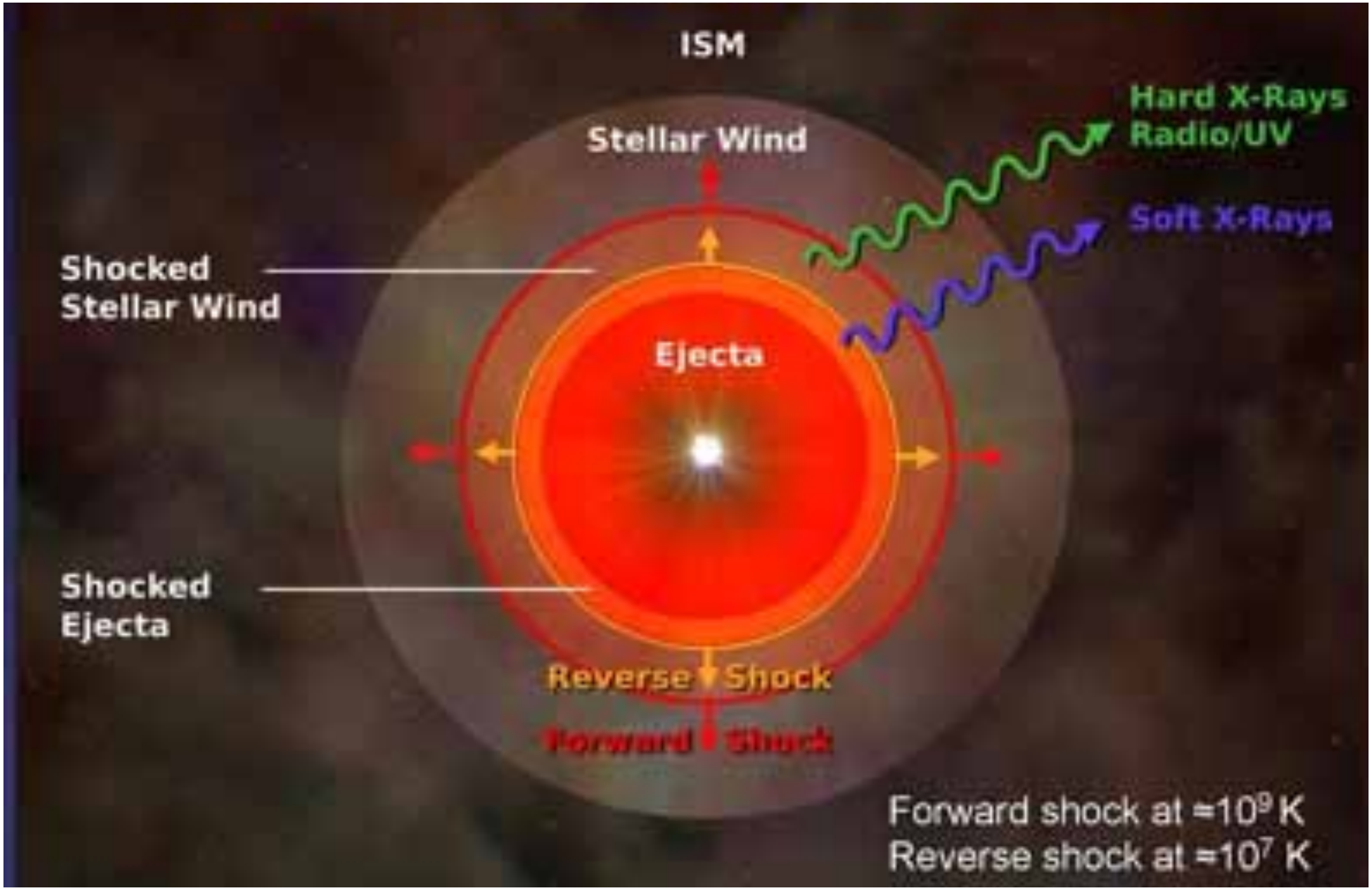
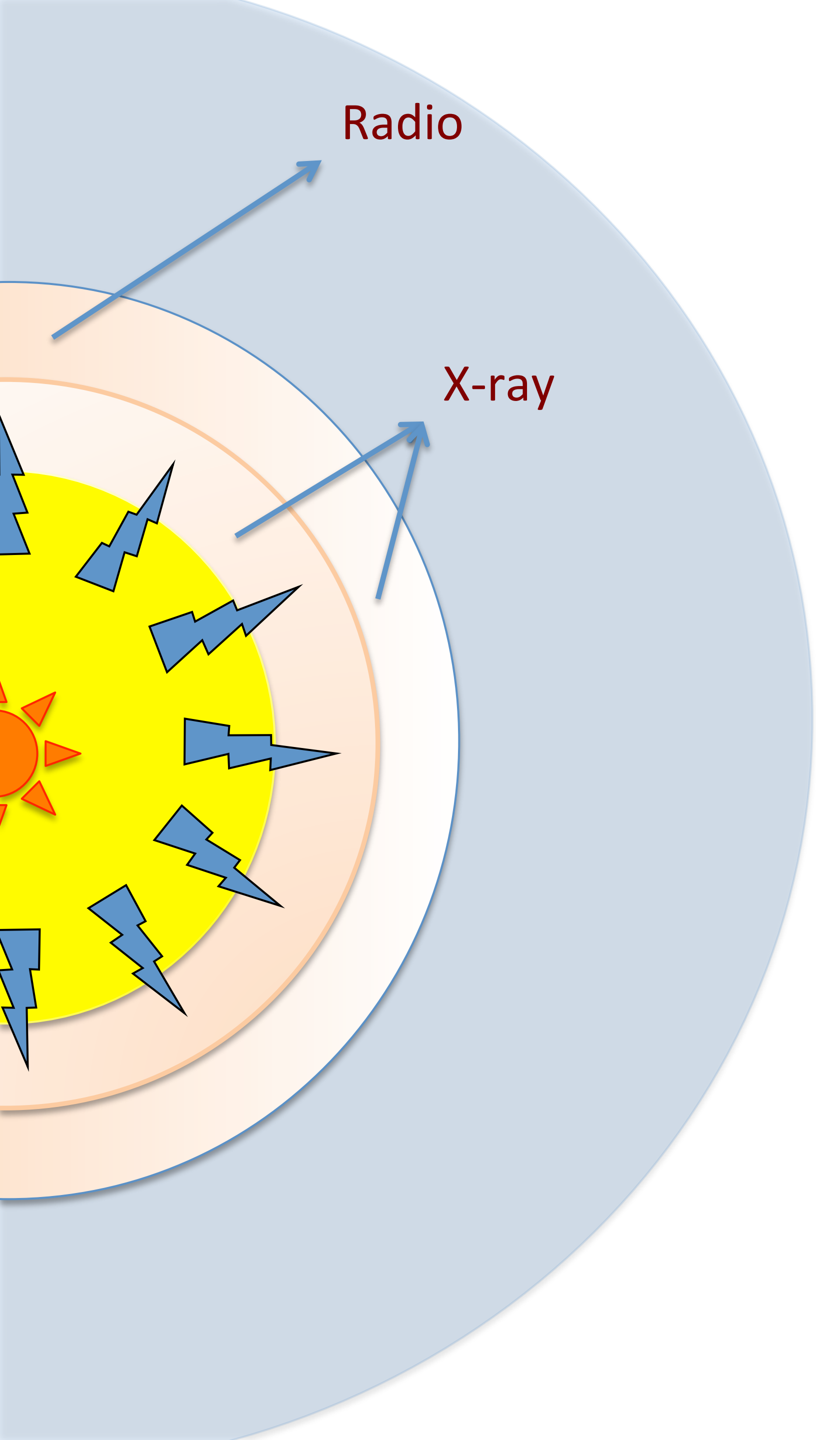
Explosive Transient Phenomena – with inputs from X-ray (and radio bands)

Poonam Chandra
National Centre for Radio Astrophysics
Tata Institute of Fundamental Research

Supernovae


ISM
Hard X-Rays
Radio/UV
Stellar Wind
Soft X-Rays
Shocked
Stellar Wind
Ejecta
Shocked
Ejecta
Reverse Shock
Forward Shock
Forward shock at ≈10⁹ K
Reverse shock at ≈10⁷ K



- Radio and X-ray emission

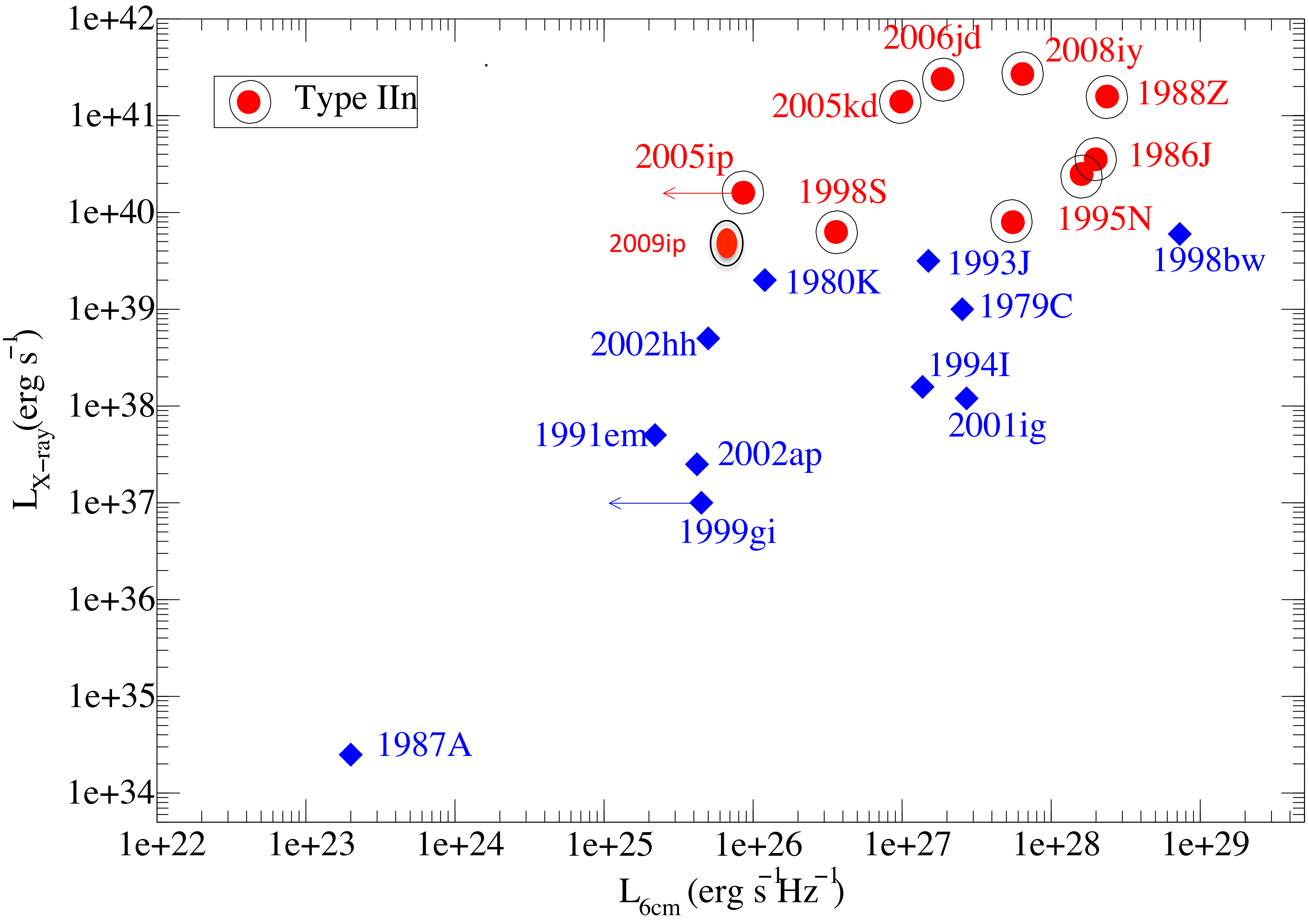
- Radio: Information about the mass loss rate of the star, density of the CSM, size etc.
- X-ray : Density and temperatures of the shocked ejecta, chemical composition

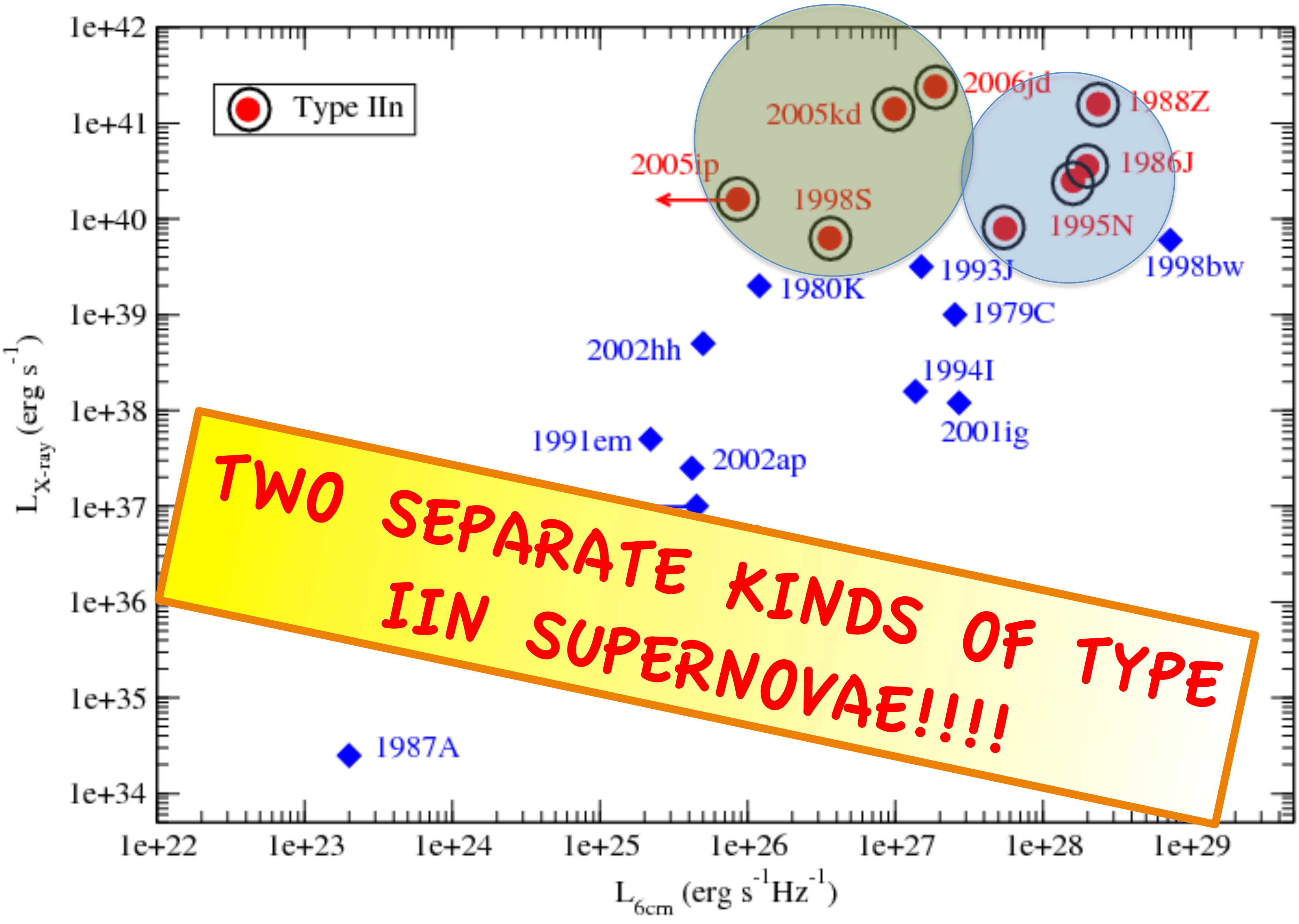
Type IIn supernovae

- Explosion in very dense environments
- Very high mass loss rates ~ 10^{-3}-0.1 M_{sun}/Yr
- Very high bolometric and Hα luminosities- indicative of high circumstellar interaction

- INDICATIVE OF HIGH RADIO AND X-RAY LUMINOSITY

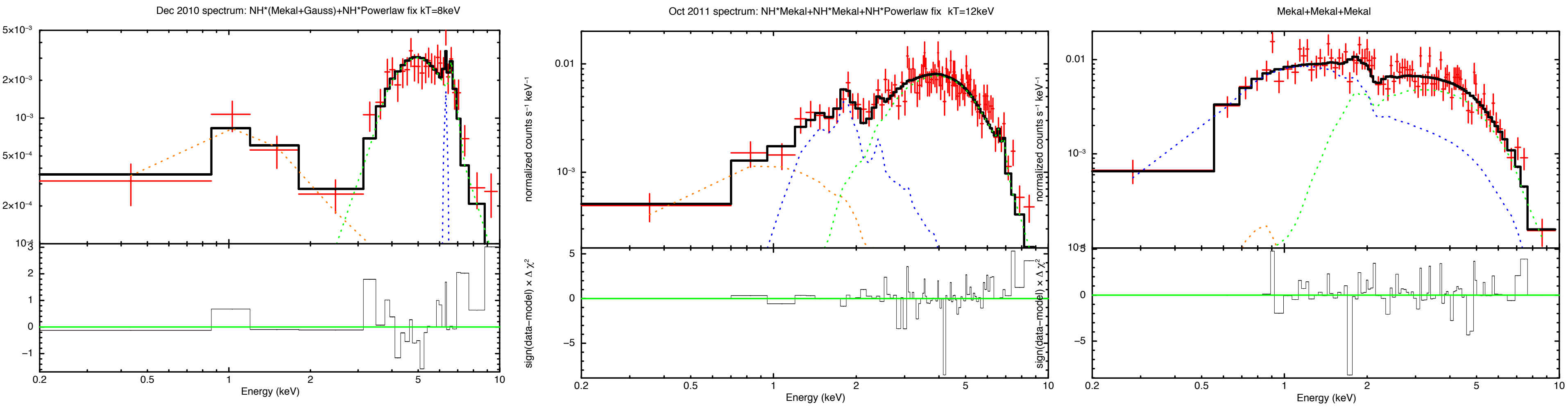
Peak radio and X-ray luminosities





TWO SEPARATE KINDS OF TYPE IIN SUPERNOVAE!!!!

SN 2010jl Chandra X-ray Spectra Comparison



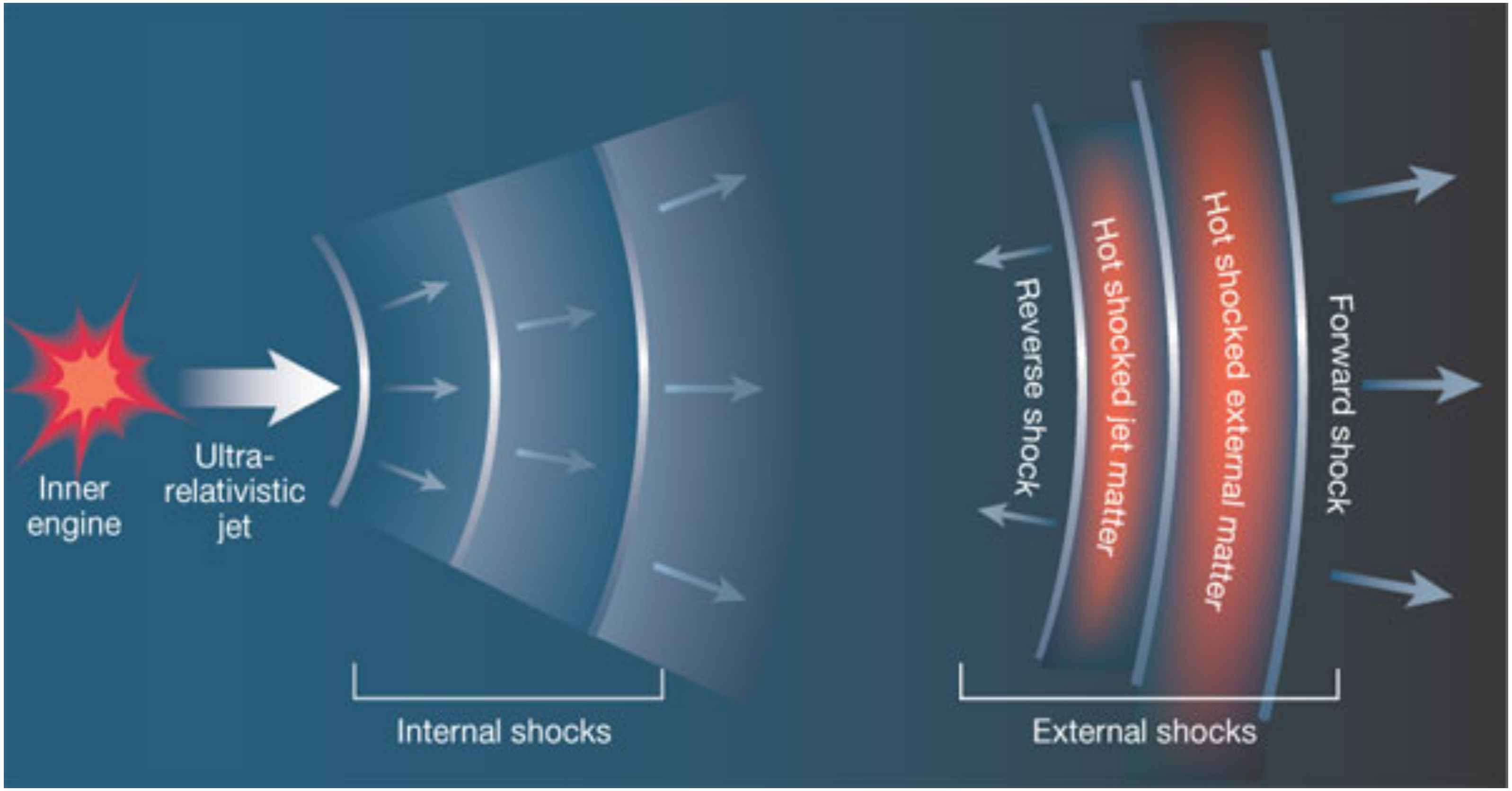
Observations	November 2010	October 2011	June 2012
Duration	39.6 ks	41.0ks	39.5ks
Counts	468	1342	1484
Count Rate	1.13E-2 cts	3.29E-2 cts	3.68E-2 cts
Column Density	9.7E23 cm^{-2}	2.67E23 cm^{-2}	6.6E22 cm^{-2}
Temperature	>10 keV	> 10 keV	> 10 keV

Mass loss rate 8E-3 M$_{sun}$/yr

Chandra et al. 2012, ApJ Letters 2012, 750, L2

Gamma Ray Bursts

Meszaros and Rees 1997



Afterglow Detection Statistics

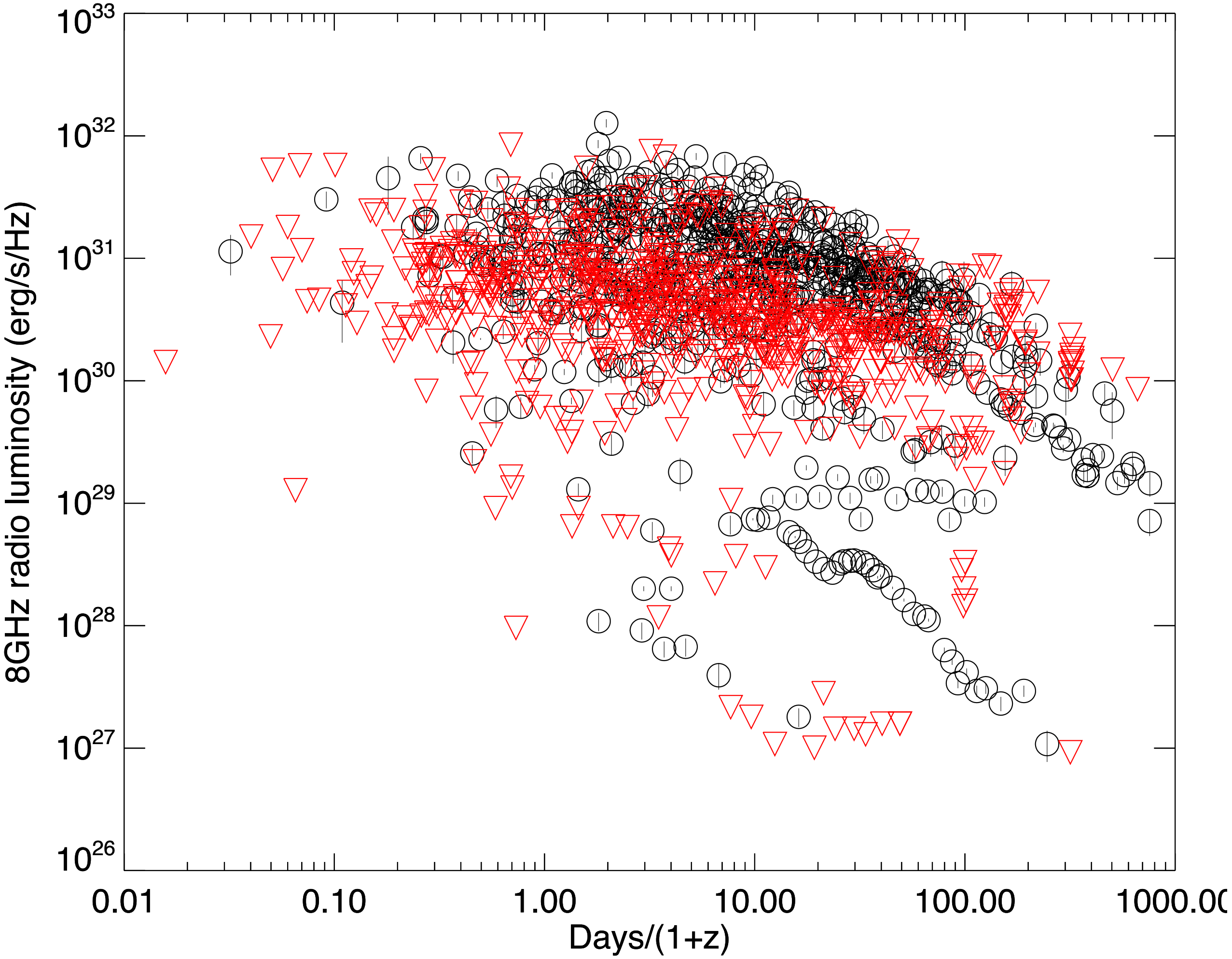
- 95 out of 304 GRBs detected in radio – 31%
- Pre-Swift radio detection 42/123 – 34%
- Post-Swift radio detection 53/181 – 29%

- X-ray detection rate 42% (pre-Swift) to 93% (post-Swift) .
- Optical detection rate 48% (pre-Swift) to 75% (post-Swift) .

Chandra et al. 2012, ApJ 746, 156

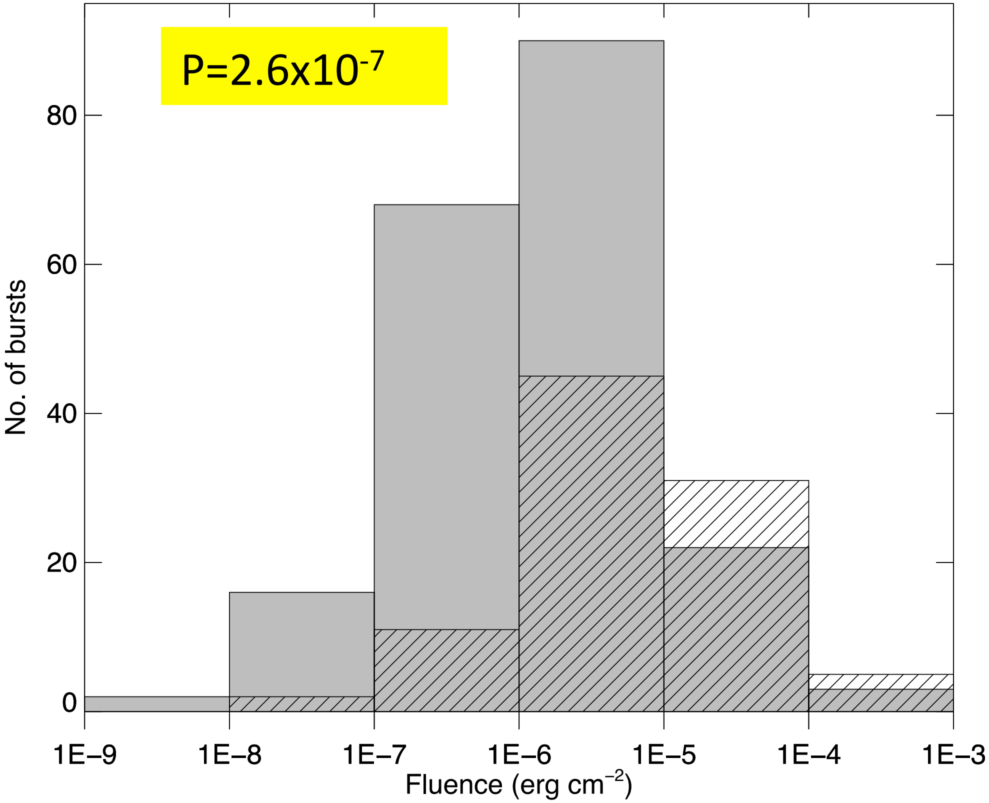
Radio Detection Biases

Chandra et al. 2012, ApJ 746, 156



Detectability of radio afterglows - fluence

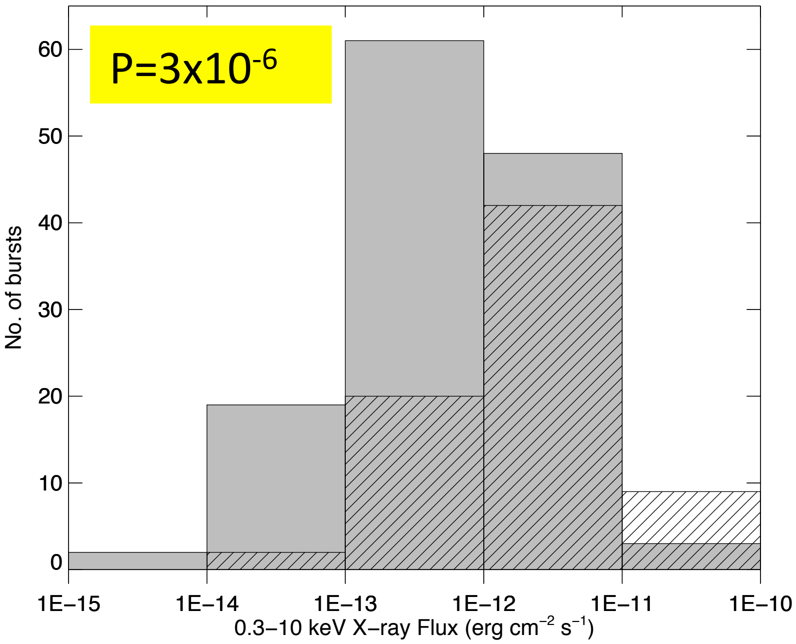
- 176/206 (85%) non-detections fluence $<1\times10^{-6}$ erg cm^{-2}
- 82/95 (86%) detections fluence $>1\times10^{-6}$ erg cm^{-2}

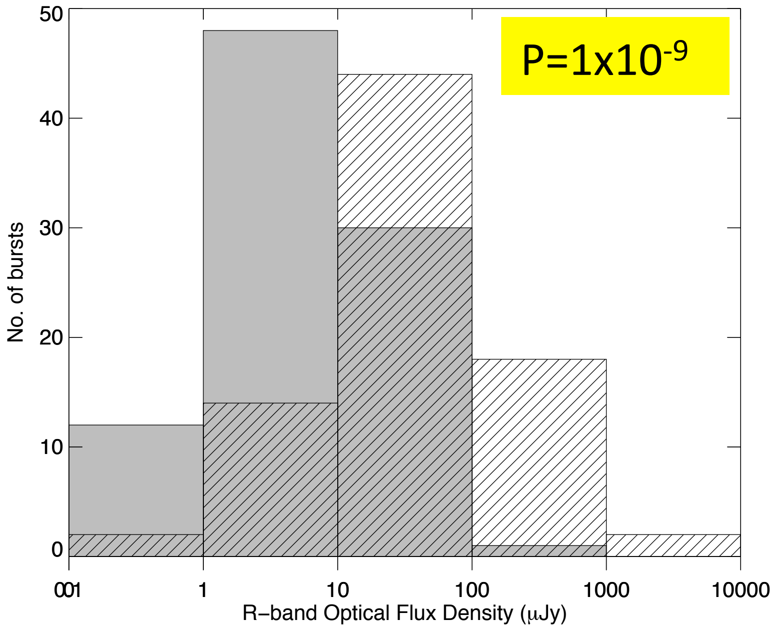


Nysewander et al. 2009, Swirt XRT repository

Chandra et al. 2012, ApJ 746, 156

Detectability of radio afterglows – X-ray and optical

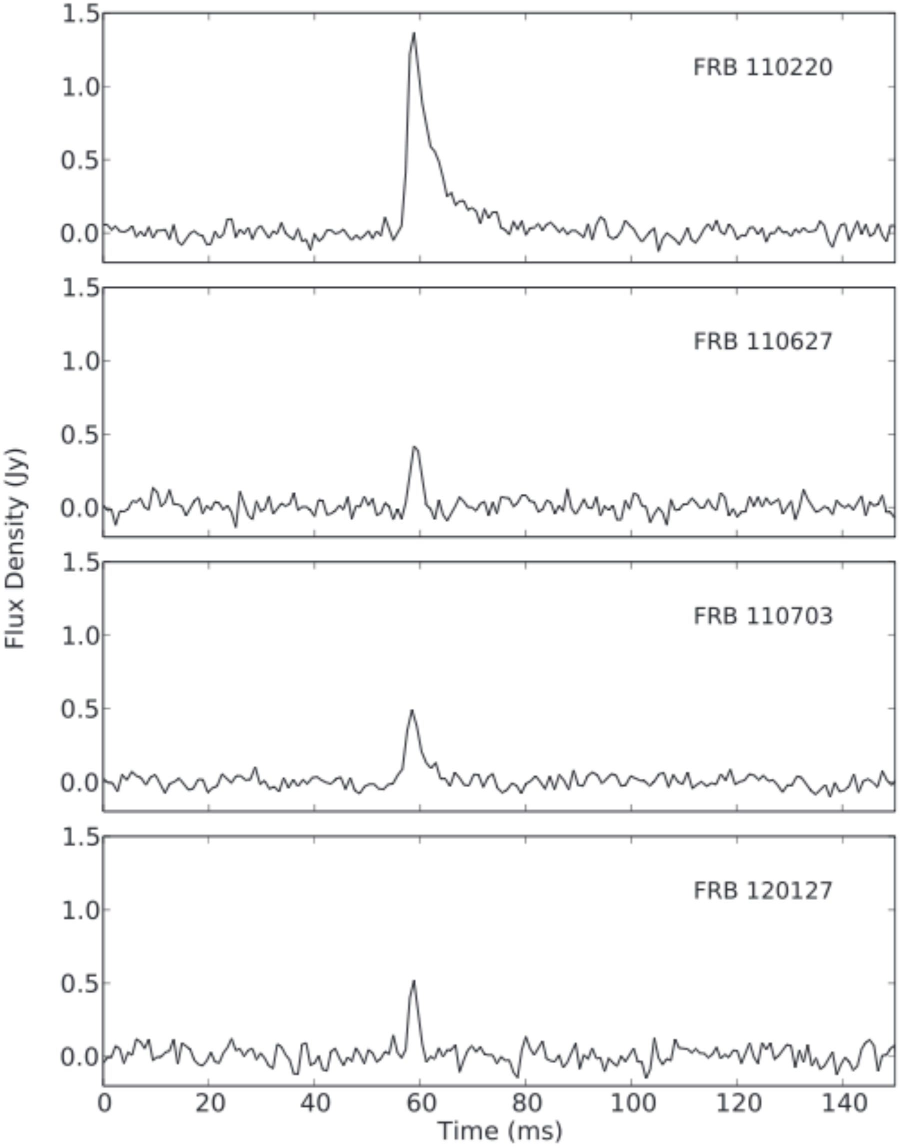




Gehrels et al. 2008, de Pasquale et al. 2006, Sakamoto et al.2008, 2011

Chandra et al. 2012, ApJ 746, 156

Fast Radio Bursts



(Thornton et al. 2013)

Fast Radio Bursts (??)

- Discovered in Parkes Pulsars and Fast transients survey (Thornton et al. 2013).
- Coherent radio emission lasting milliseconds.
- Dispersion measurements indicate $z \sim 0.5$-1.
- The inferred total energy 10^{38}–10^{40} ergs.
- The peak radio luminosity is $\sim 10^{43}$ erg s^{-1}.
- No host galaxy detection (so far).
- No electromagnetic counterpart detection.
- Unknown origin.

Fast Radio Bursts

- Several theories, of Galactic and extragalactic origin.
- FRBs can be produced when a spinning supramassive neutron star loses centrifugal support and collapses to a black hole (Falcke & Rezzolla 2013).
- Such implosions can happen in supra-massive neutron stars shortly.
- Some are physically associated with GRBs (Zhang et al. 2014).
- Signatures in X-rays and radio.

Electromagnetic signatures

- Magnetar driven GRBs radio bright (Hancock and Gaensler 2013)
- Look for radio bright afterglows for FRB association.
- X-ray signature- internal X-ray plateau
- Seen in two GRBs 101011A and 100704A

Conclusions

- X-ray and radio studies can unravel the nature and environments of the explosive transient phenomena.
- Radio and X-ray signals are very crucial in FRBs. A hint of FRB/GRB association in two GRBs.