EVLA Constraints on the Progenitors of Supernovae Type Ia

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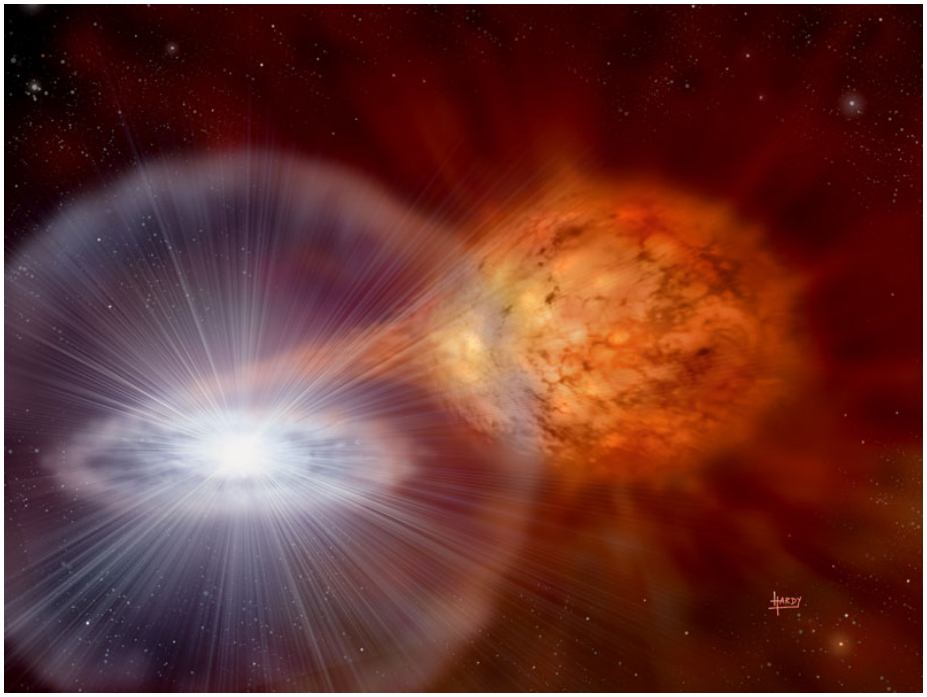
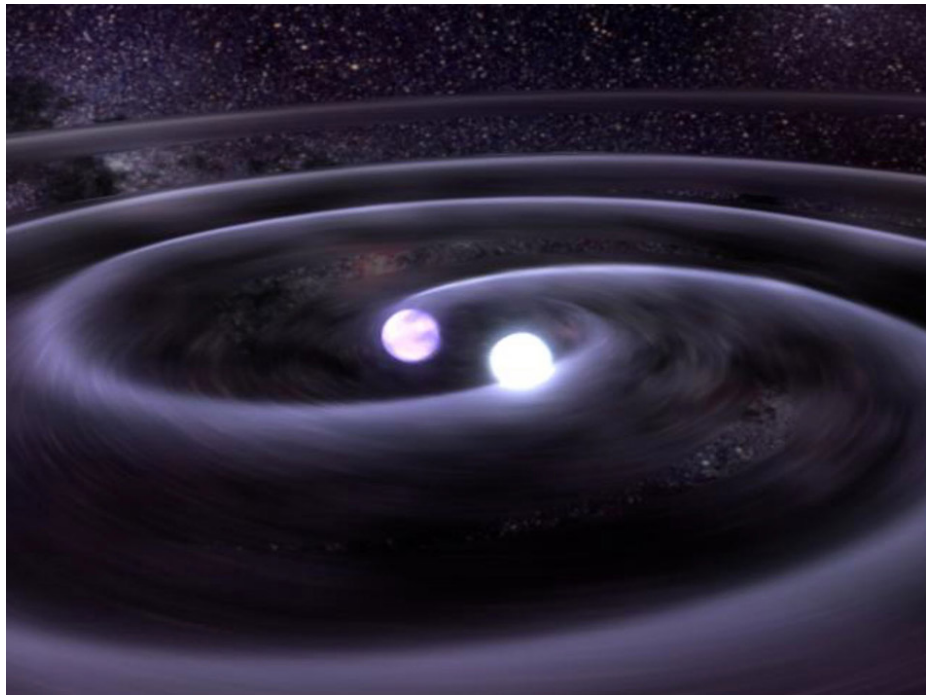
Atacama Large Millimeter/submillimeter Array
Expanded Very Large Array
Robert C. Byrd Green Bank Telescope
Very Long Baseline Array

NRAO

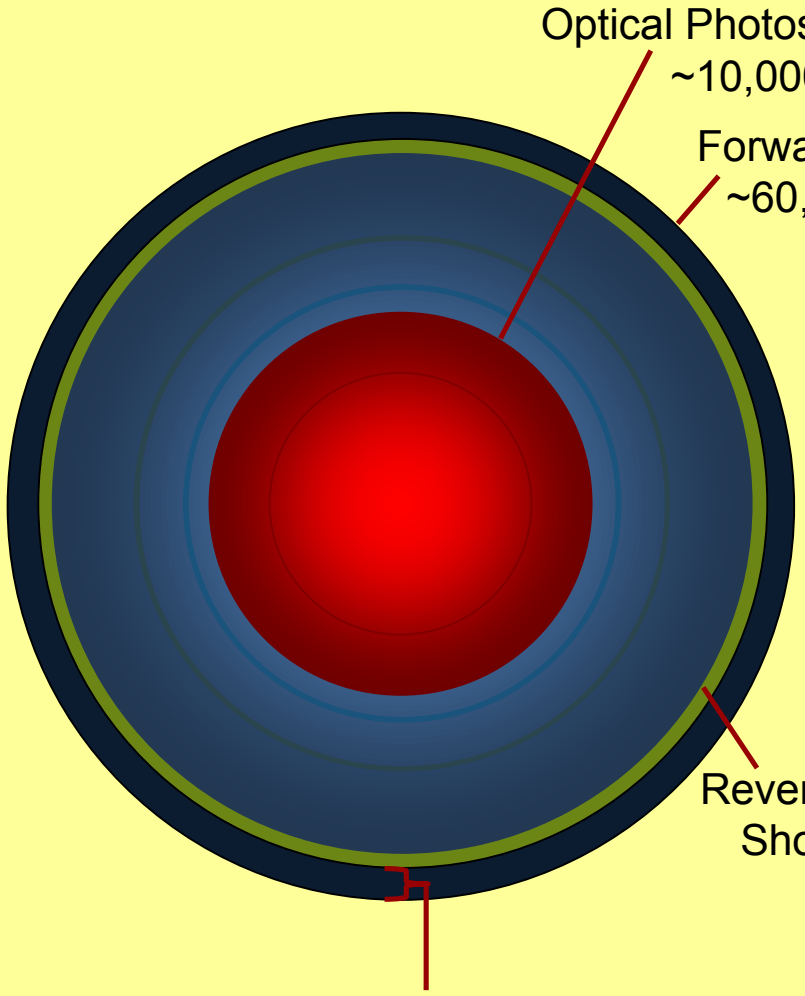
What are the progenitors of Type Ia supernovae (and how do they explode)?



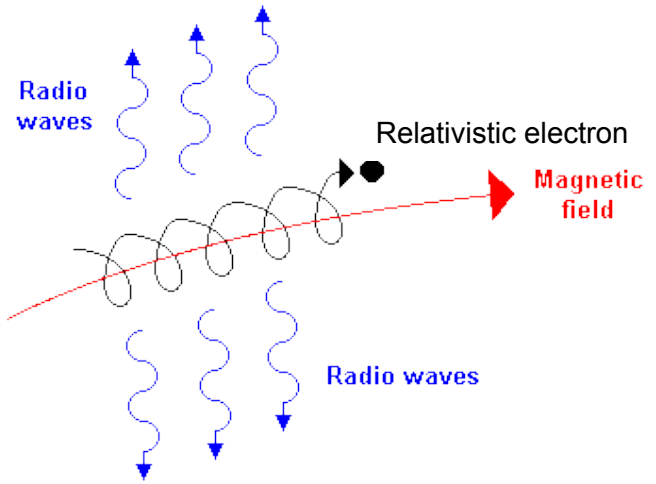


Single Degenerate or Double Degenerate?

How does radio trace circumstellar material?



Synchrotron Emission



Energy densities of magnetic field and relativistic electrons scale with post-shock energy density:

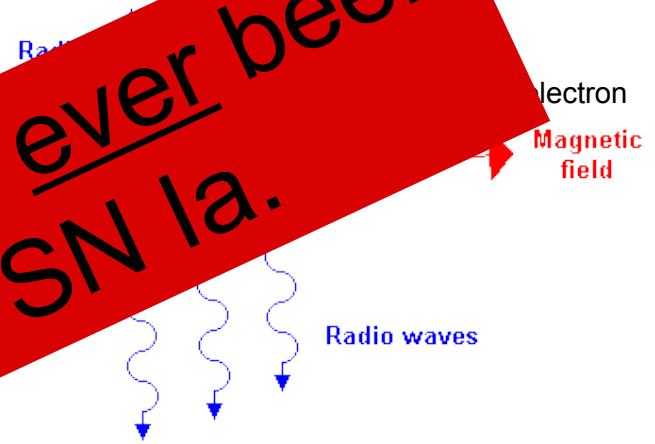
$$U_B \sim U_e \propto \rho_{csm}\ v_s^2$$

$$\boxed{L_{radio} \propto \rho_{csm}^2}$$

How does radio trace circumstellar material?

No radio emission has ever been detected from a SN Ia.

Synchrotron Emission



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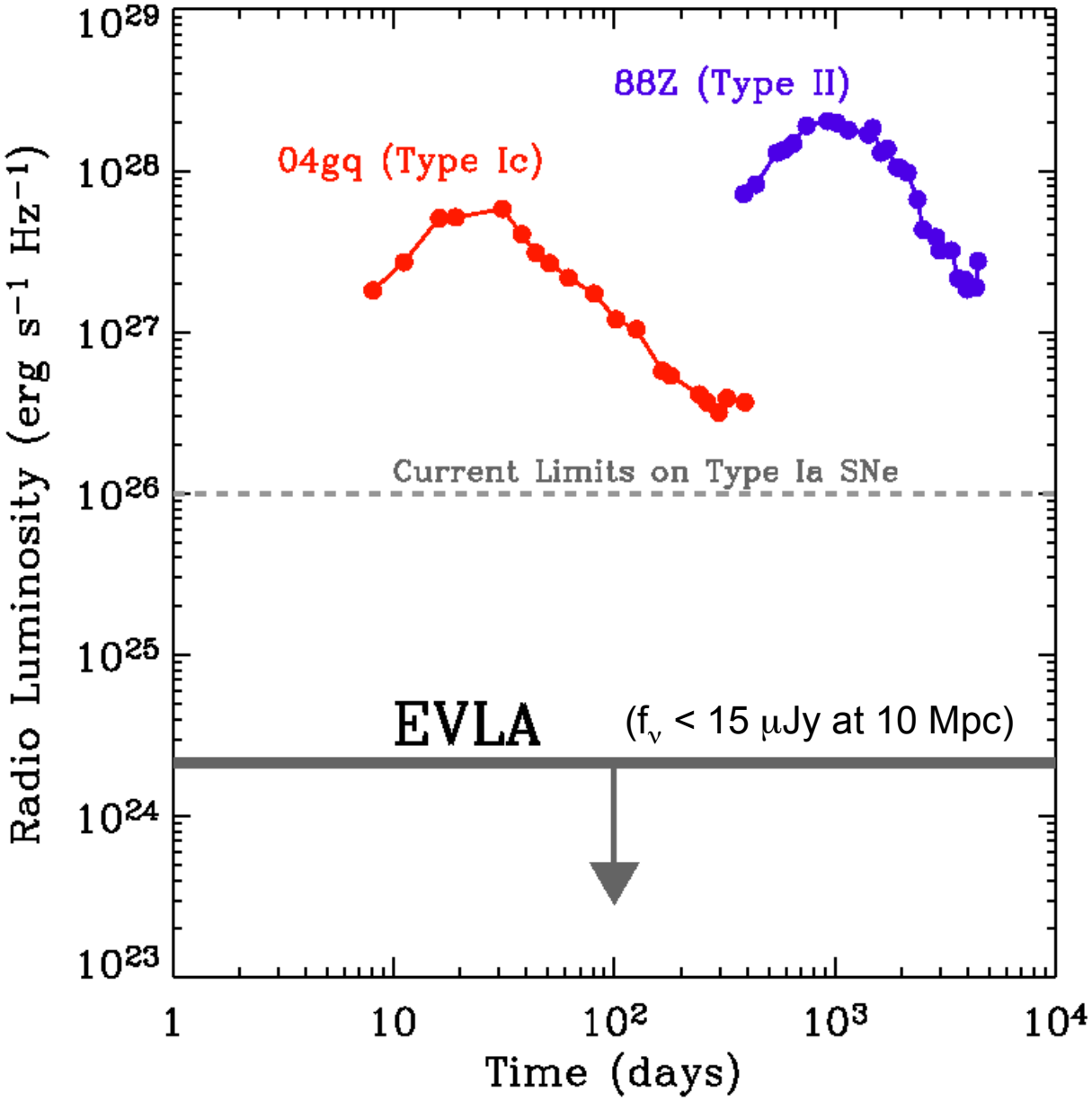
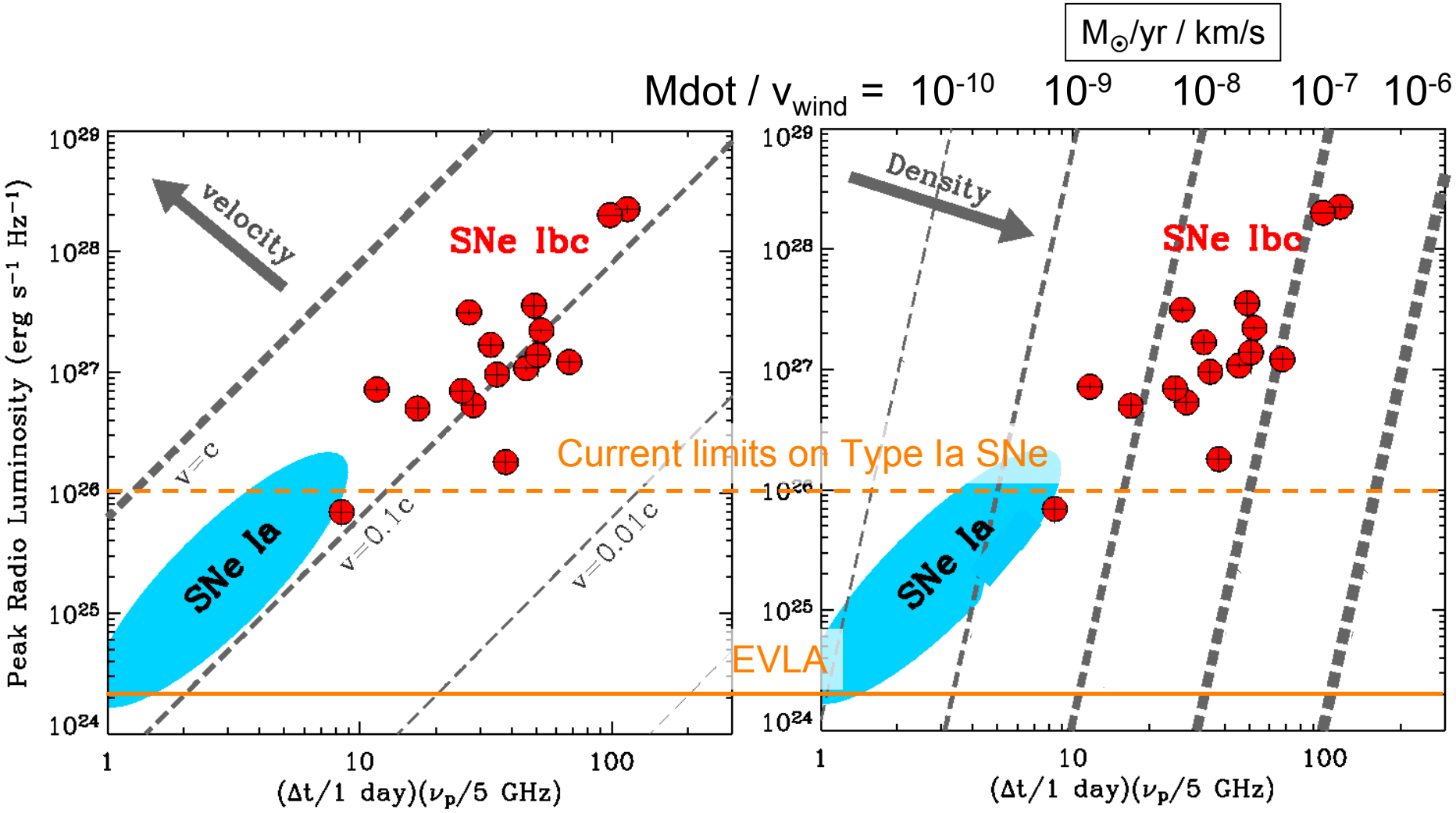
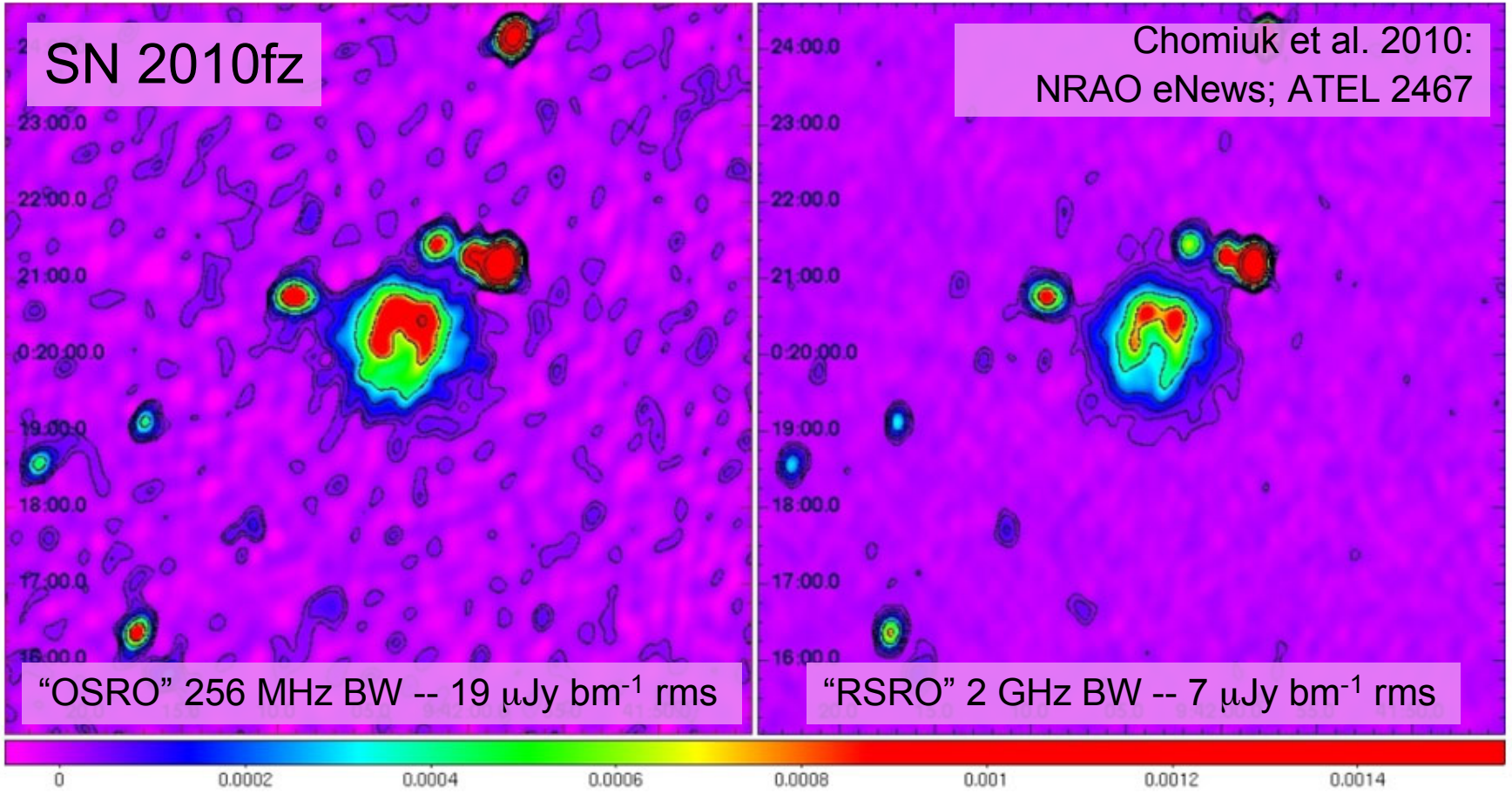

88Z (Type II)
04gq (Type Ic)
Current Limits on Type Ia SNe
EVLA
(f_ν < 15 μJy at 10 Mpc)
Radio Luminosity (erg s^{-1} Hz^{-1})
Time (days)
10^{29}
10^{28}
10^{27}
10^{26}
10^{25}
10^{24}
10^{23}
1
10
10^2
10^3
10^4

We can extend models for SNe Ibc to SNe Ia.

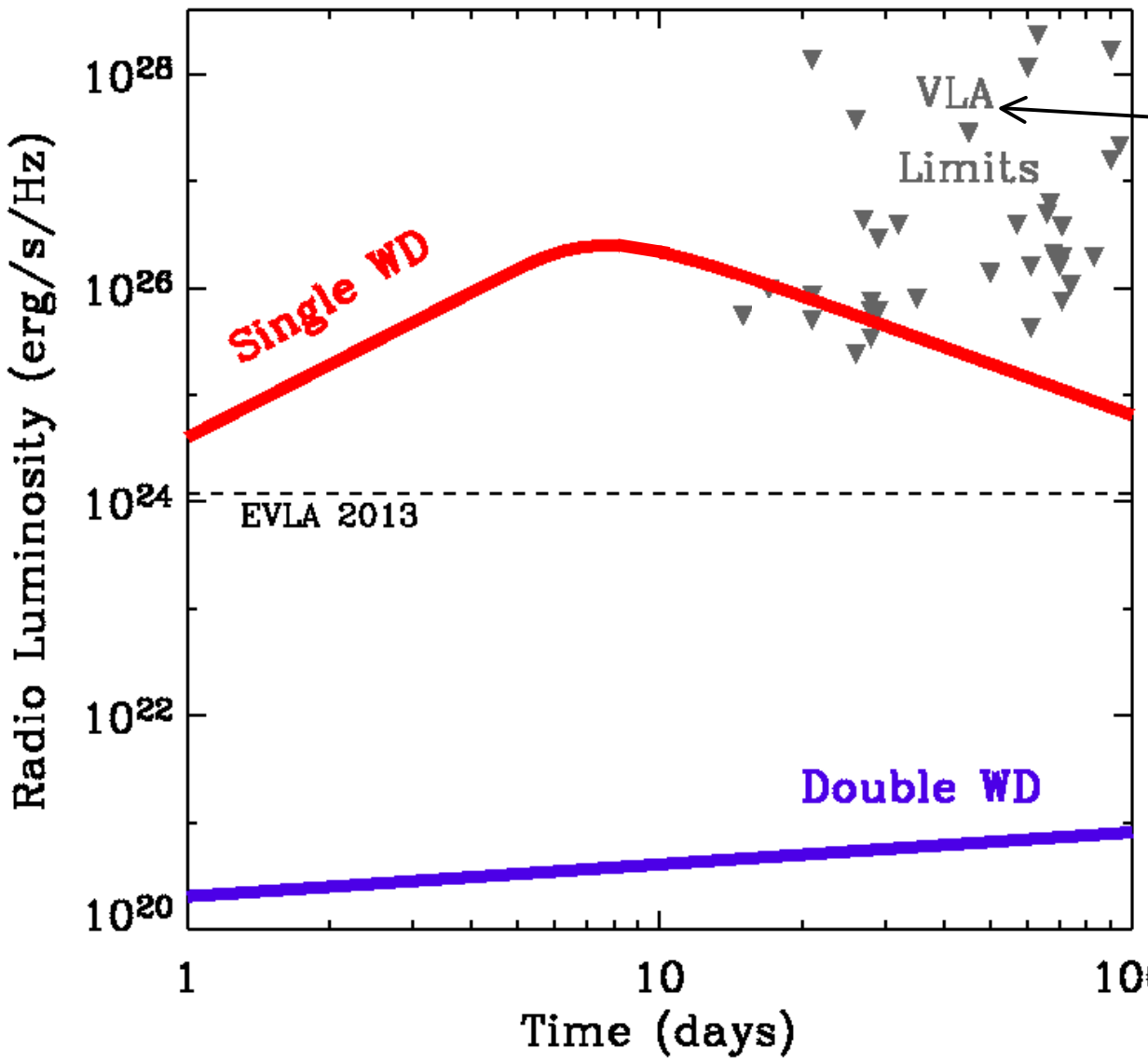


More bandwidth, More sensitivity



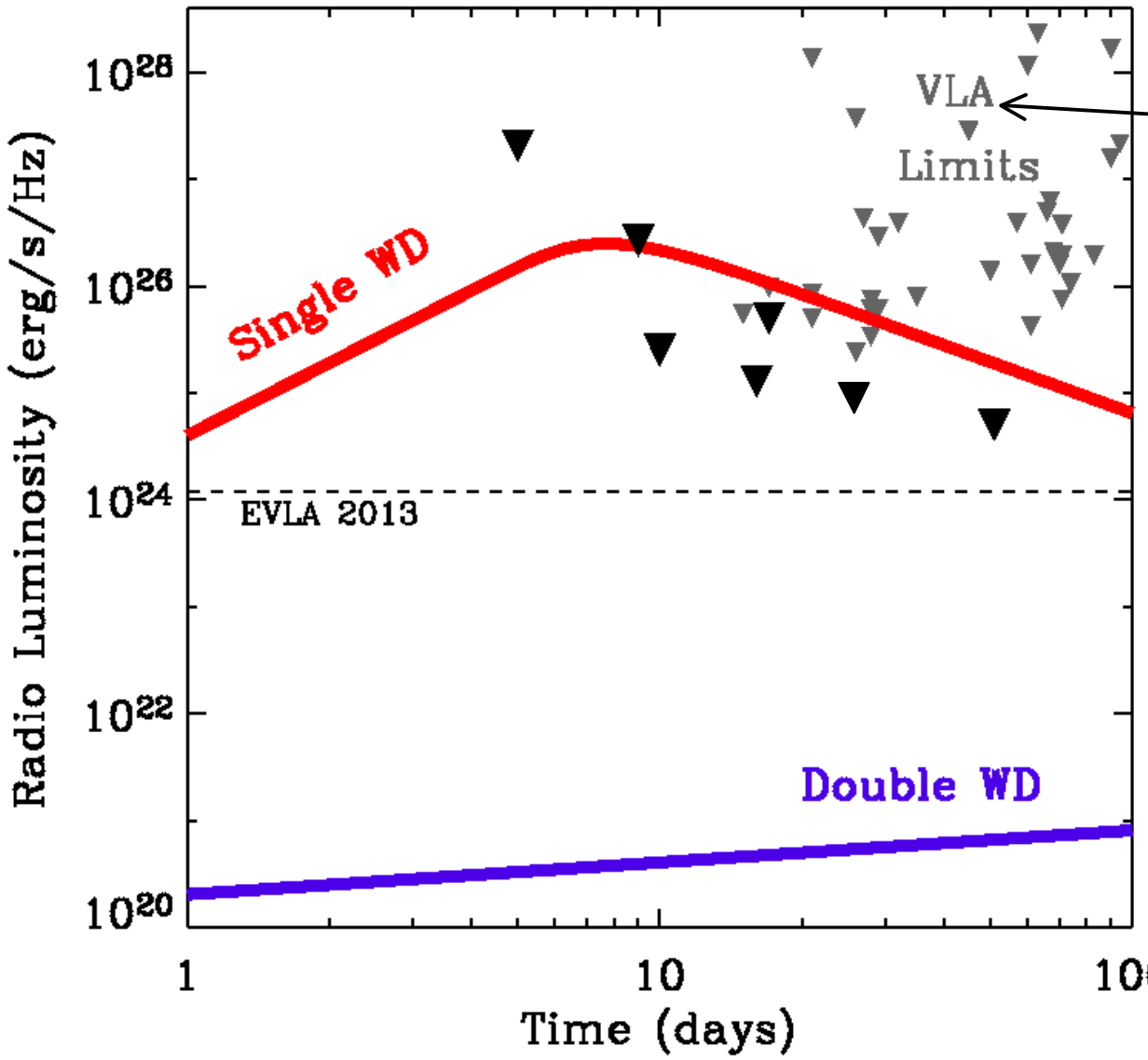
Can routinely reach rms ~ 7 μJy beam^{-1} in a 1 hour observation at 6 GHz.

VLA Limits



Panagia et al. 2006

EVLA Limits



Panagia et al. 2006

Conclusions

- The EVLA can detect the interaction of SNe Ia with circumstellar material, testing single degenerate models.
- We have obtained five wide-band EVLA observations of nearby SNe Ia.
- So far, all non-detections.
- The data are inconsistent with some single degenerate models. More detailed modeling is needed.
- Early optical detection and prompt EVLA triggering is key.
- EVLA program for 3 years and ~15 SNe …Stay tuned!

EVLA Targets

ID	Distance	Bandwidth / 3σ limit	Phase (Days From Max Light)
PTF 10icb	37 Mpc	256 MHz $< 45\ \mu Jy\ bm^{-1}$	-8
SN 2010ev	34 Mpc	1 GHz $< 48\ \mu Jy\ bm^{-1}$	0
SN 2010fz	23 Mpc	2 GHz $< 21\ \mu Jy\ bm^{-1}$	-10
SN 2010ih	26 Mpc	2 GHz $< 39\ \mu Jy\ bm^{-1}$	16
SN 2010ko	41 Mpc	2 GHz $< 18\ \mu Jy\ bm^{-1}$	36
PTF 10ygu	101 Mpc	256 MHz $< 150\ \mu Jy\ bm^{-1}$	-14 (Kasliwal et al., ATEL 2957)