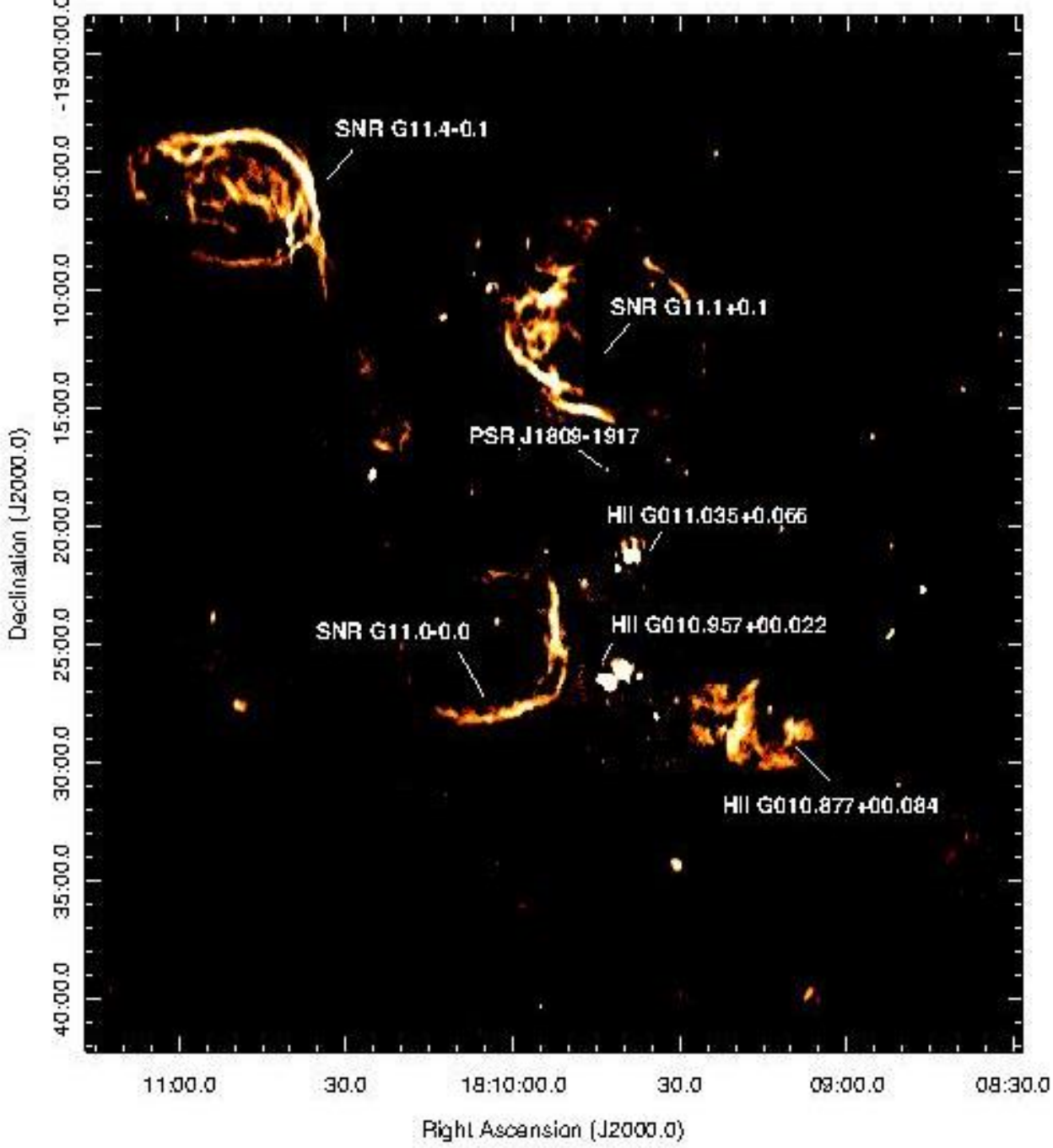




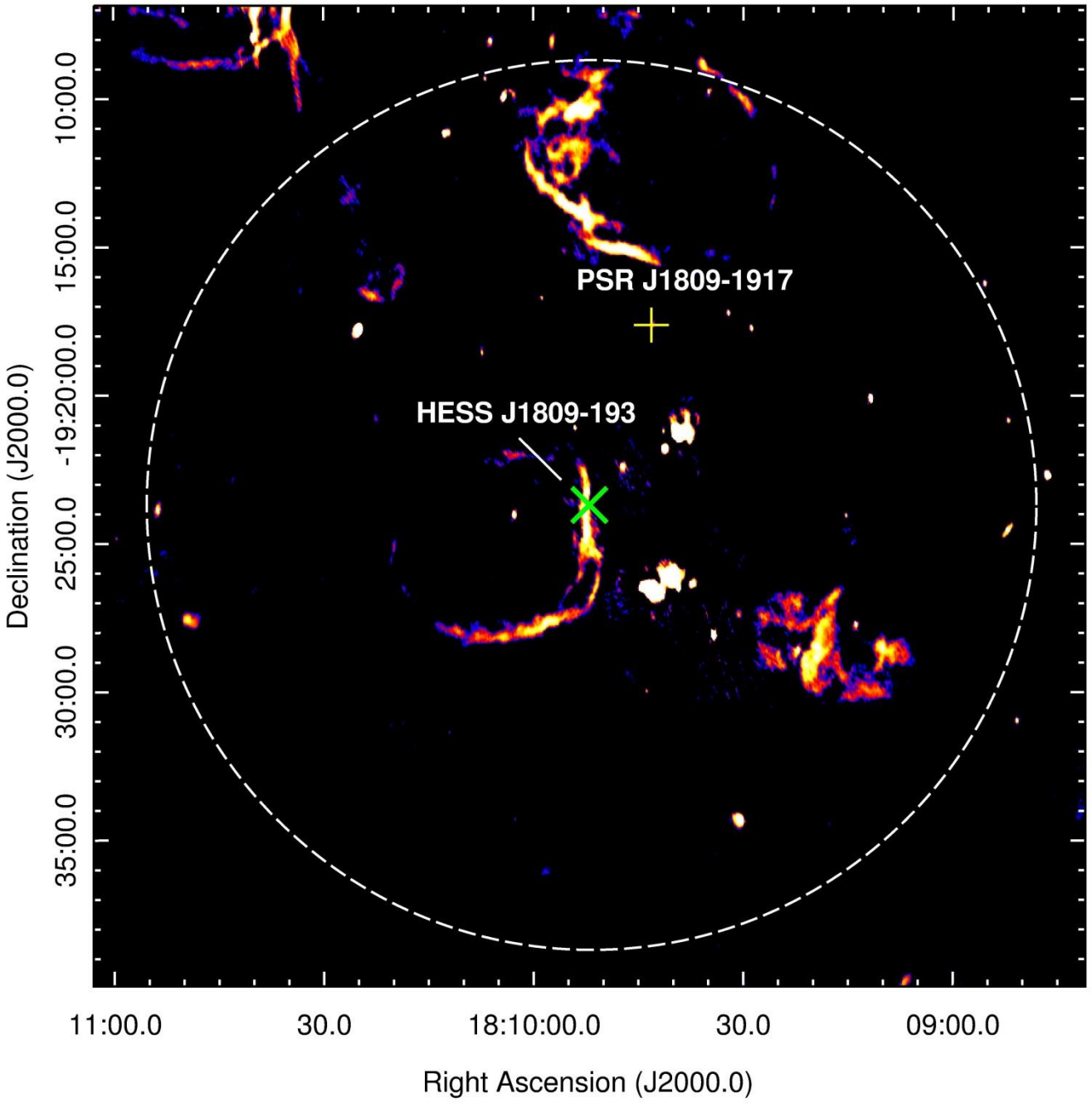
G11.2-0.3 + PSR 1811-1925

MAGPIS image at 20 cm

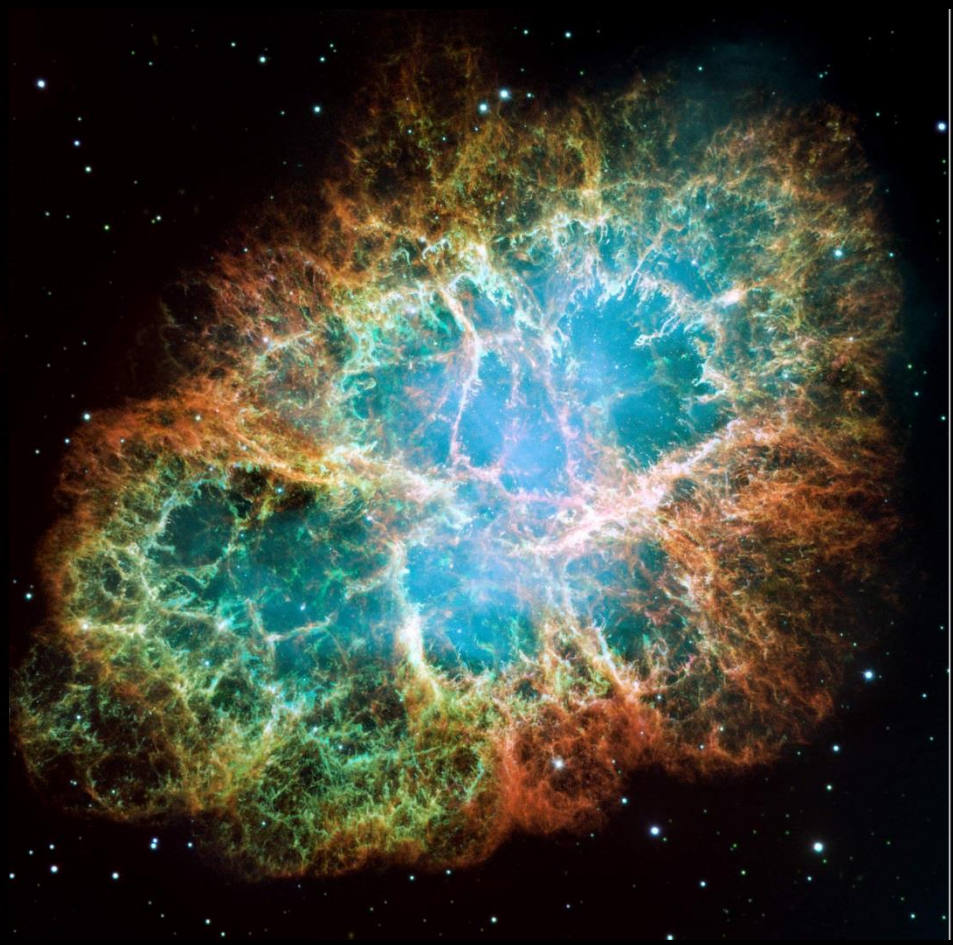




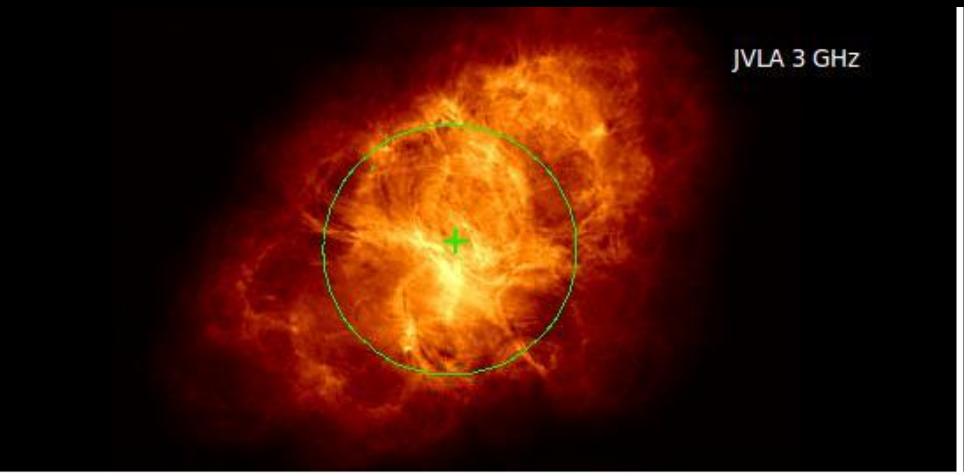
Castelletti, Giacani, Supan, et al.

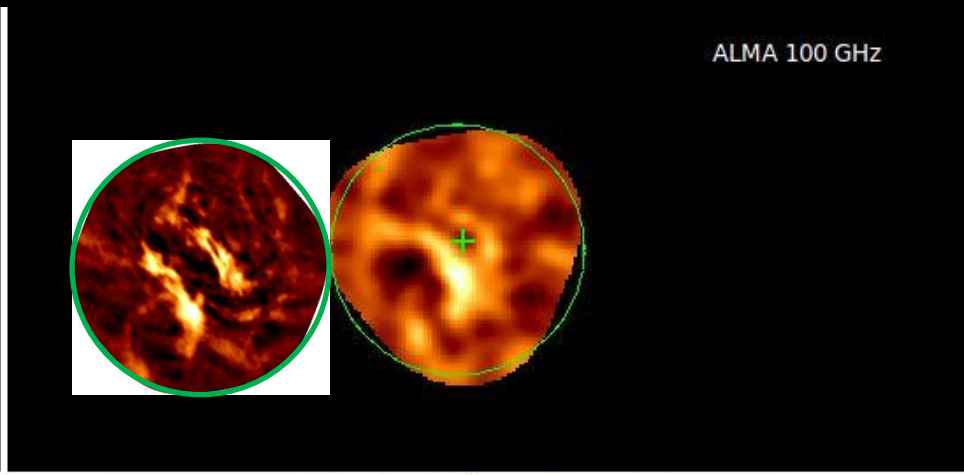

PSR J1809-1917
HESS J1809-193
Declination (J2000.0)
10:00.0
15:00.0
-19:20:00.0
25:00.0
30:00.0
35:00.0
11:00.0
30.0
18:10:00.0
30.0
09:00.0
Right Ascension (J2000.0)

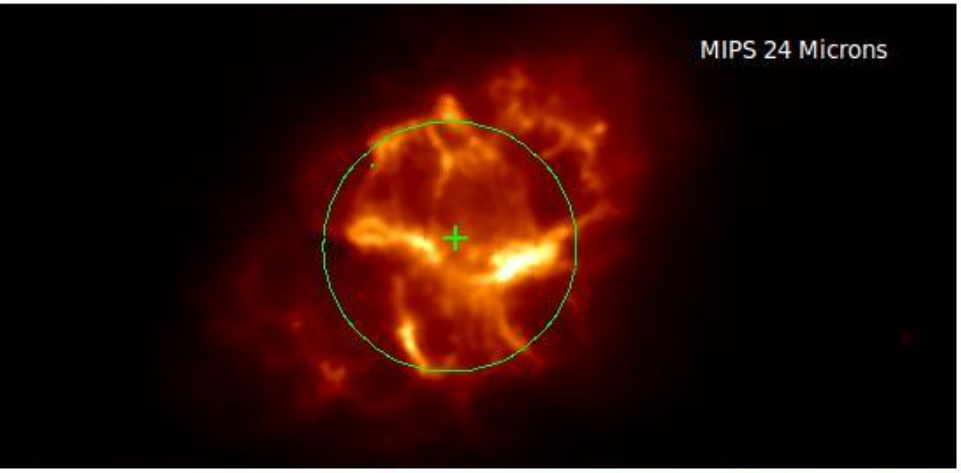
Crab Nebula a 3 GHz

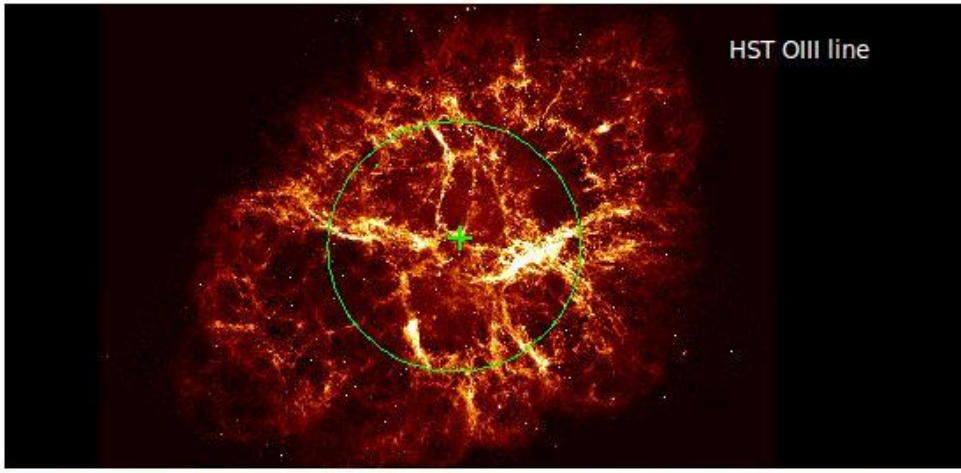


Dubner, Castelletti, Giacani, Kargaltsev, Pavlov, 2016,


JVLA 3 GHz


ALMA 100 GHz


MIPS 24 Microns


HST OIII line

Interacciones de RSN con nubes moleculares

- Astroquímica de ondas de choque
- Probable acción desencadenante del nacimiento de estrellas nuevas
- Origen de la radiación cósmica
- Naturaleza de fuentes de radiación gamma
- Propiedades del MIE frío

Cuántos casos probados hay de interacción física entre RSN y nubes moleculares (NM)?

Basado en una combinación de diferentes técnicas Chen et al. (2014) presentaron una lista:

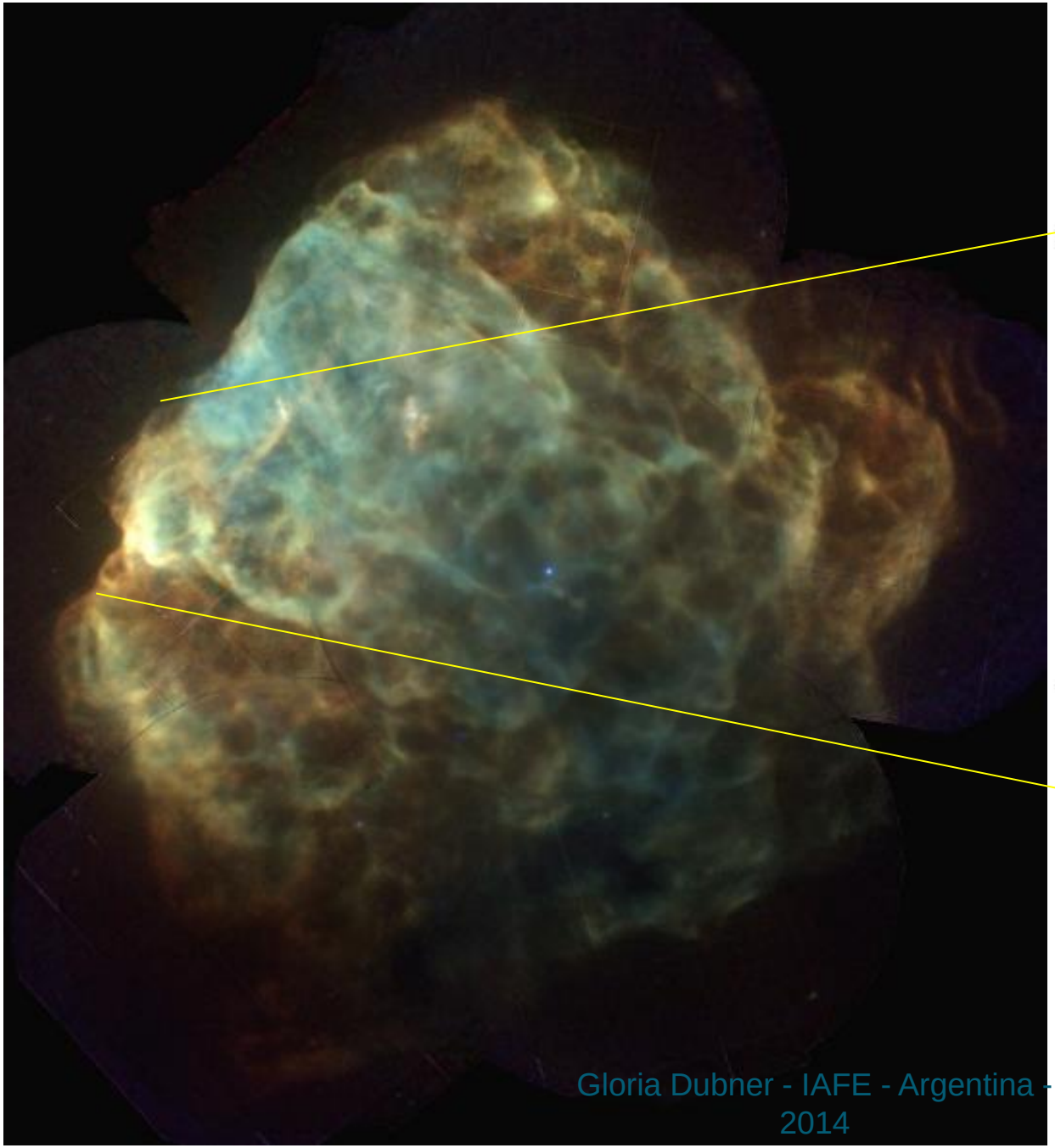
~ 70 RSN Galácticos donde se sugiere interacción con NM vecinas

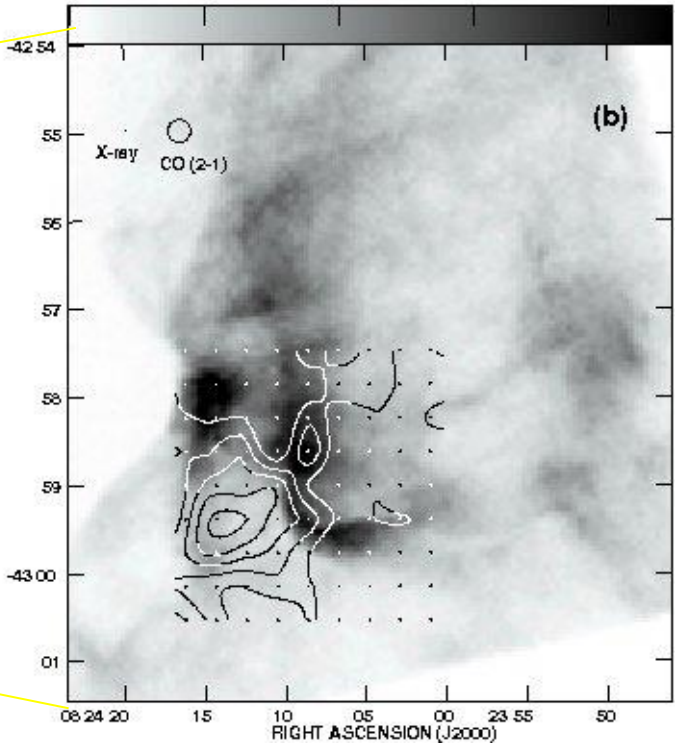
34 casos confirmados sobre la base de cumplir simultáneamente varios criterios

11 son probables

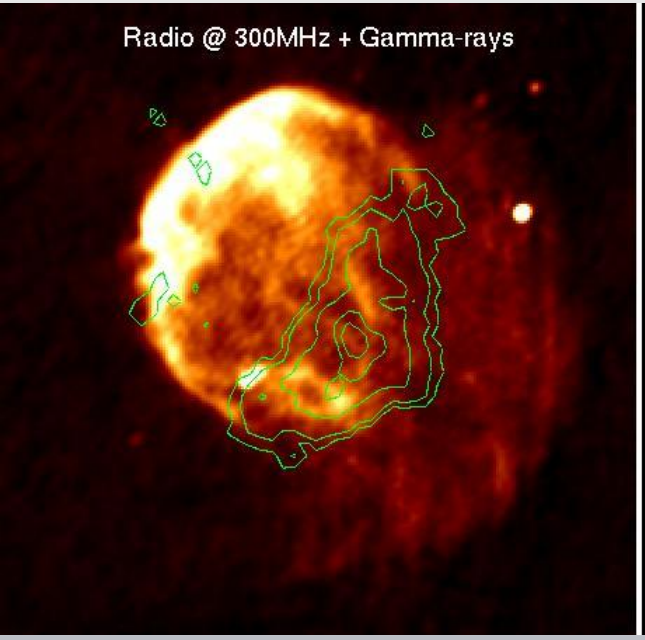
25 son posibles y requieren más estudios para confirmar.

Puppis A

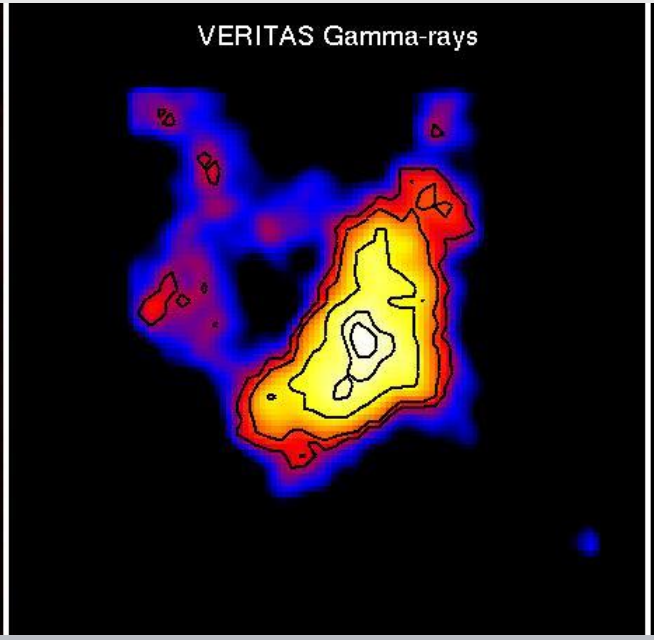




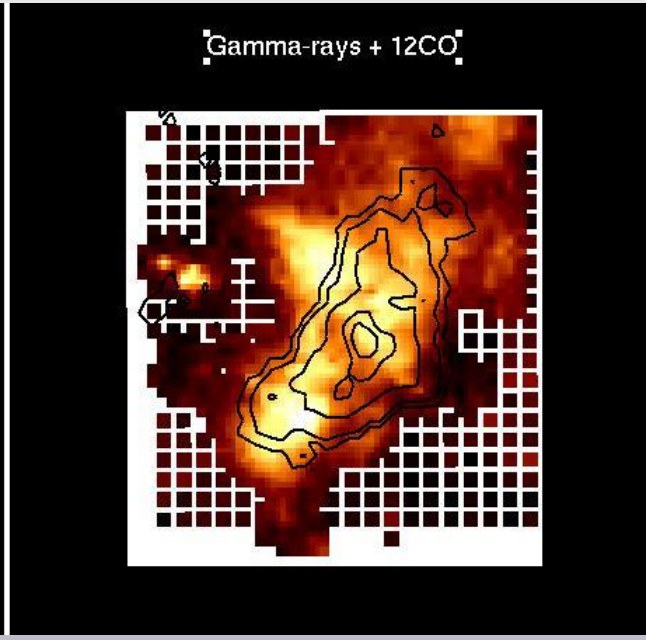
Paron et al. 2008, A&A480, 439



VLA radio at 330 MHz (Castelletti et al. 2011)

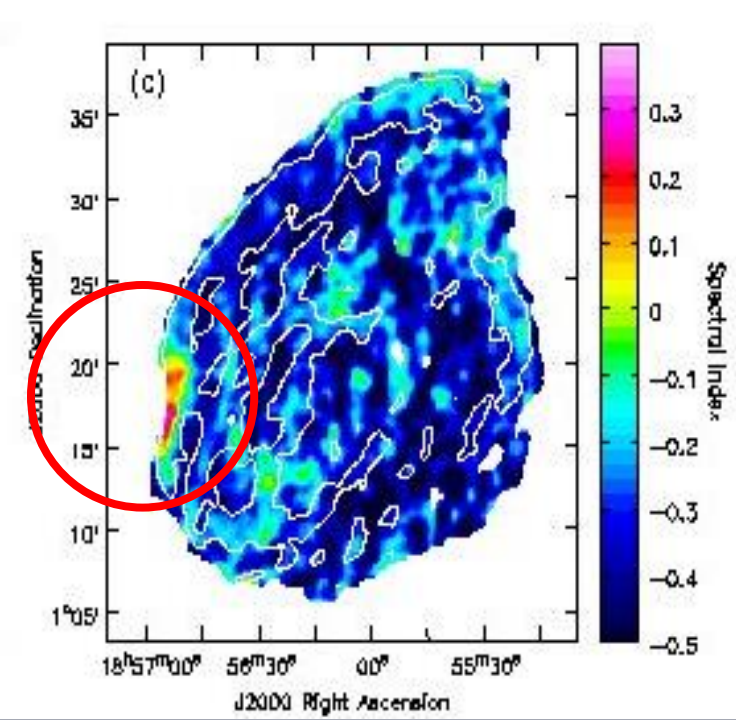


TeV VERITAS (Acciari et al. 2009) source VERJ0616.9+2230

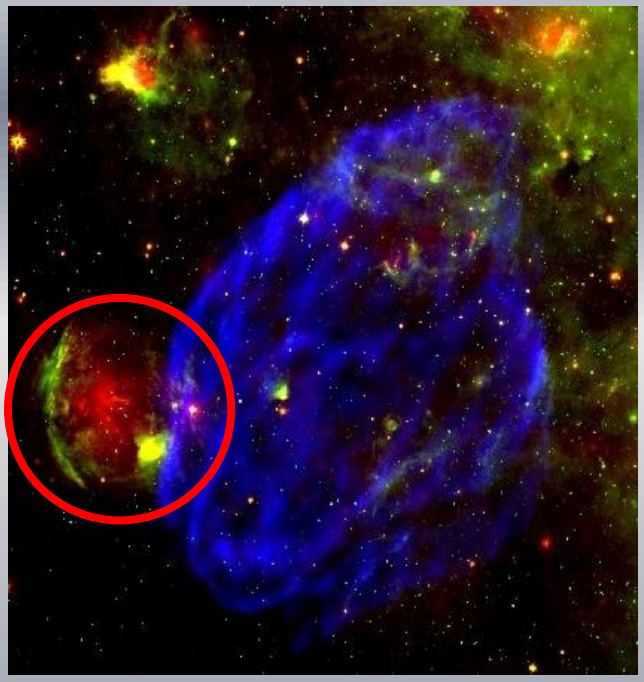


12 CO (Zhang et al. 2010)

Radio espectro del RSN W44



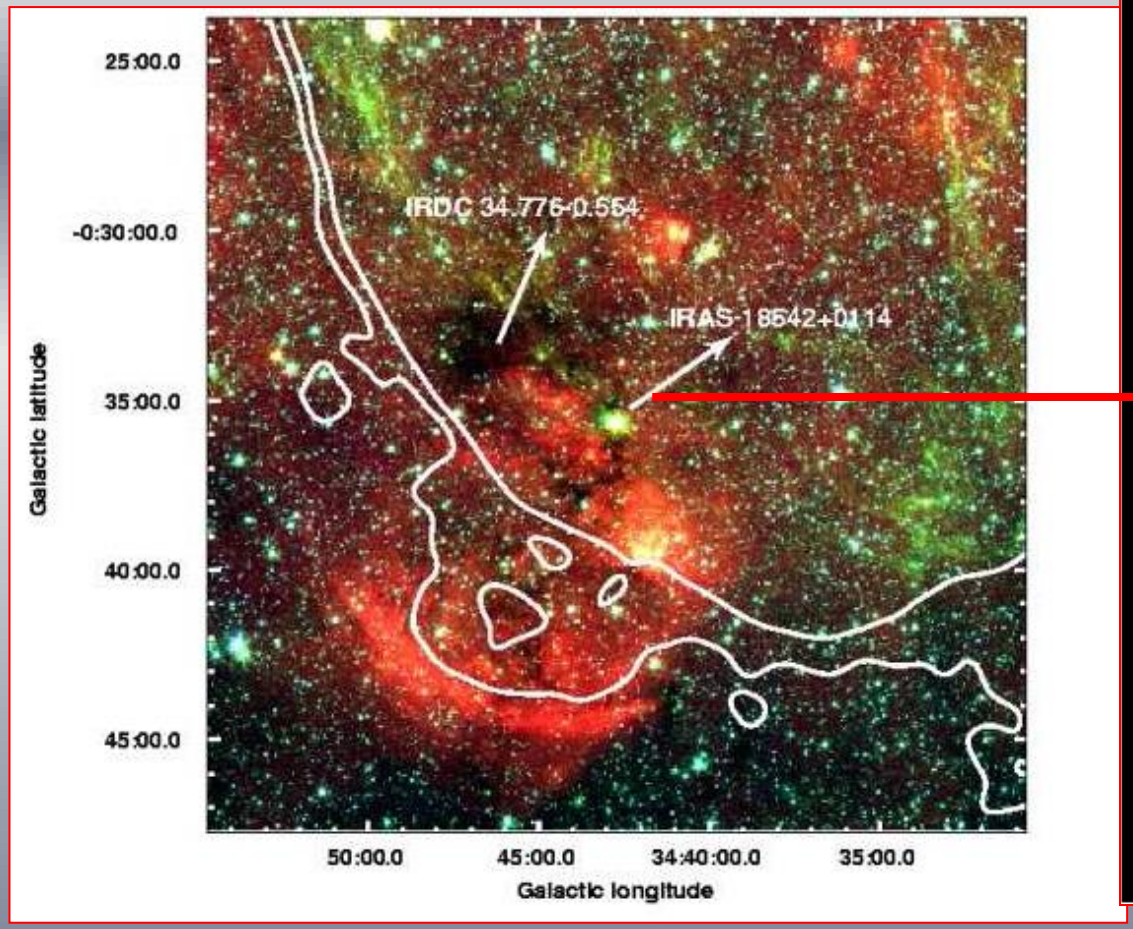
Emisión en radio e IR

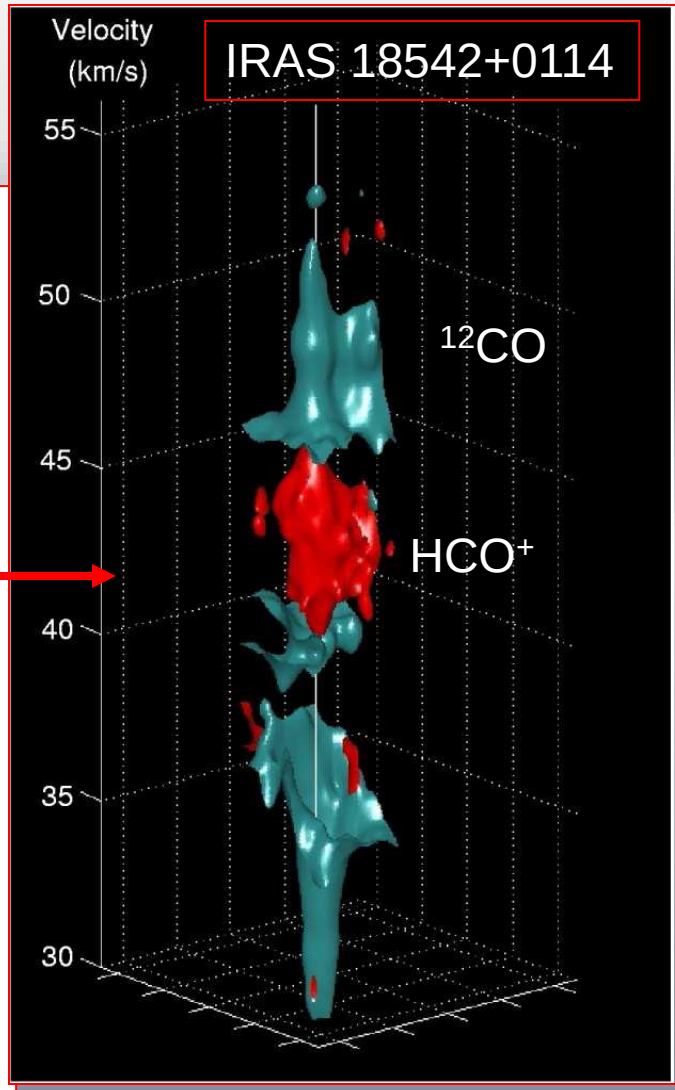


Castelletti et al. 2007, A&A 471, 537

Formación estelar en la periferia de W44

ASTE observations of ^{12}CO J = 3−2, ^{13}CO J = 3−2, HCO^+ J = 4−3 and CS J = 7−6 lines .
Paron et al. 2009, A&A 498, 445





Spitzer-IRAC : 3.5 μm = blue, 4.5 μm = green and 8 μm = red

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REVIEW ARTICLE

Radio emission from supernova remnants

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Abstract The explosion of a supernova releases almost instantaneously about 10^{51} ergs of mechanic energy, changing irreversibly the physical and chemical properties of large regions in the galaxies. The stellar ejecta, the nebula resulting from the powerful shock waves, and sometimes a compact stellar remnant, constitute a supernova remnant

Mi agradecimiento al IAR
que me dio las raíces para crecer