The discovery and evolution of SN 2008iz in M82

A. Brunthaler, I. Marti-Vidal, K. Menten, M. Reid,
C. Henkel, G. Bower, & H. Falcke
and
R. Beswick, T. Muxlow, D. Fenech …

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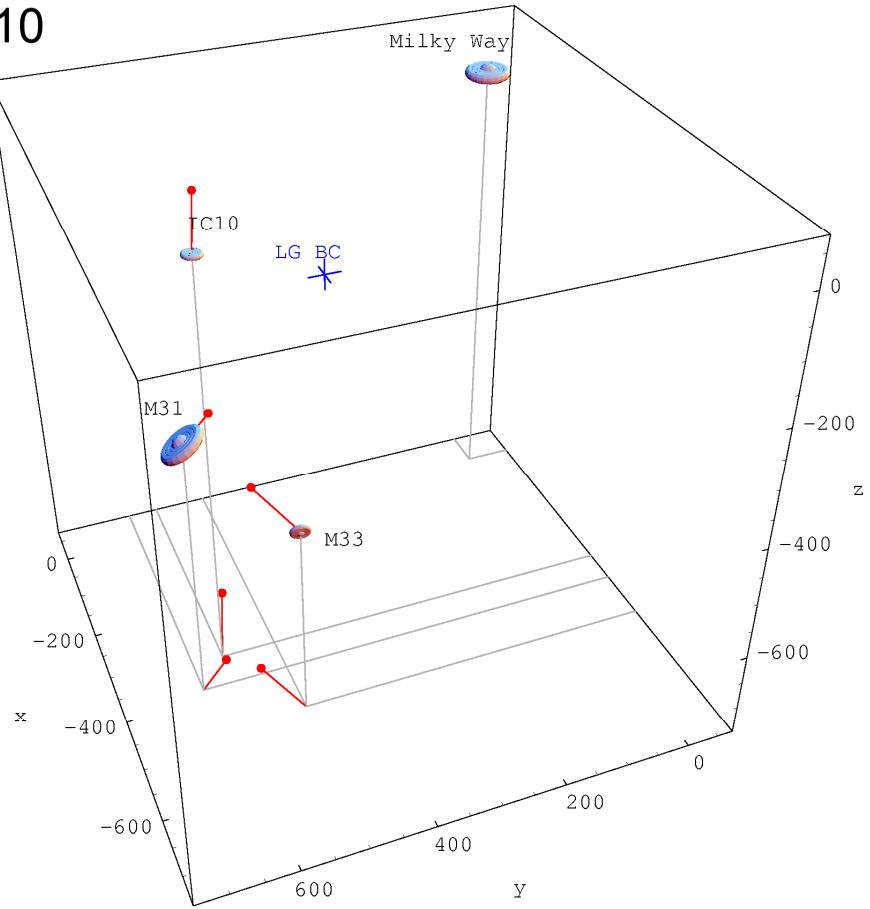
Proper Motions in the Local Group

- VLBI astrometry can reach microarcsecond accuracies
- allows proper motion measurements of external galaxies
- First targets: Water masers in M33 and IC10



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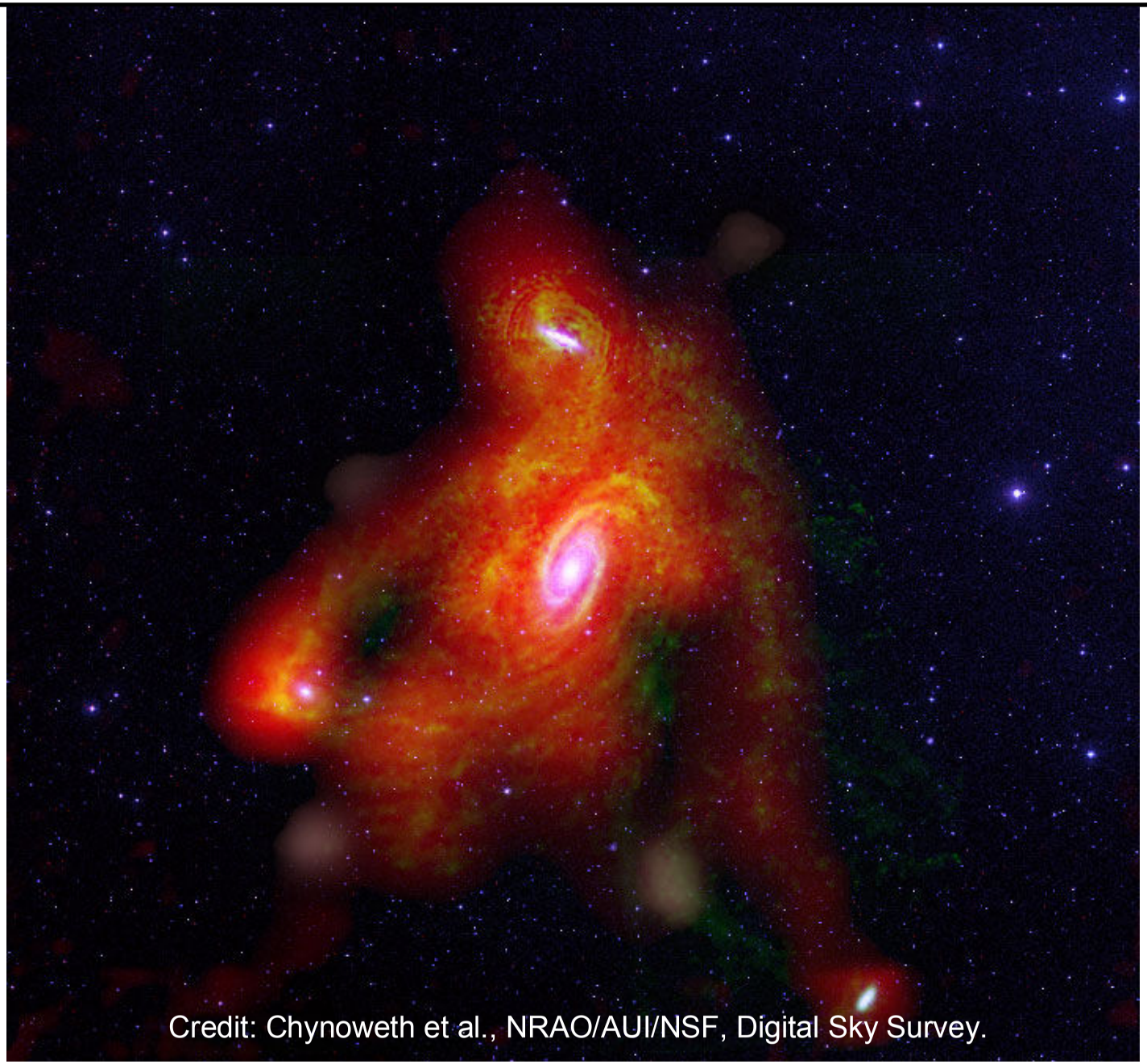
M81 Group of Galaxies



Credit: Chynoweth et al., NRAO/AUI/NSF, Digital Sky Survey.

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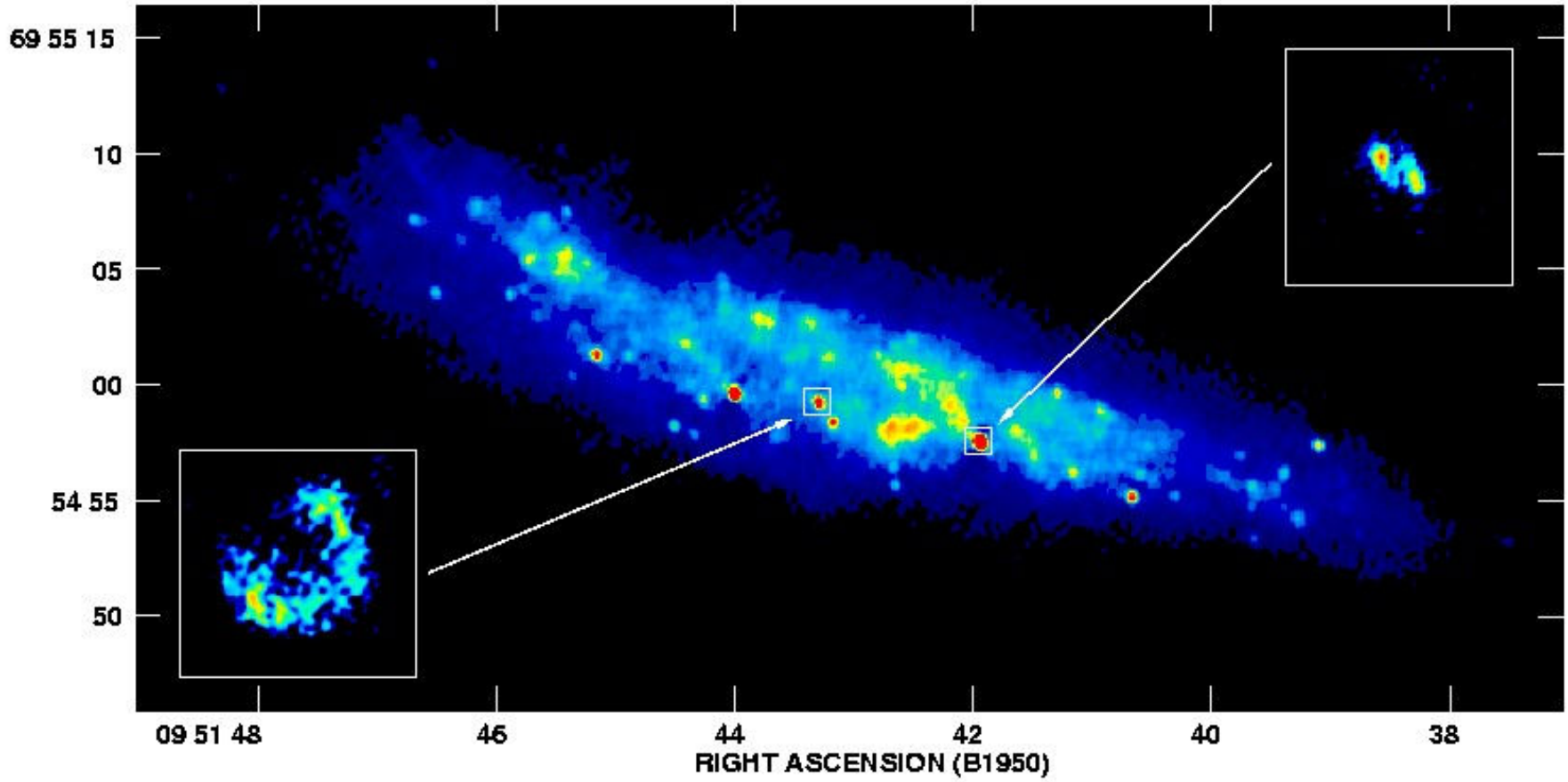
M82



MERLIN and VLA composite at 5 GHz (Muxlow et al.)

- extensively studied over last decades in the radio (Kronberg et al. 1985, 2000; Muxlow et al. 1994; Beswick et al. 2006, Fenech et al. 2008)

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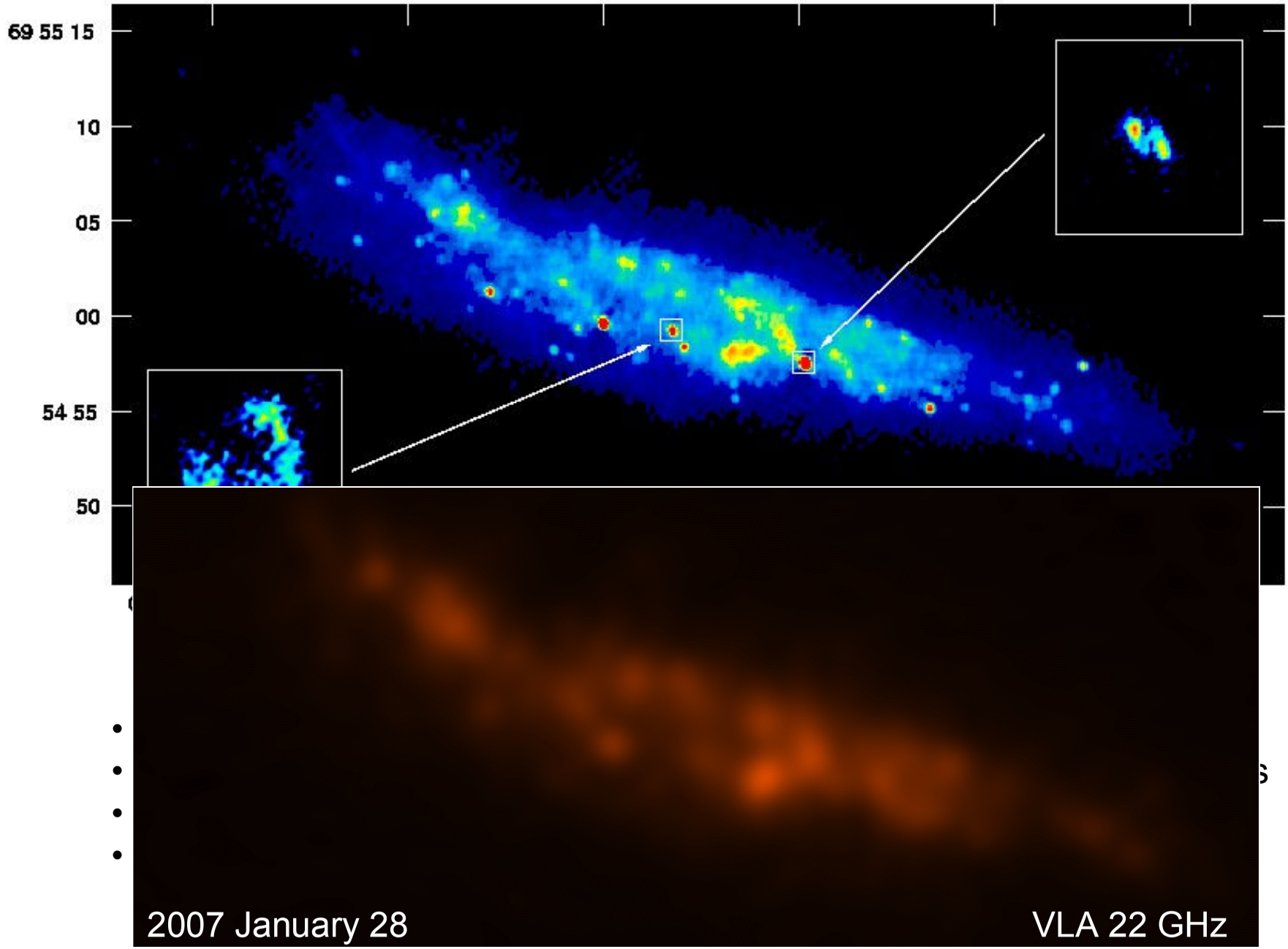

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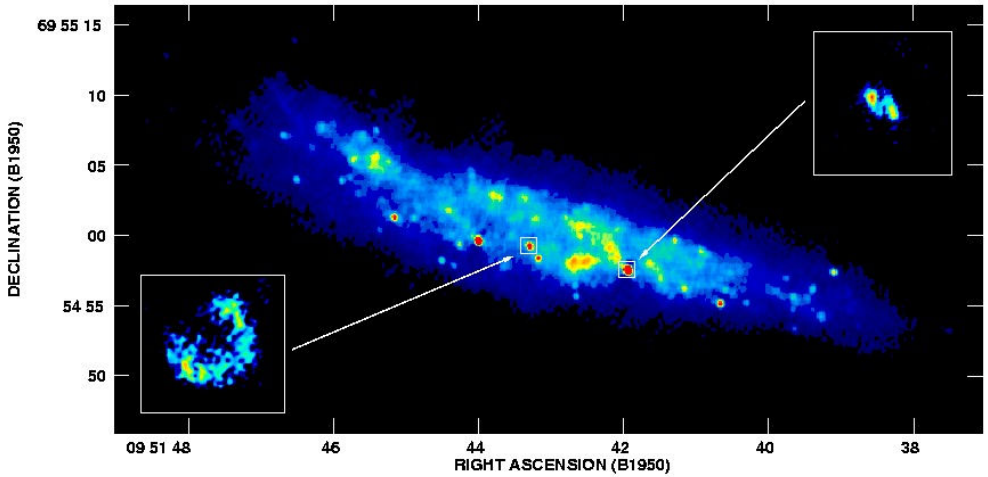
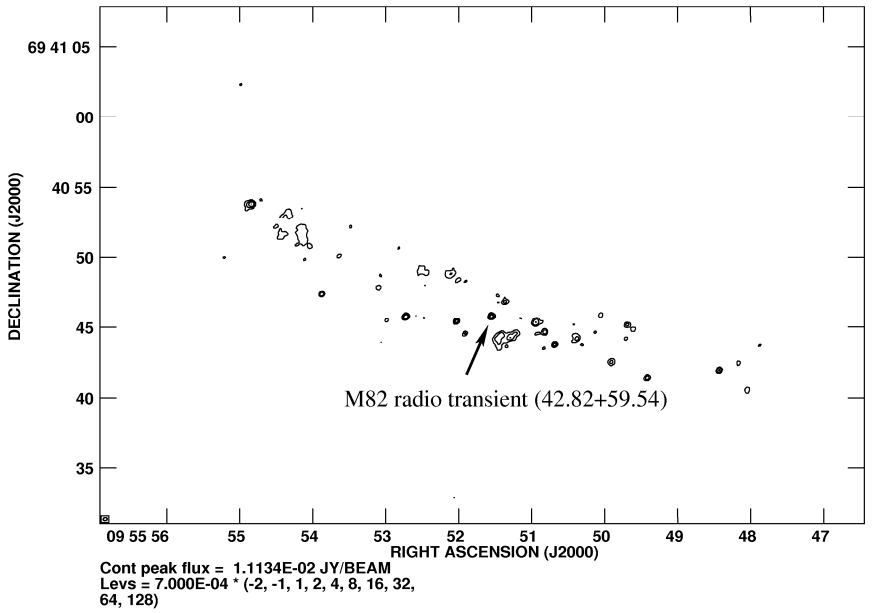


Third epoch: 2009 April 08

New source: ~ 10 mJy



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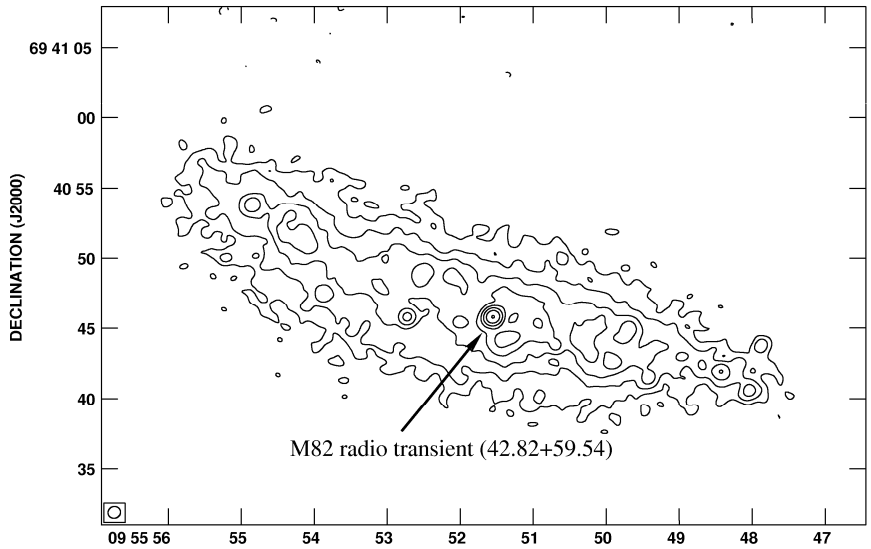
Second epoch: 2008 May 24

New source: ~ 90 mJy



Third epoch: 2009 April 08

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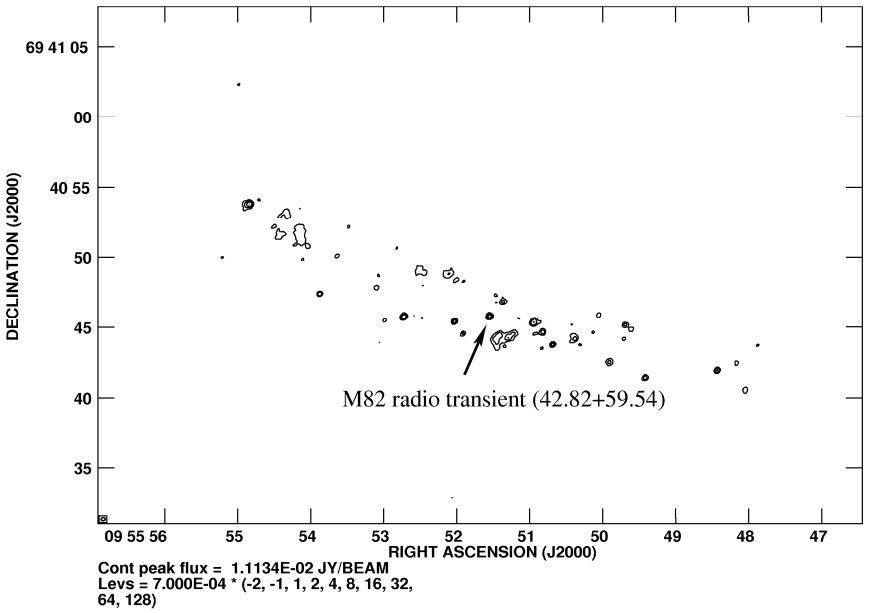

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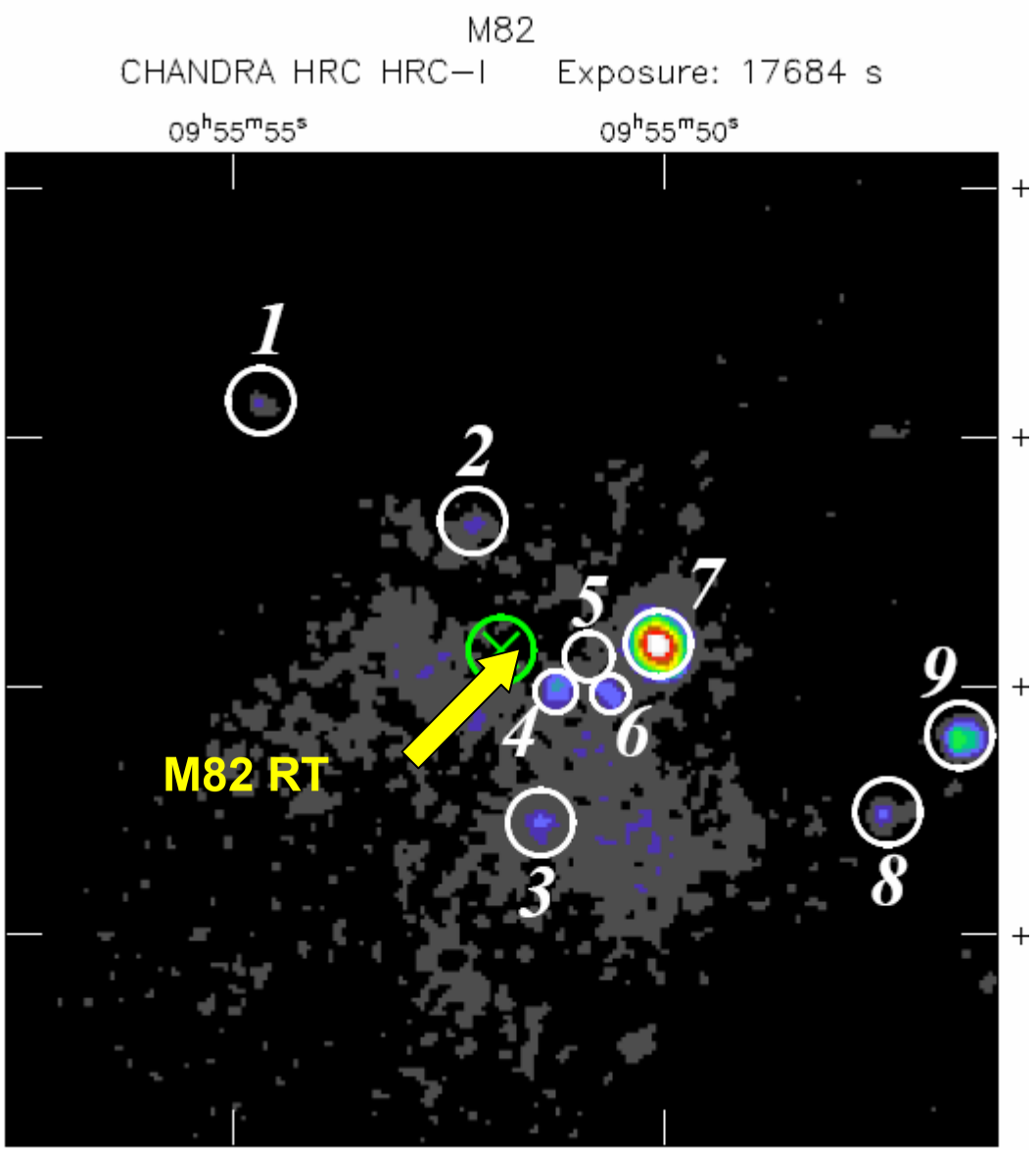
Transient in M82

- No previously known X-ray source (Matsumoto et al. 2001)



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- No previously known radio source at cm wavelengths (> 17 μJy)
  (e.g. Körding et al. 2005, Fenech et al. 2008)

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- Archival VLA Data:

  - bright source on 2008 March 24 (22 GHz) (~100 mJy)
  - nothing on 2007 October 29 (4.8 GHz)

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VLBI on Transient in M82

- RT in 2“ FoV of VLBI obs.

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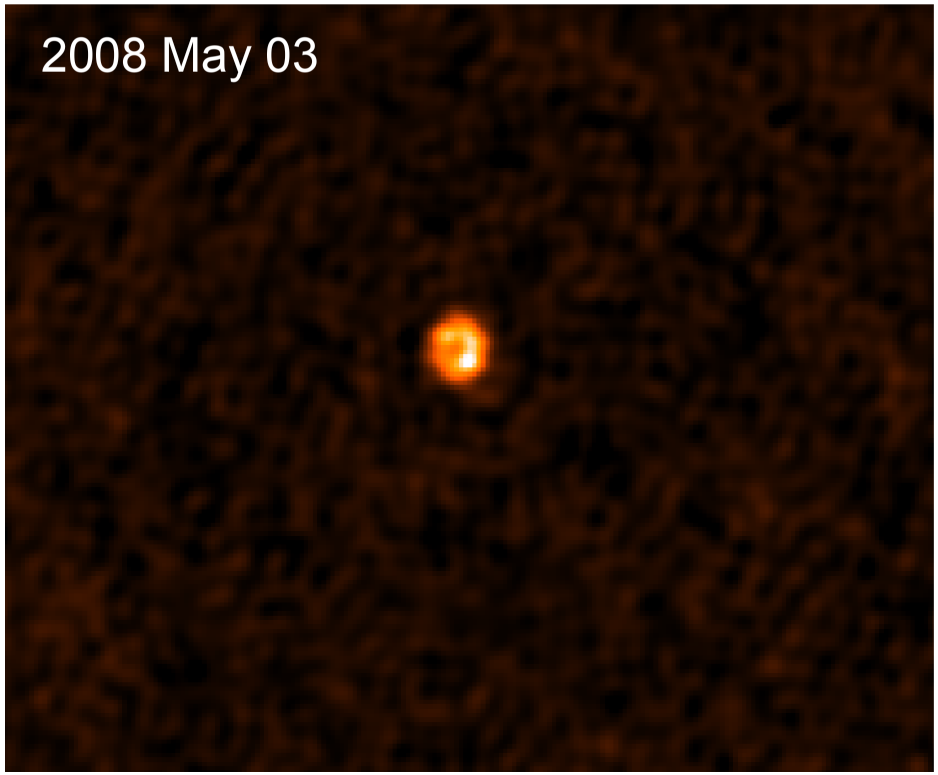
VLBI on Transient in M82

- RT in 2“ FoV of VLBI obs.
- radius = 0.32 mas

=> clearly a Supernova!



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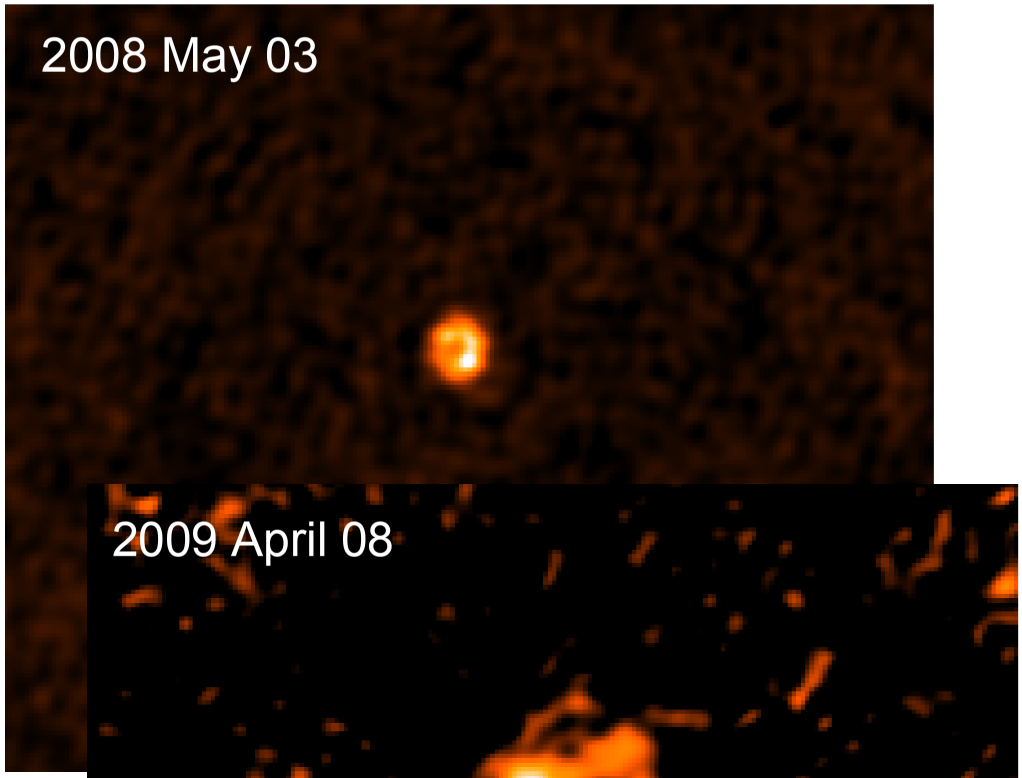

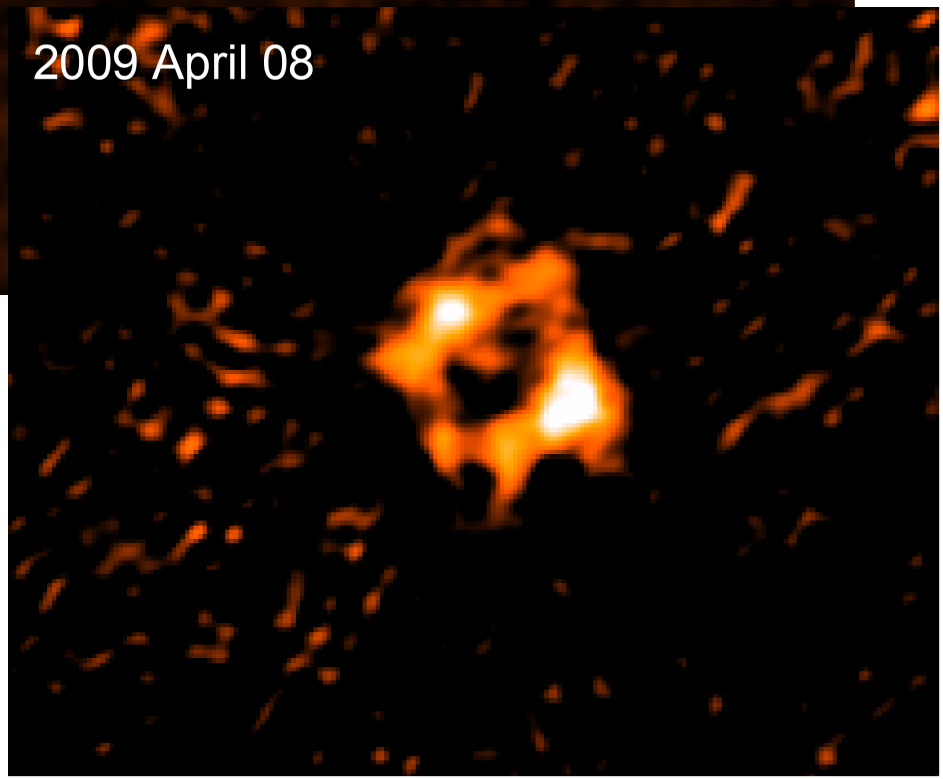

- radius = 1.58 mas
- Expansion rate ~ 23,000 km/s
- Explosion date: 2008 Feb. 25

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SN 2008iz

Electronic Telegram No. 1803

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SUPERNOVA 2008iz IN M82

A. Brunthaler, K. M. Menten, and C. Henkel, Max-Planck-Institut fuer Radioastronomie; M. J. Reid, Harvard-Smithsonian Center for Astrophysics; G. C. Bower, University of California, Berkeley; and H. Falcke, University of Nijmegen and ASTRON, report the discovery of a radio supernova in M82. The position of 2008iz is R.A. = 9h55m51s.55, Decl. = +69o40'45".8 (equinox 2000.0), which is 2".0 west and 1".3 south of the radio kinematic center (Weliachew et al. 1984, A.Ap. 137, 335). SN 2008iz was first discovered as a bright radio transient of unknown origin (cf. http://www.astronomerstelegram.org/?read=2020; also, Brunthaler et al. 2009, A.Ap., in press, with a pre-publication version posted at http://lanl.arxiv.org/abs/0904.2388). VLBI images taken with the NRAO Very Long Baseline Array, the phased Very Large Array, the Green Bank Telescope, and the Effelsberg 100-m telescope on 2008 May 3 and 2009 Apr. 8 at 22 GHz show (at sub-milliarcsecond resolution) a ring-like structure with an expansion velocity of roughly 11000 km/s (for an assumed distance of 3.6 Mpc). This confirms the supernova nature of this source. The measured expansion rate indicates an explosion date in late January 2008. Very Large Array observations on 2009 Apr. 27 at 1.4, 4.8, 8.4, 22, and 43 GHz indicate an optically thin syncrotron sprectrum with a spectral index of -0.8 (typical for type-II supernovae).

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SN 2008iz

- Closest radio supernova since 1993J!

- No detection in X-ray and UV data from May 2008 (Swift)

- No X-rays with Chandra on 2008 October 4, and 2009 April 17 and 29.

- Nothing in NIR from April 2009 (PARITEL) and June 2009 (Fraser et al. ATel 2131)

- No detection in the optical (SN 1993J in M81 had magnitude of ~10)

- The supernova is highly obscured by gas and dust in the ISM!

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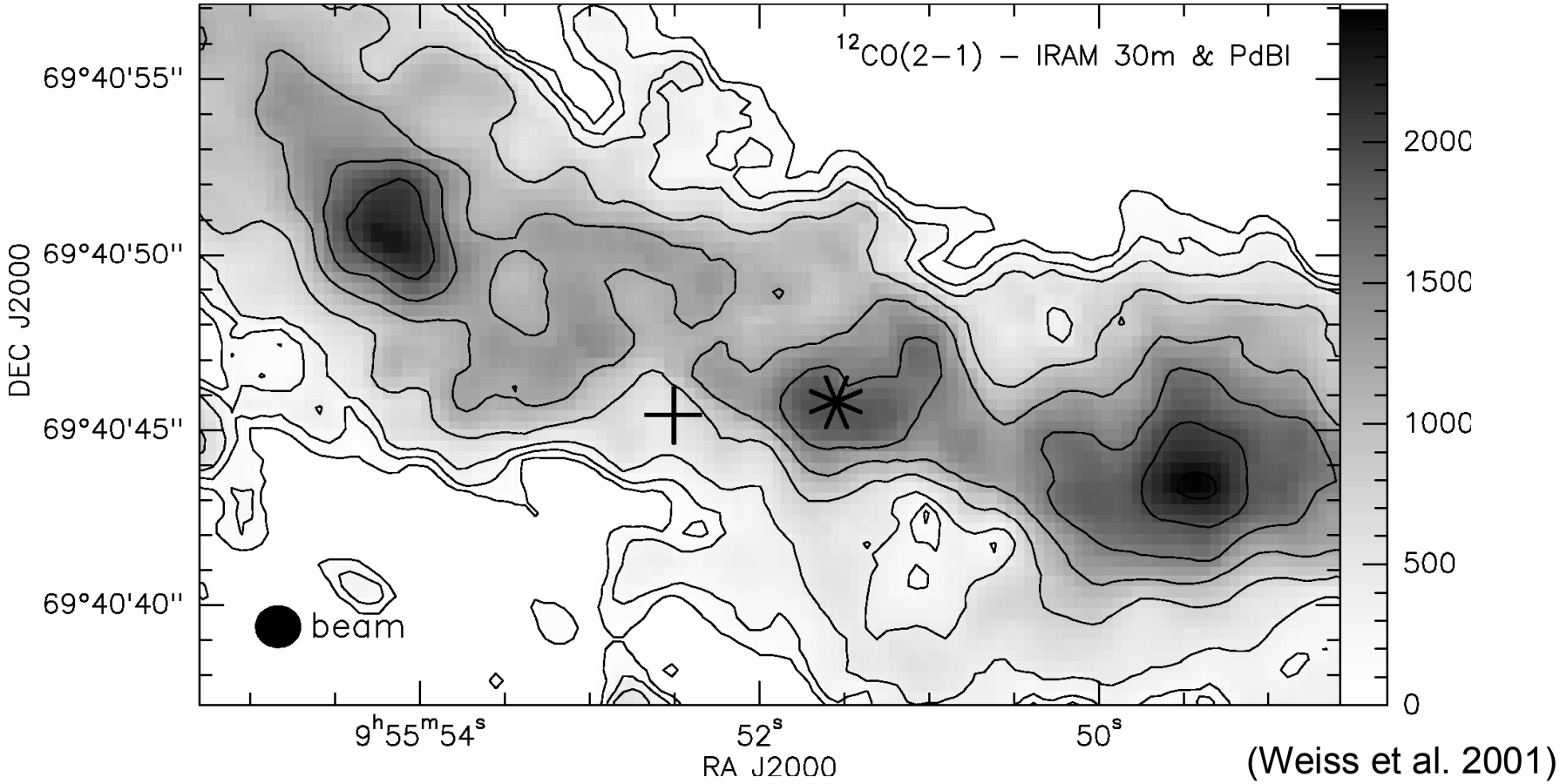
SN 2008iz



(Weiss et al. 2001)

- H_2 column density of ~ 5.4 $\times 10^{22}$ cm^{-2}
- visual extinction: A_V, of 24.4 mag

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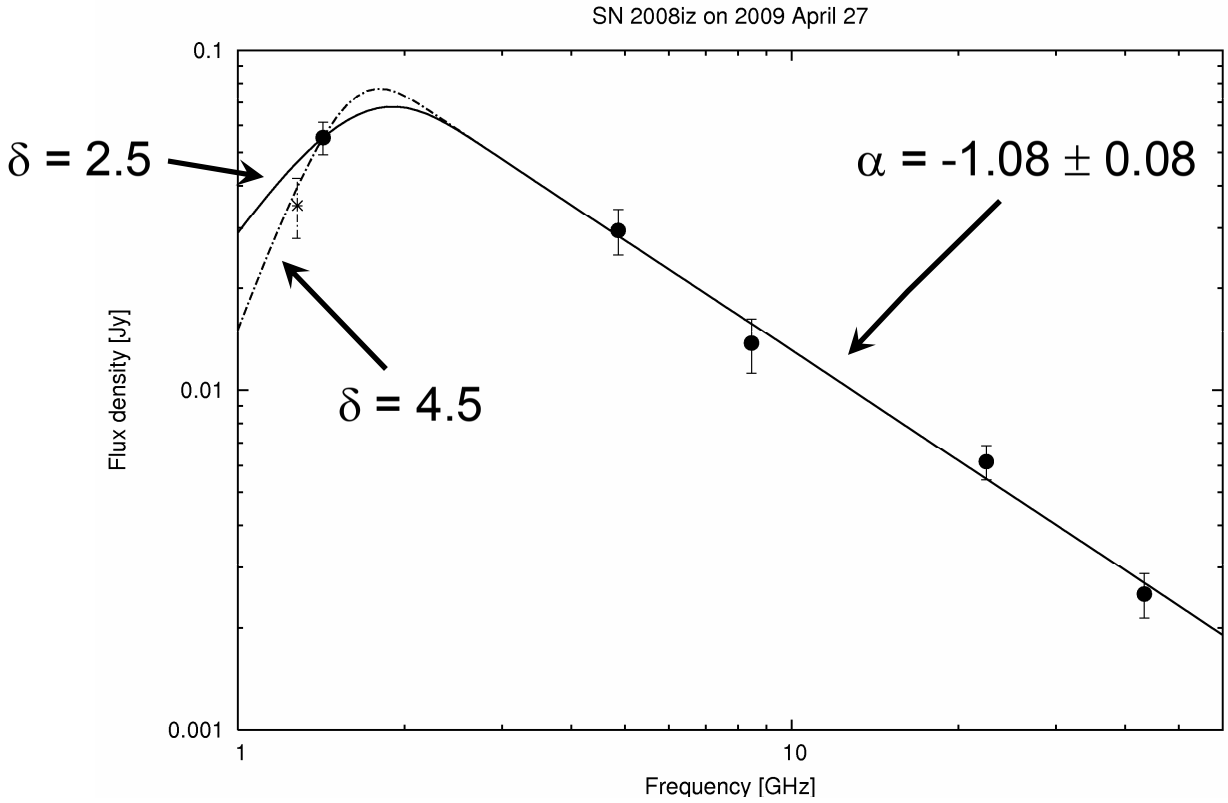
Radio Spectrum of SN 2008iz

- VLA (and GMRT) spectrum on 2009 April 27: broken power law
- turnover frequency: 1.51 ± 0.09 GHz
- typical for type II SN



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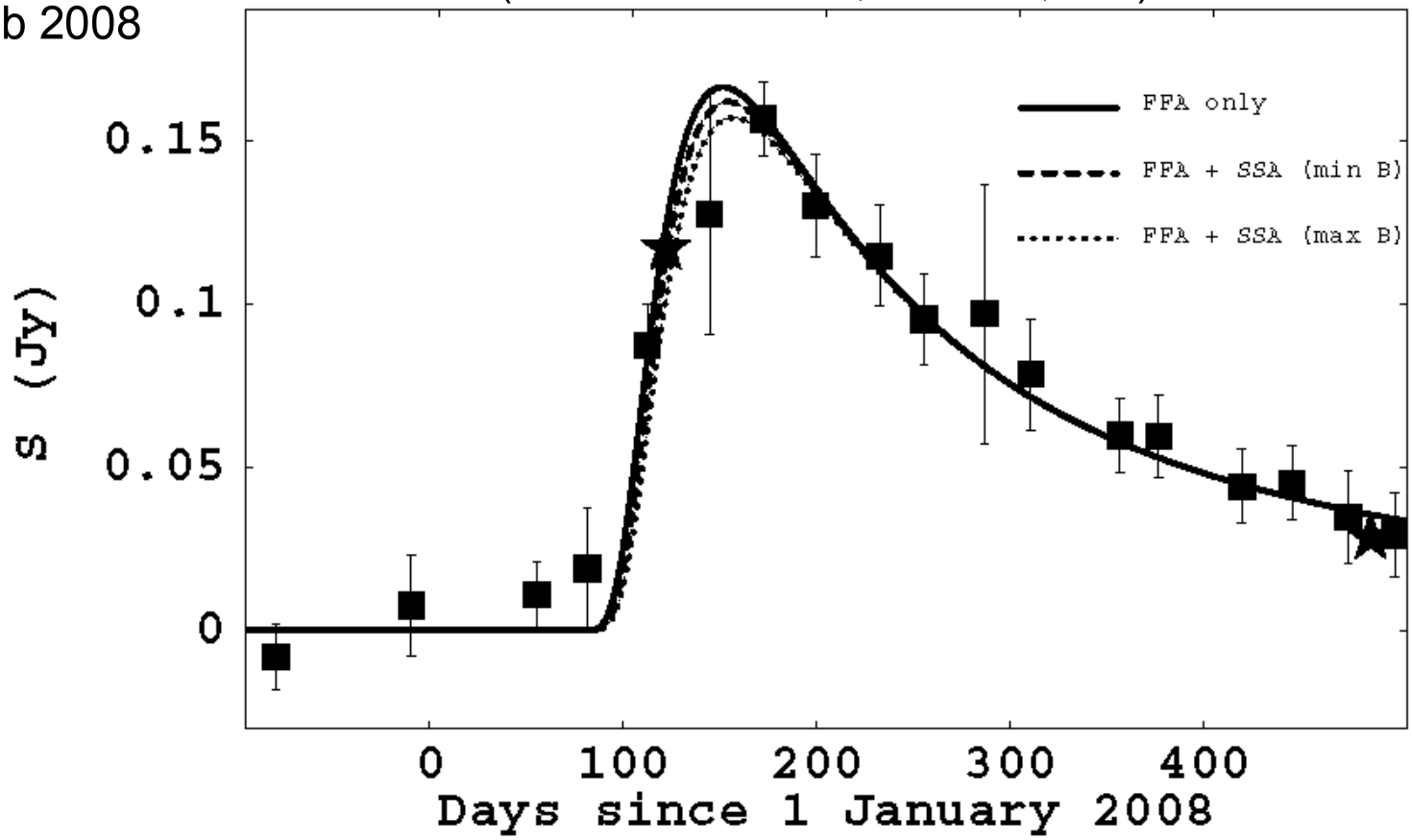
Light curve of SN 2008iz

- Flux monitoring of IDV sources with Urumqi telesope (5 GHz)
- M82 was used as calibrator

- Lightcurve at 5 GHz recovered!

- $m = 0.89 \pm 0.03$
- t_0 = 18 Feb 2008

(Marchili et al. 2010, A&A 509, A47)



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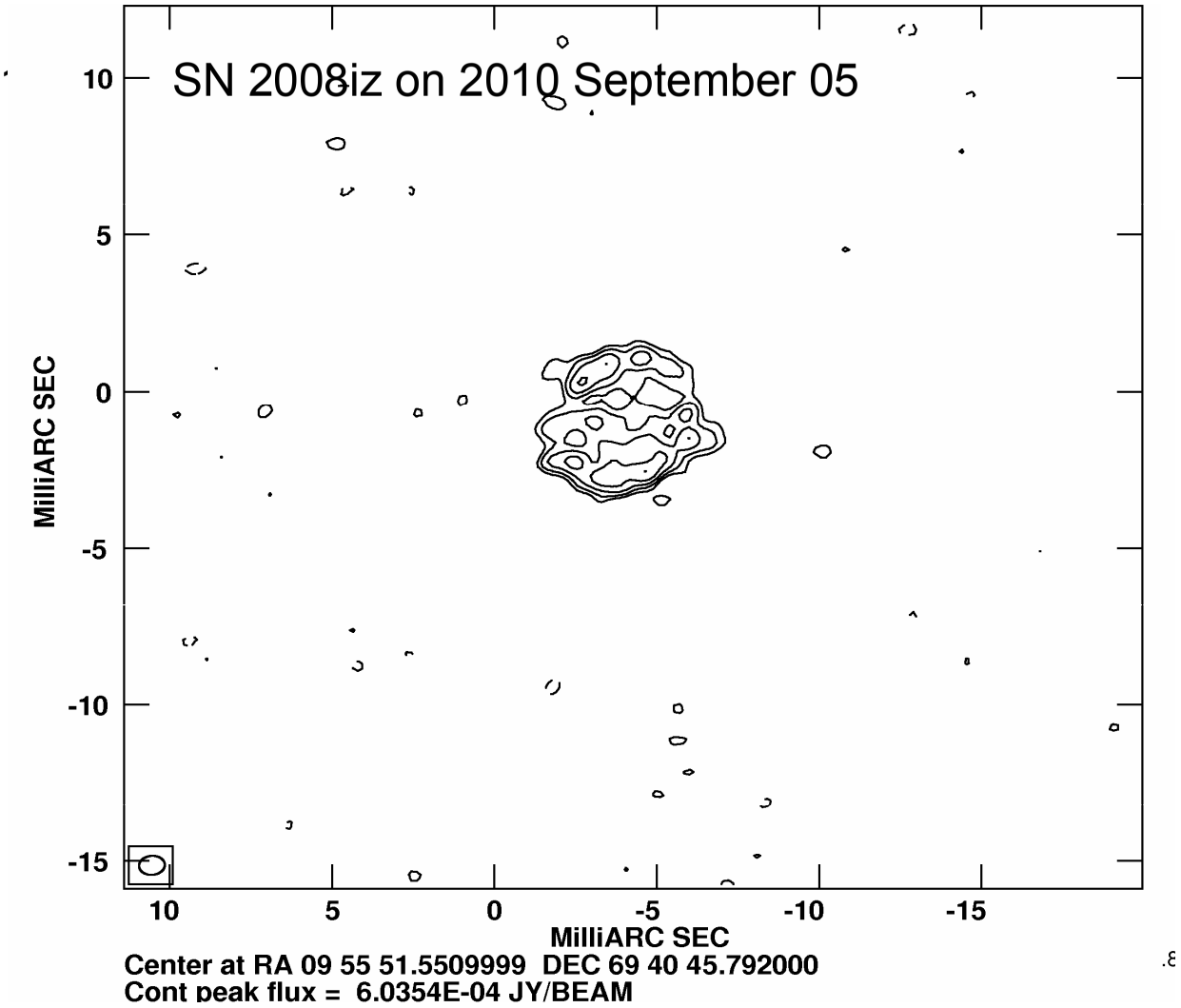
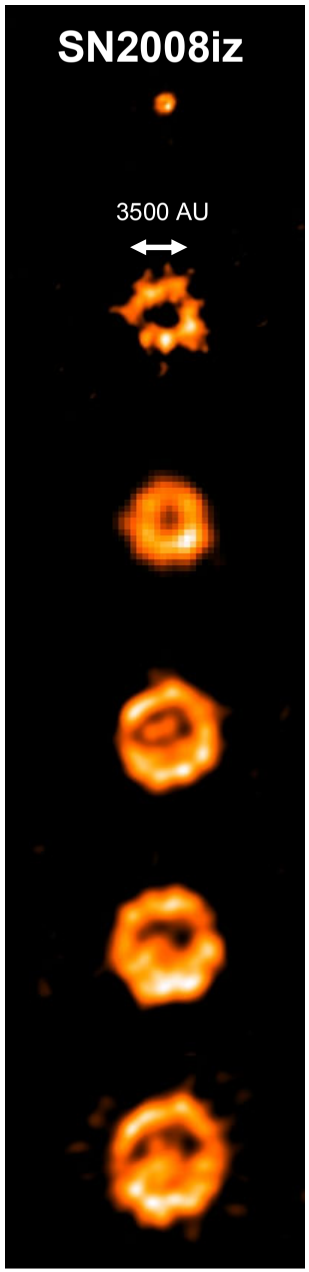
SN 2008iz

- also eVLBI data from April and May 2009 at 1.6 GHz (unresolved)
- started bi-monthly VLBA+Ef monitoring at 18, 6 and 4 cm
-





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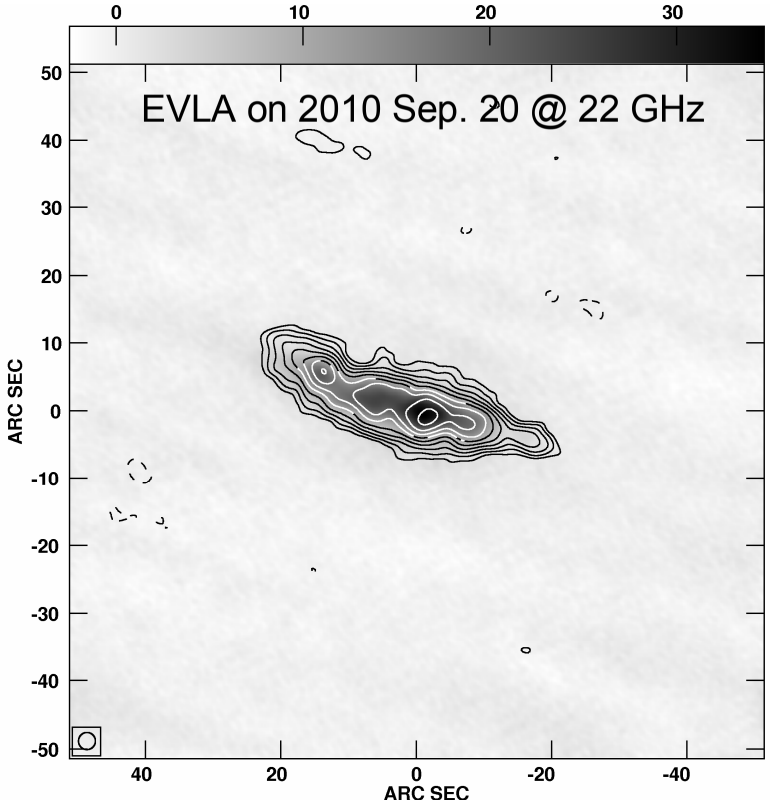
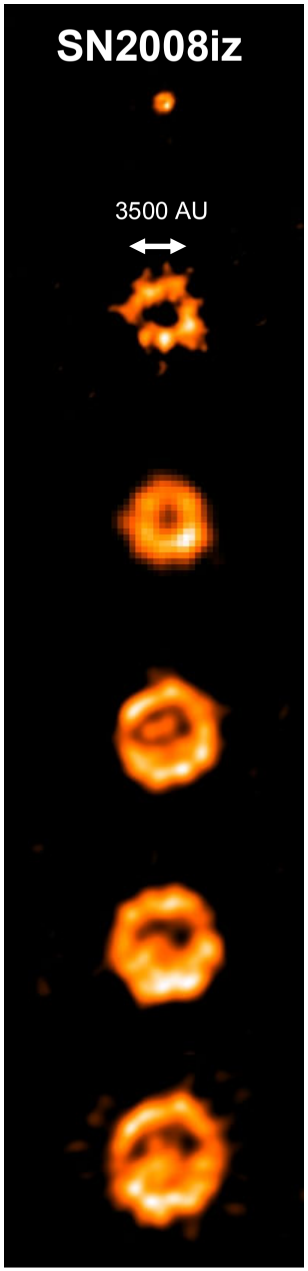
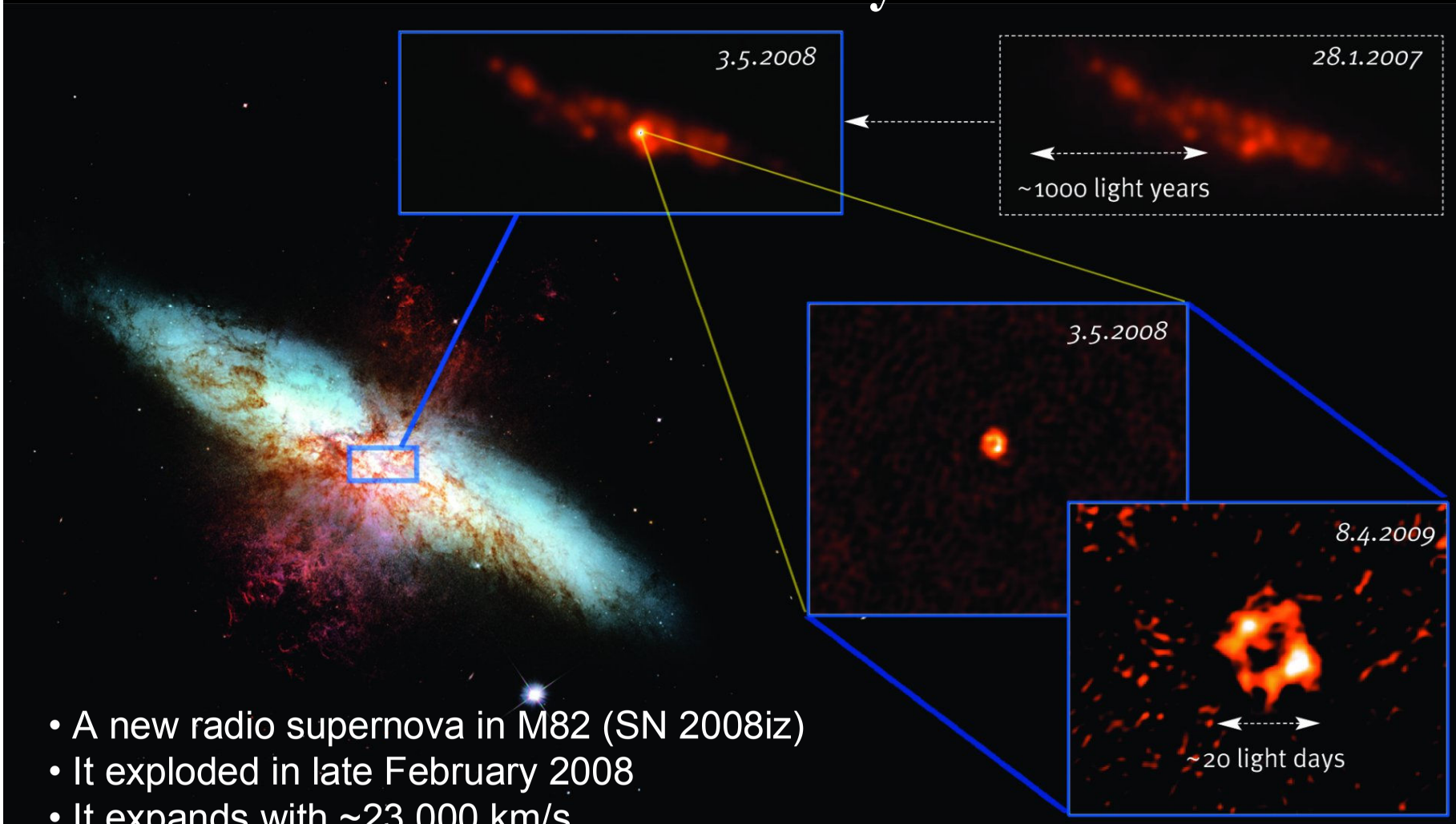
SN 2008iz

- also eVLBI data from April and May 2009 at 1.6 GHz (unresolved)
- started bi-monthly VLBA+Ef monitoring at 18, 6 and 4 cm
- 1.7 GHz lightcurve from VLBA monitoring
- also (E)VLA monitoring (1.4 – 43 GHz)





Summary



- A new radio supernova in M82 (SN 2008iz)
- It exploded in late February 2008
- It expands with ~23,000 km/s
- spectral index α = -1.08, probably type II
- Radio lightcurve recovered from Urumqi monitoring
- So far, no detection at other wavebands
- more to come….

An accurate distance to the Cygnus X star-forming region

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Questions? Email: kazi@mpifr-bonn.mpg.de

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Introduction

The Cygnus X star formation region is one of the closest giant molecular cloud complexes and is therefore an extensively studied region of high mass star formation. However, the distance to this region has been a long-standing issue, since it is unclear if all the star-forming clouds are at the same distance (Schneider et al. 2006) or whether a projection of clouds at different distances (Uyaniker et al. 2001).

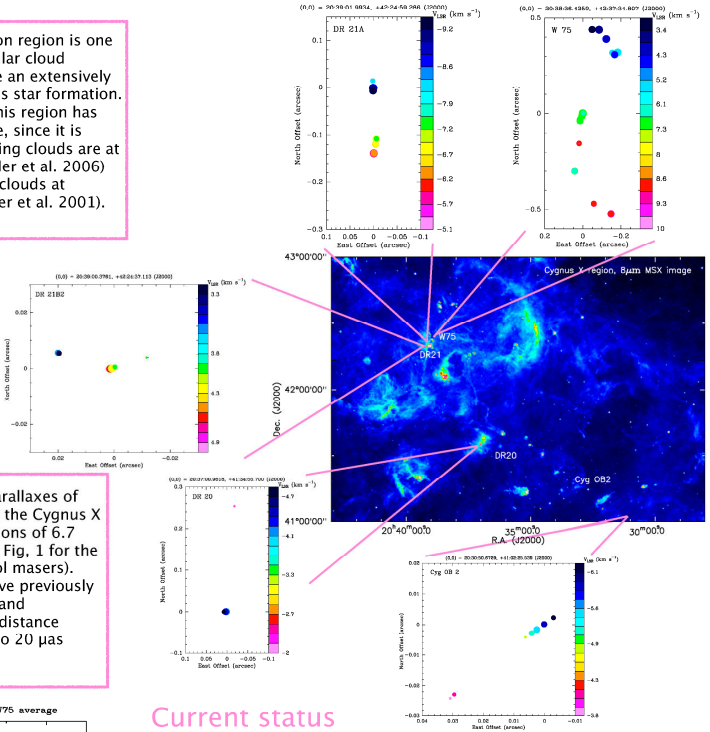

Fig. 1.: An 8 μm Midcourse Space eXperiment (MSX) map of the Cygnus X region. We show the 6.7 GHz methanol maser maps of the five star-forming clouds from the first epoch of our EVN observations.

Our goal

We want to measure the parallaxes of five star-forming clouds in the Cygnus X region using EVN observations of 6.7 GHz methanol masers (see Fig. 1 for the observed 6.7 GHz methanol masers). Using this transition we have previously measured proper motions and parallaxes up to a 2.5 kpc distance reaching accuracies of up to 20 μas (Rygl et al. 2010).

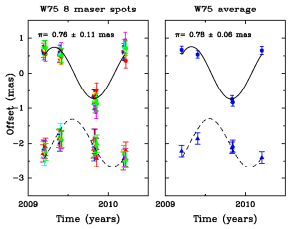

Fig. 2: Parallax fit of 5 epochs using 8 maser spots in W75. The solid line gives the fit in R.A. and the dashed line the fit in Declination. The left panel shows the fit on 8 maser spots and the right panel the fit to the average of the spots per epoch.

Current status

September 2010, five epochs have been observed and reduced. Some epochs include the Yamaguchi and Misuzama antennas in Japan and the Shanghai antenna in China.

We measure a **preliminary distance toward W75 of 1.28±0.10 kpc, reaching an accuracy of 60 μas** (see Fig. 2). This is nearer than the commenly assumed photometric distance to the Cygnus X region of 1.7 kpc (Humphreys 1978, Schneider et al. 2006). More accurate calibration, addition of other background sources and of course more observed epochs will improve this measurement. The distance analysis of the other star-forming clouds is on the way, and will answer the question if the Cygnus X complex is truly one physically connected region.

References:
Humphreys, R.M. 1978, ApJS, 38, 309
Rygl, K.L.J., Brunthaler A., et al. 2010, A&A, 511, A2
Schneider, N., Bontemps, S., et al. 2006, A&A, 458, 855
Uyaniker B., Fürst, E., et al. 2001, A&A, 371, 675

Acknowledgements:
This research made use of data products from the Midcourse Space Experiment and the NASA/ IPAC Infrared Science Archive. The maser plots were created using the scripts of Dr. L. Moscadelli.