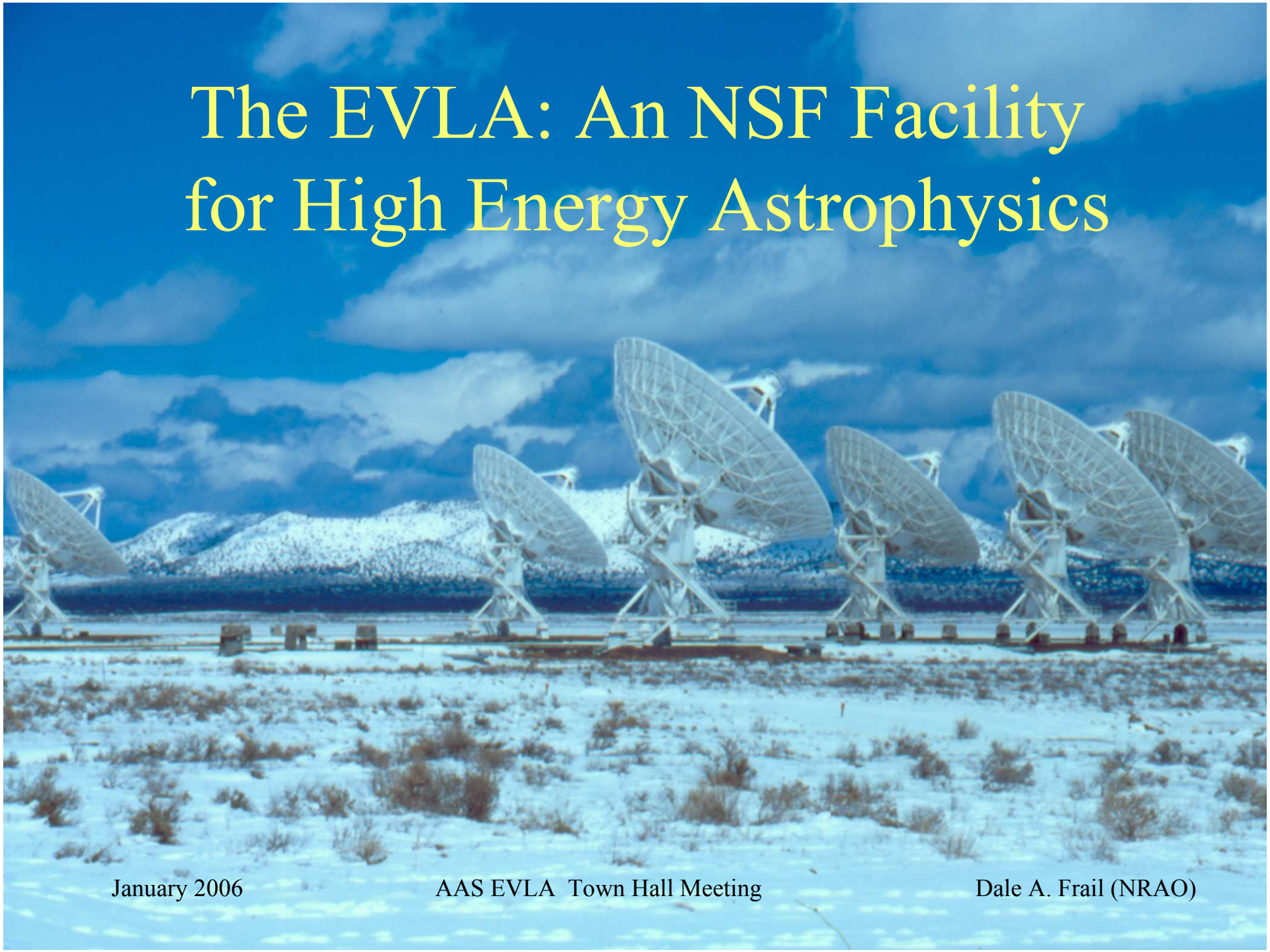
The EVLA: An NSF Facility for High Energy Astrophysics

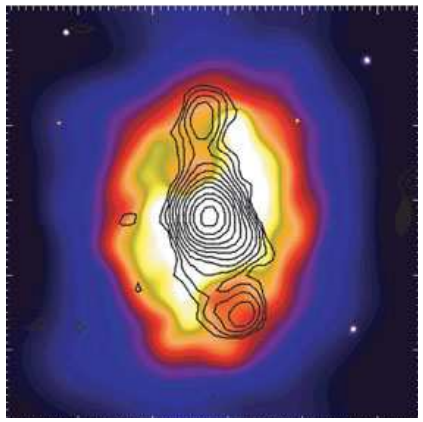


January 2006 AAS EVLA Town Hall Meeting Dale A. Frail (NRAO)

EVLA Design Driven By Four Themes

Magnetic Universe

Measure the strength and topology of the cosmic magnetic field.



Obscured Universe

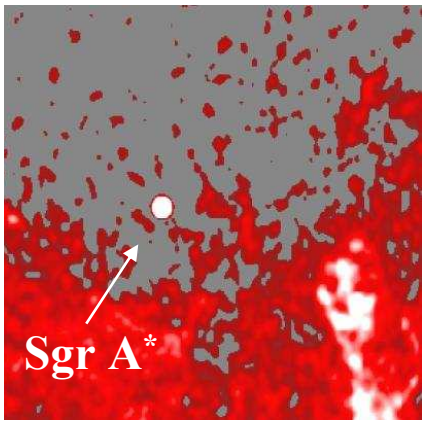
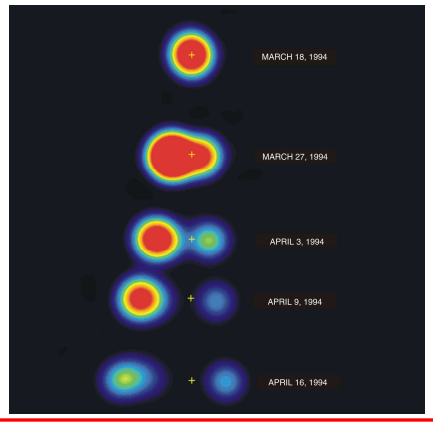


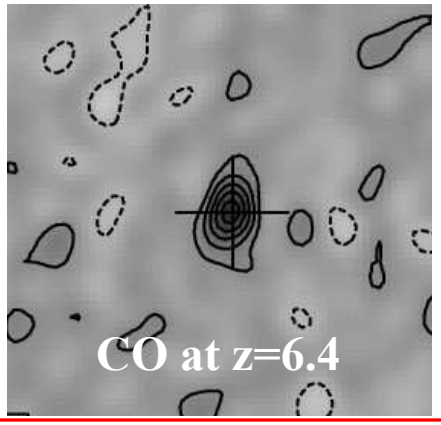
Image young stars and massive black holes in dust enshrouded environments.

Transient Universe

Follow the rapid evolution of energetic phenomena.



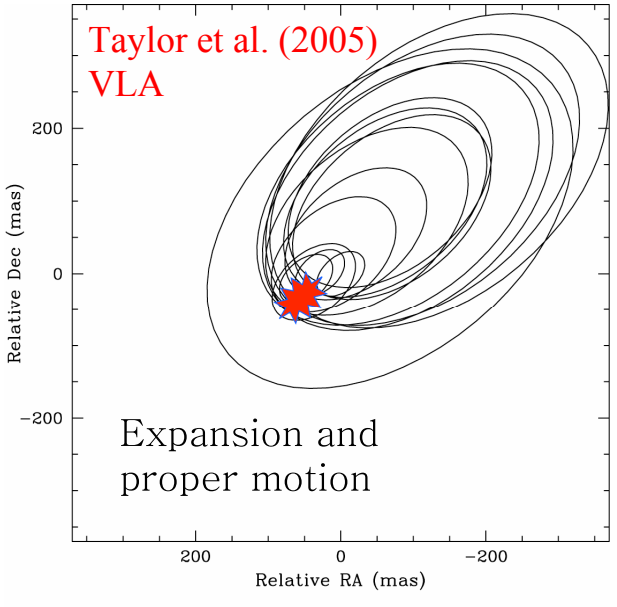
Evolving Universe

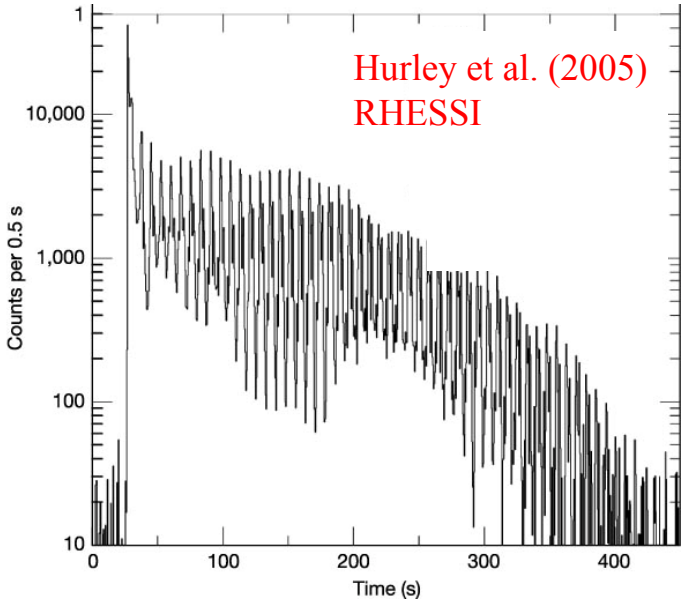


Study the formation and evolution of stars, galaxies and AGN.

Radio **is** High Energy Astrophysics

- Physics at the extremes
  - AGN, GRBs, SNe, clusters, PWN, SNRs, PSRs, SGRs, XRBs
- Radio synchrotron = HE electrons

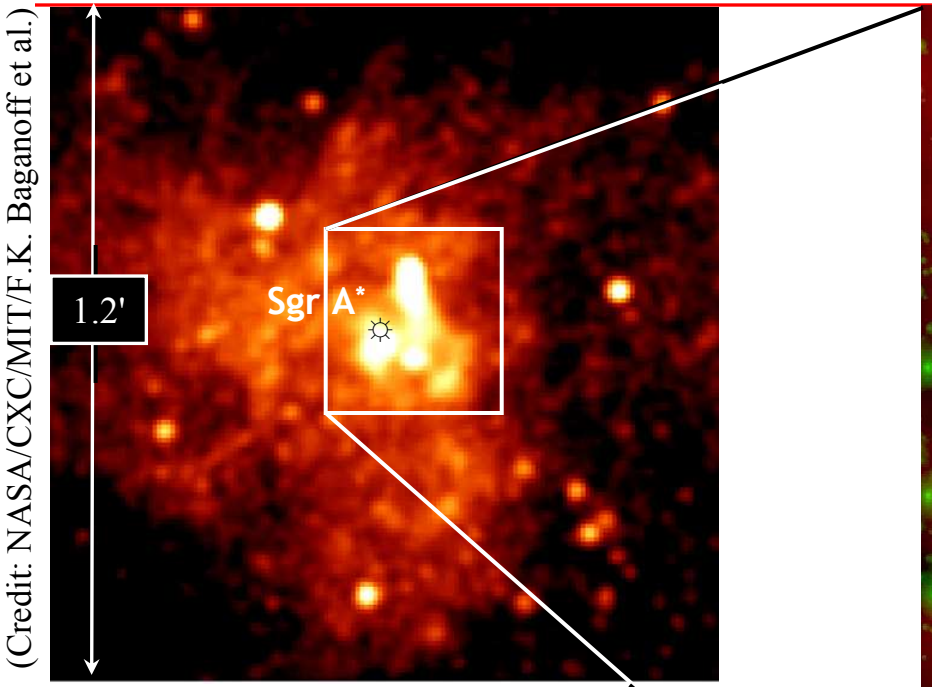




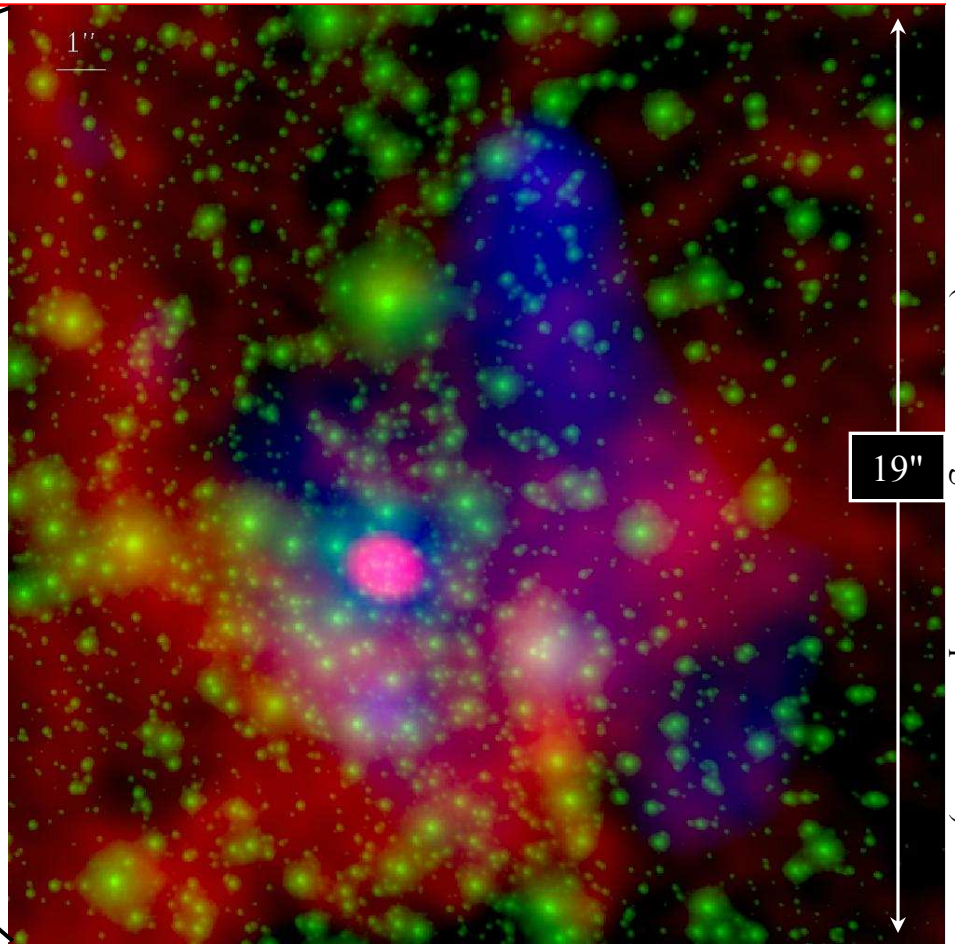
SGR1806-20 hyper-flare of December 27, 2004.

- geometry and magnetic field
- expansion and proper motion
- distance scale

Strong Gravity and Black Hole Accretion



(Credit: NASA/CXC/MIT/F.K. Baganoff et al.)



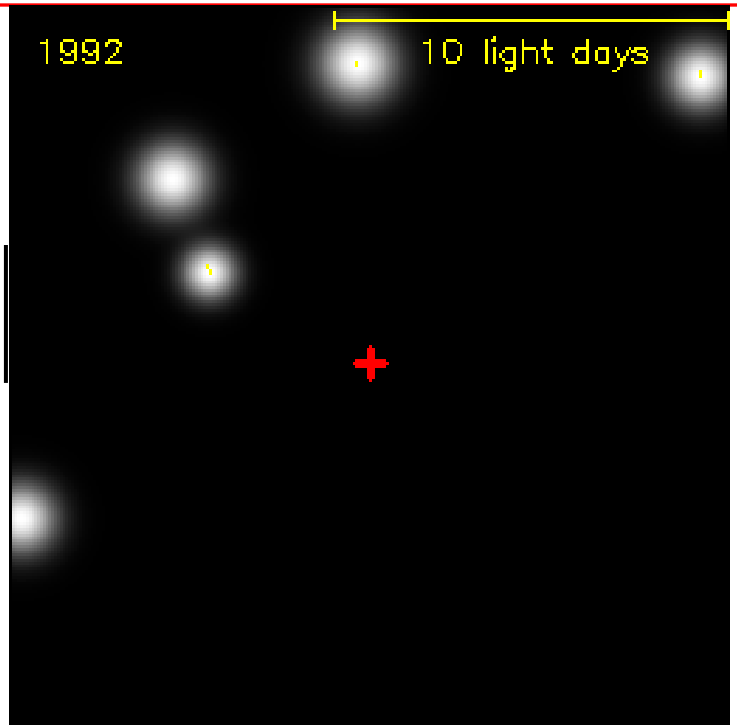
(Credit: Wang et al. astro-ph/0512643)

Galactic center is rich in massive stars and hence NS and BH remnants

- 10^2-10^3 PSRs with P_{orbit}<100 yr
- Current GC PSR searches are insensitive due to turbulent ionized gas

(Red=radio; blue=X-ray; Green=NIR)

Strong Gravity and Black Hole Accretion



Credits: MPE, Genzel et al.

At 22 GHz : rms (50 ksec) = 1 μJy

$\vartheta_{scat} = 2$ mas; $t_{scat} = 1.3$ msec

VLA beam = 100 mas; FOV = $\pm 60''$

Detect 2 - 15 PSRs within 4000 AU of SgrA*

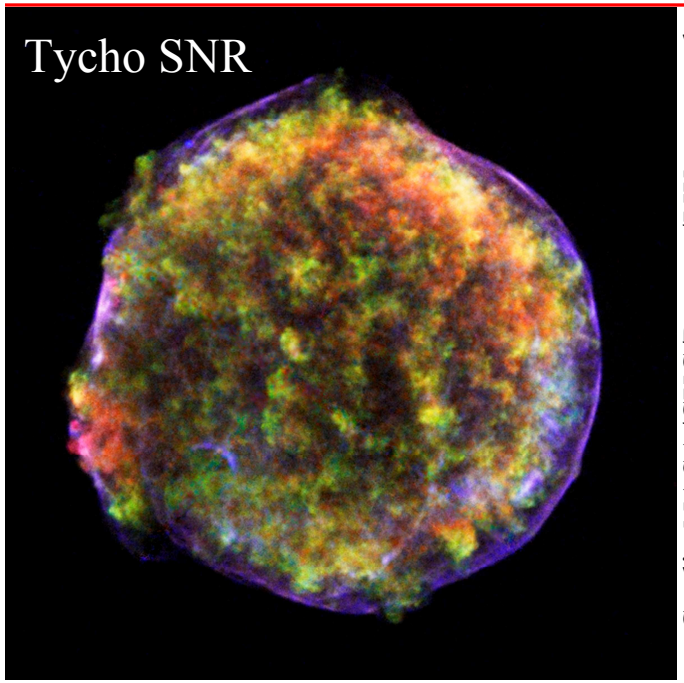
EVLA capabilities

- 10-fold increase in sensitivity (rms=1 uJy)
- 10^6 : 1 image fidelity (PSR : SgrA*)
- 10's mas position astrometry
- Millisecond pulsar timing

Results from long-term timing and astrometry

- Measure mass and spin of SMBH
  - Keplerian orbits (M_{BH})
  - Relativistic spin-orbital coupling ($\vec{\Omega}$)
  - Complements Con X Fe-line florescence
- Tests of GR in ultra-strong regime
  - And alternate theories of gravity
- Probes of the magneto-ionic accretion environment around a black hole

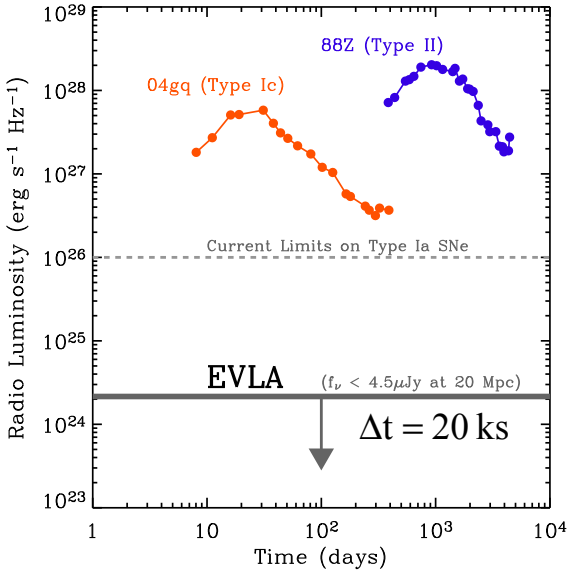
The Progenitors of Type Ia Supernova



Credit: NASA/CXC/Rutgers/J.Warren et al.

EVLA capabilities

- order of magnitude (20X) increase in instantaneous sensitivity
- continuous frequency coverage
- real-time dynamic scheduling

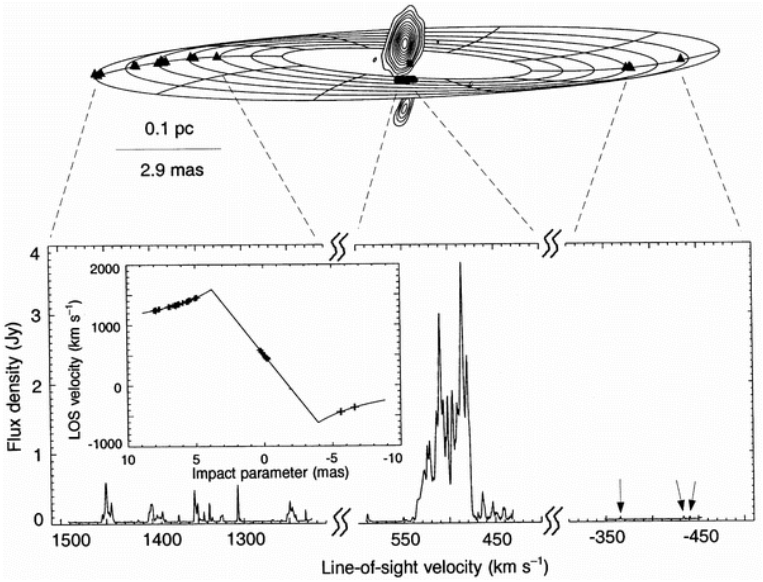


Deep ignorance about SN Ia progenitor and explosion mechanism

- high spatial and spectral X-ray observations combined w/ theory
- ✓ detect progenitor circumstellar medium

100-fold increase in SN Ia event rate

Cosmology and Compton-thick AGN



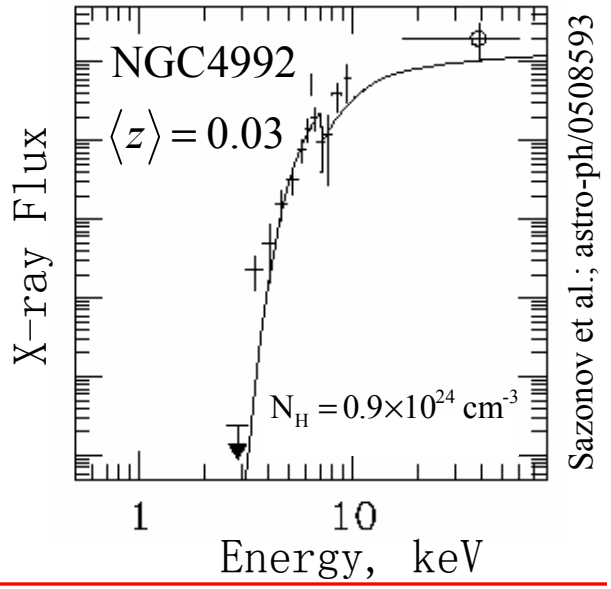
EVLA capabilities

- observe systemic and satellite lines over 1000's km/s
- identify maser regions at mas resolution

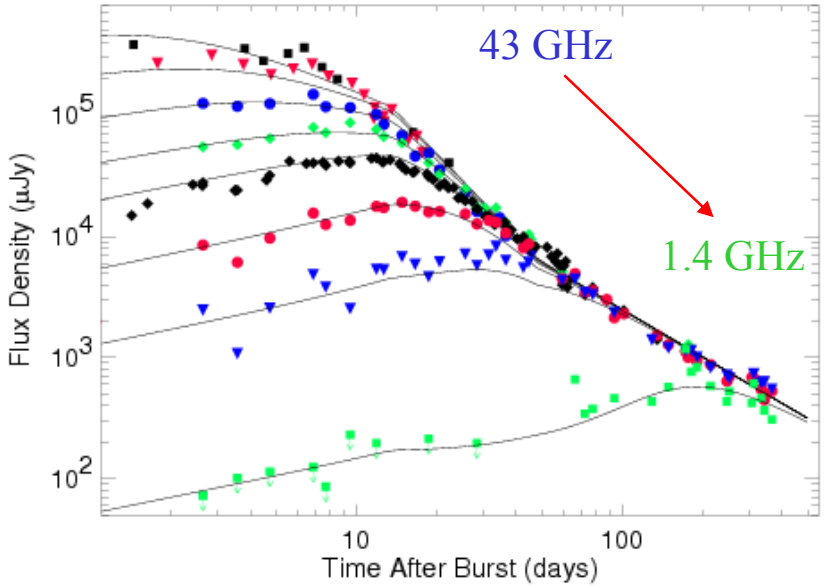
Ho and Dark Energy probe

Direct geometric distances determined from nuclear masers (e.g. NGC 4258)

- maser amplification depends on nuclear gas column density ($L_{H_2O} \propto N_H^3$)
- Compton-thick galaxies identified by hard X-ray imagers, e.g. NuSTAR, Swift-BAT



Gamma-Ray Bursts: Black Hole Birth



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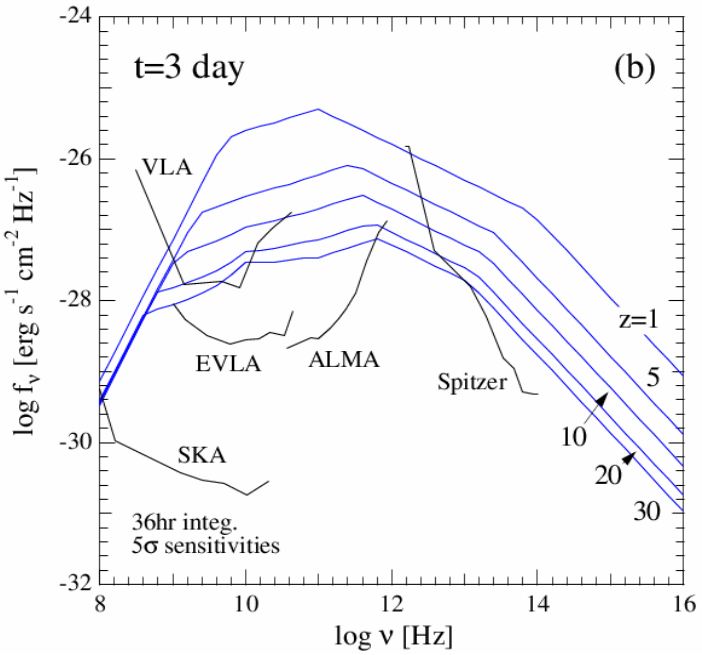

Inoe, Omukai, & Ciardi 2004

Radio observations of GRB afterglows are key but are currently severely sensitivity limited

- Constrains the <u>total</u> energy released by central engine independent of θ_{jet}, θ_{view}, or Γ

Probes density structure of circumburst medium

- Breaks optical/X-ray degeneracy

The EVLA: A North American Partnership

National Research
Council Canada

Conseil national
de recherches Canada

The EVLA Project on the Web
http://www.aoc.nrao.edu/evla/