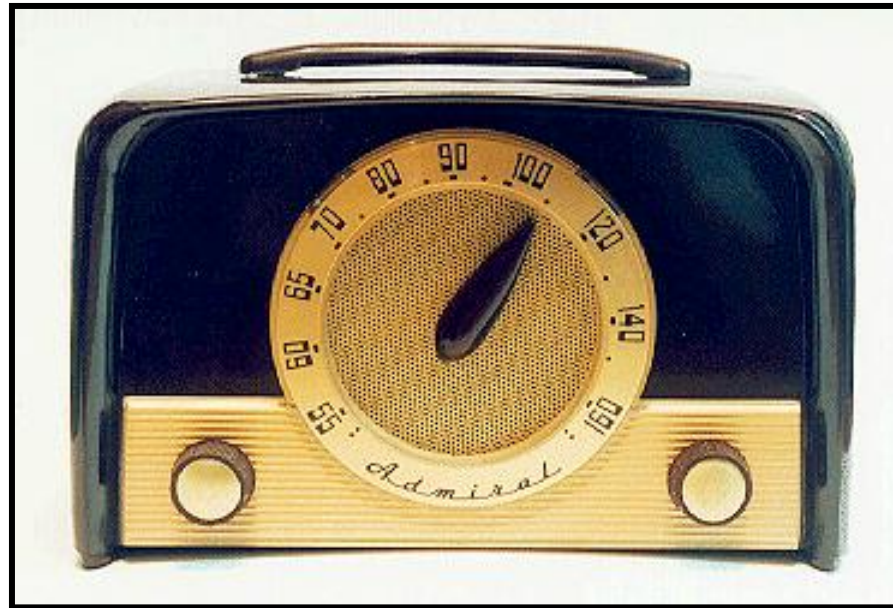


*A Broader Perspective on the
GRB-SN Connection*

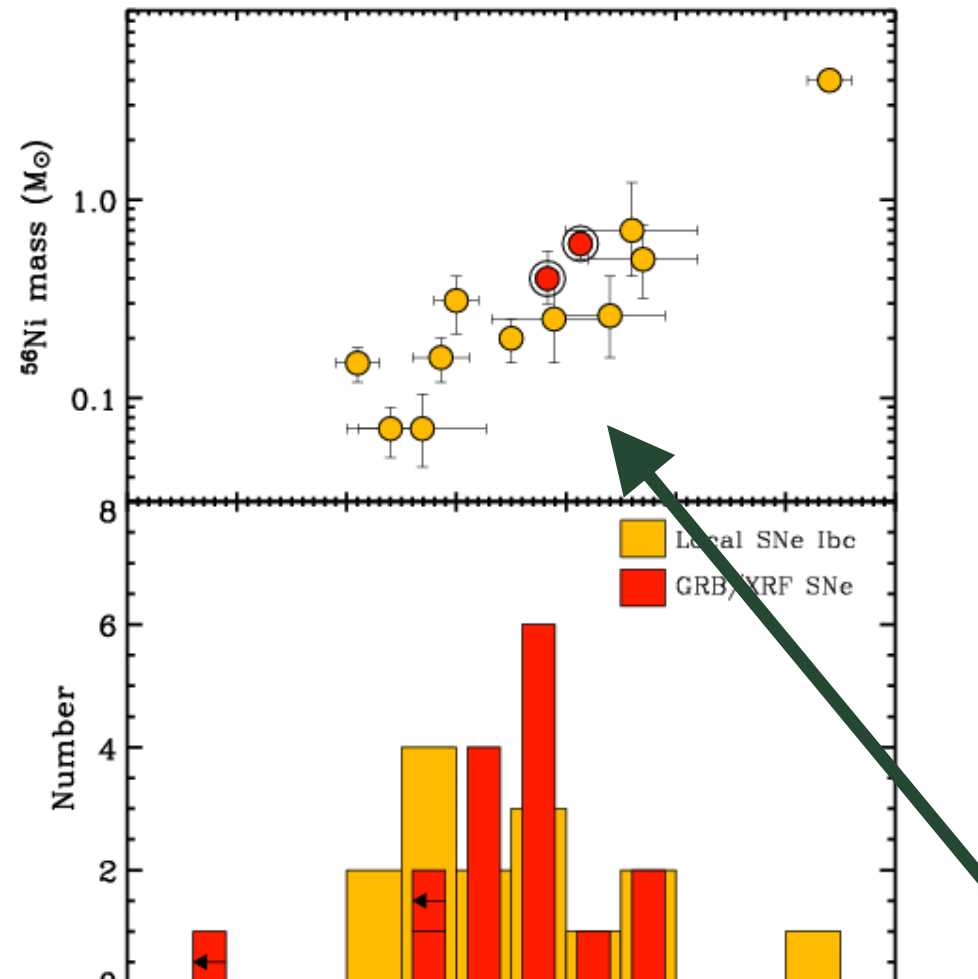


Alicia M. Soderberg

Caltech

Schramm Symposium, Dec 11 2005

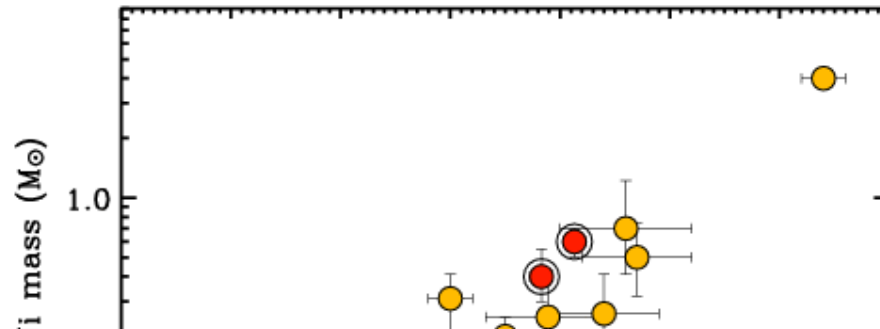
Optical Peak Magnitudes



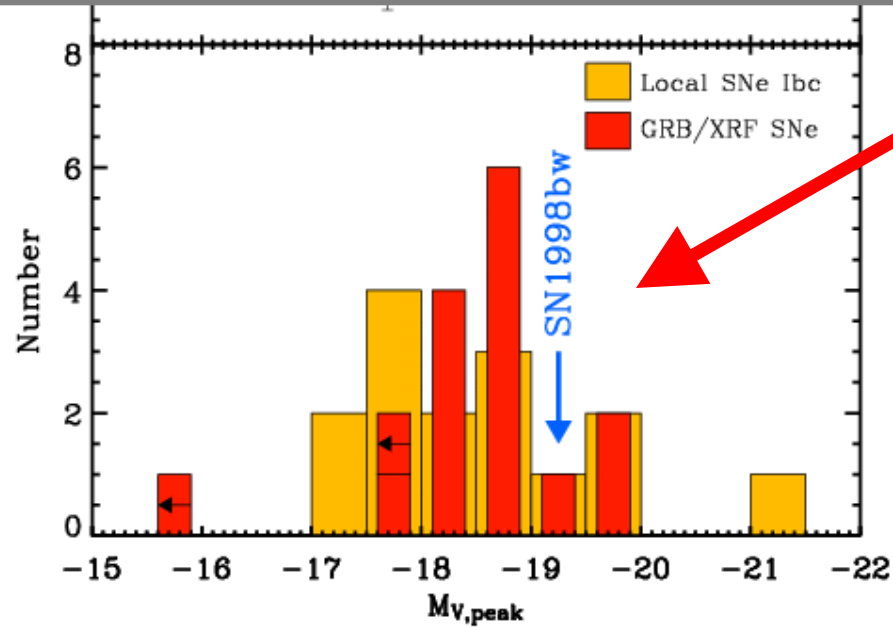
#1 - Peak magnitude as a proxy for Nickel mass

(Soderberg, ApJ, in press)

Optical Peak Magnitudes



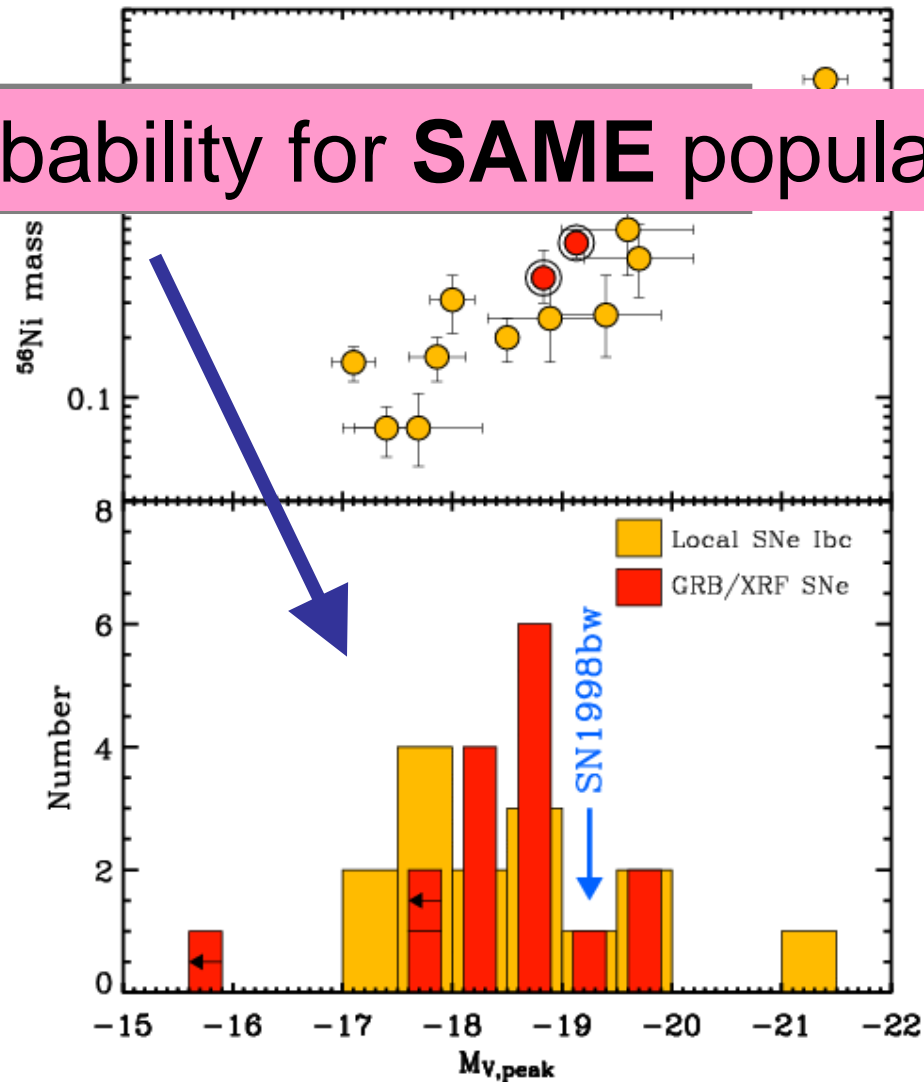
#2 - Most GRB-SNe are NOT as bright as 98bw



(Soderberg, ApJ, in press)

Optical Peak Magnitudes

→ 90% probability for **SAME** population

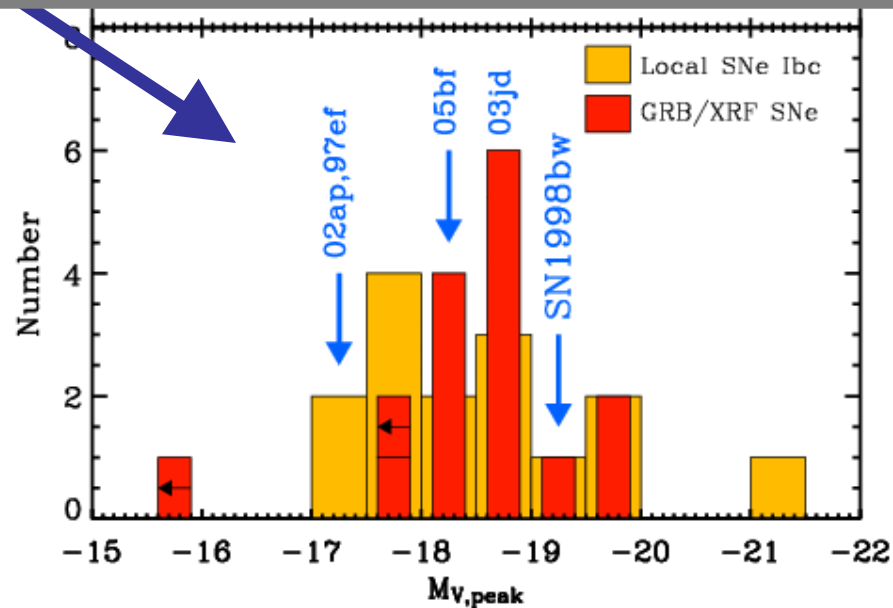


(Soderberg, ApJ, in press)

Optical Peak Magnitudes

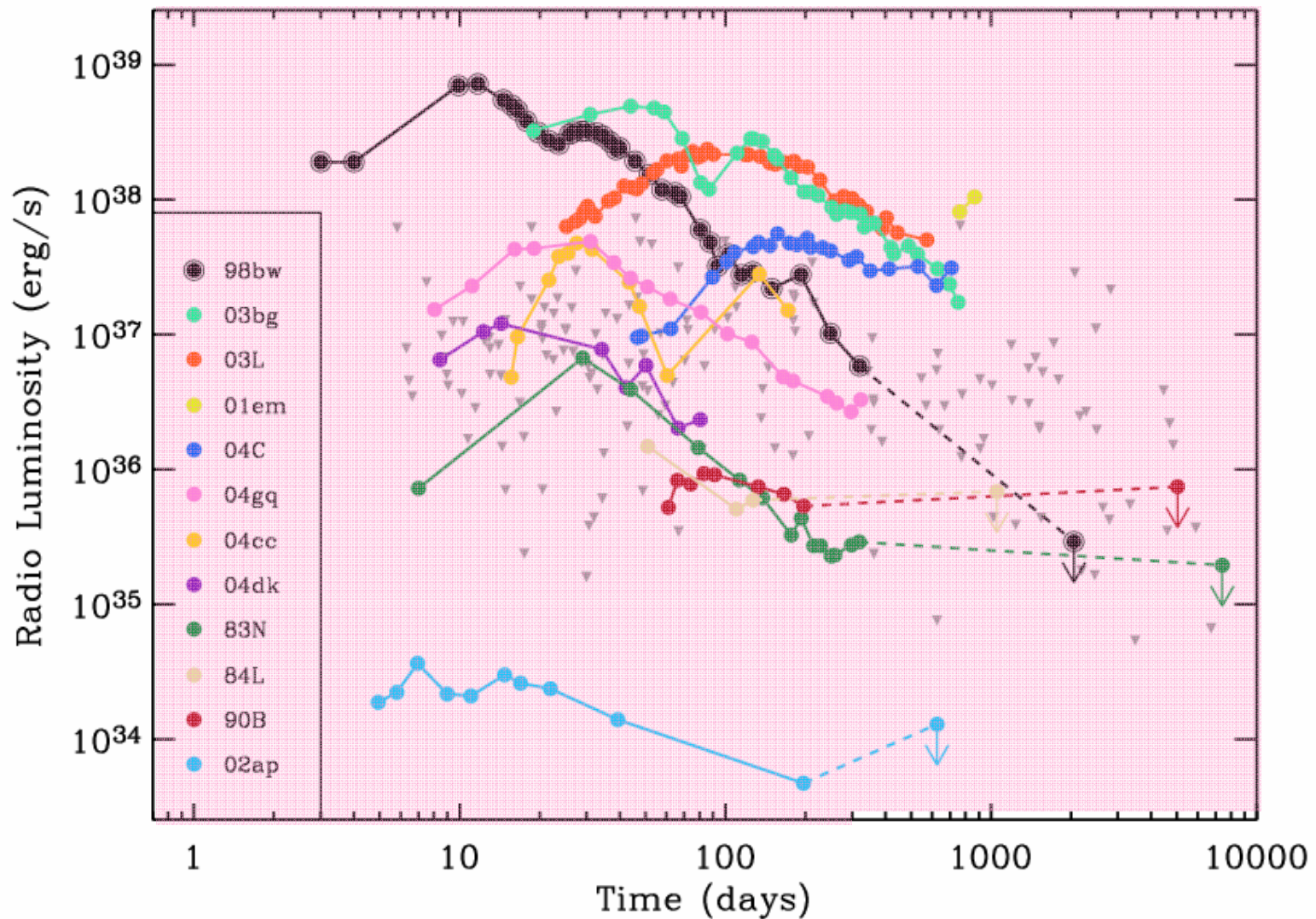
“Hypernovae” are 5-10% of SNe Ibc.

- Broad optical absorption lines → fast velocities (like 98bw)
- Mildly asymmetric → polarimetry and nebular spectra
- Argued that **ALL** hypernovae harbor GRBs



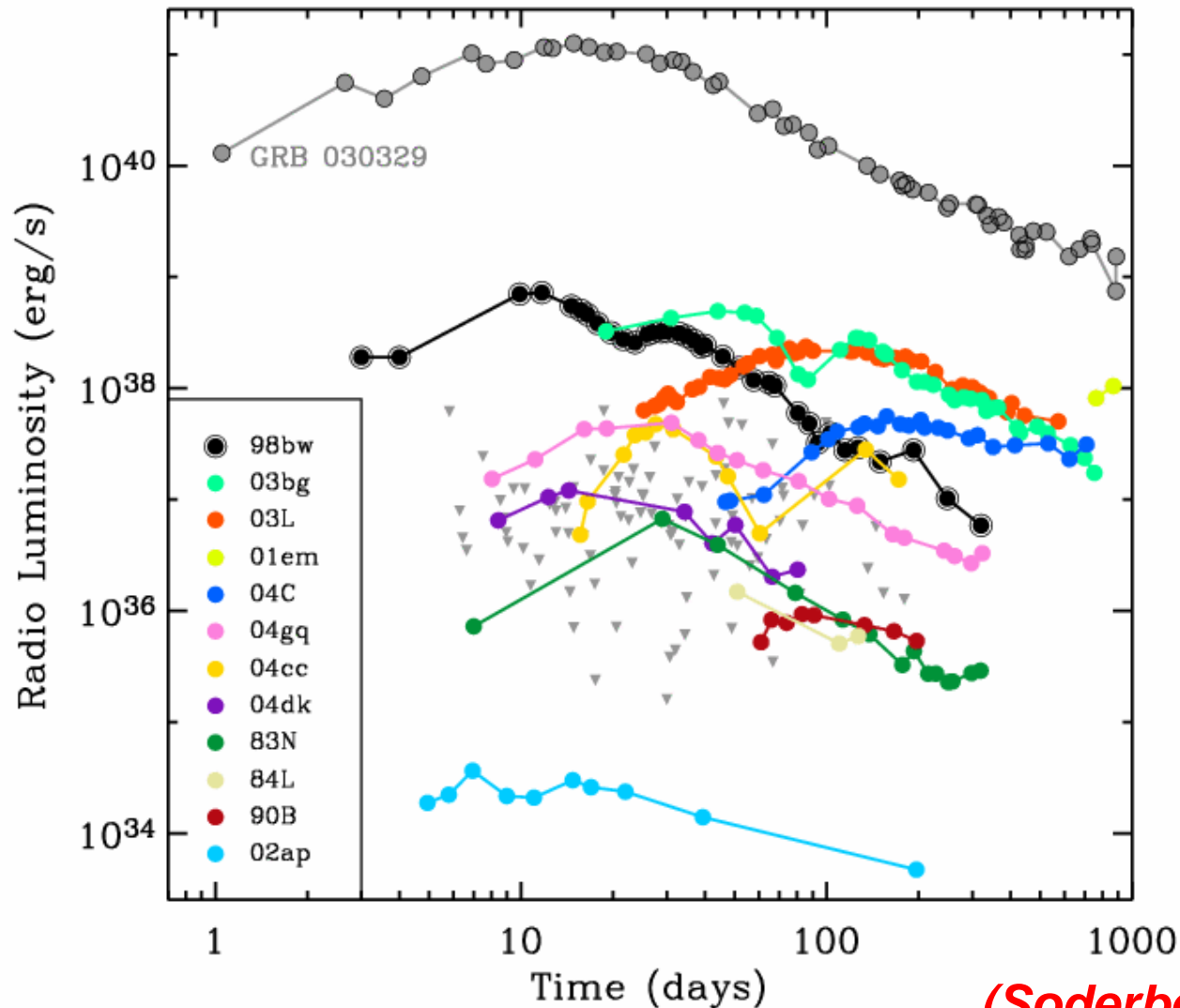
(Soderberg, ApJ, in press)

Our VLA Survey of Type Ibc Supernovae



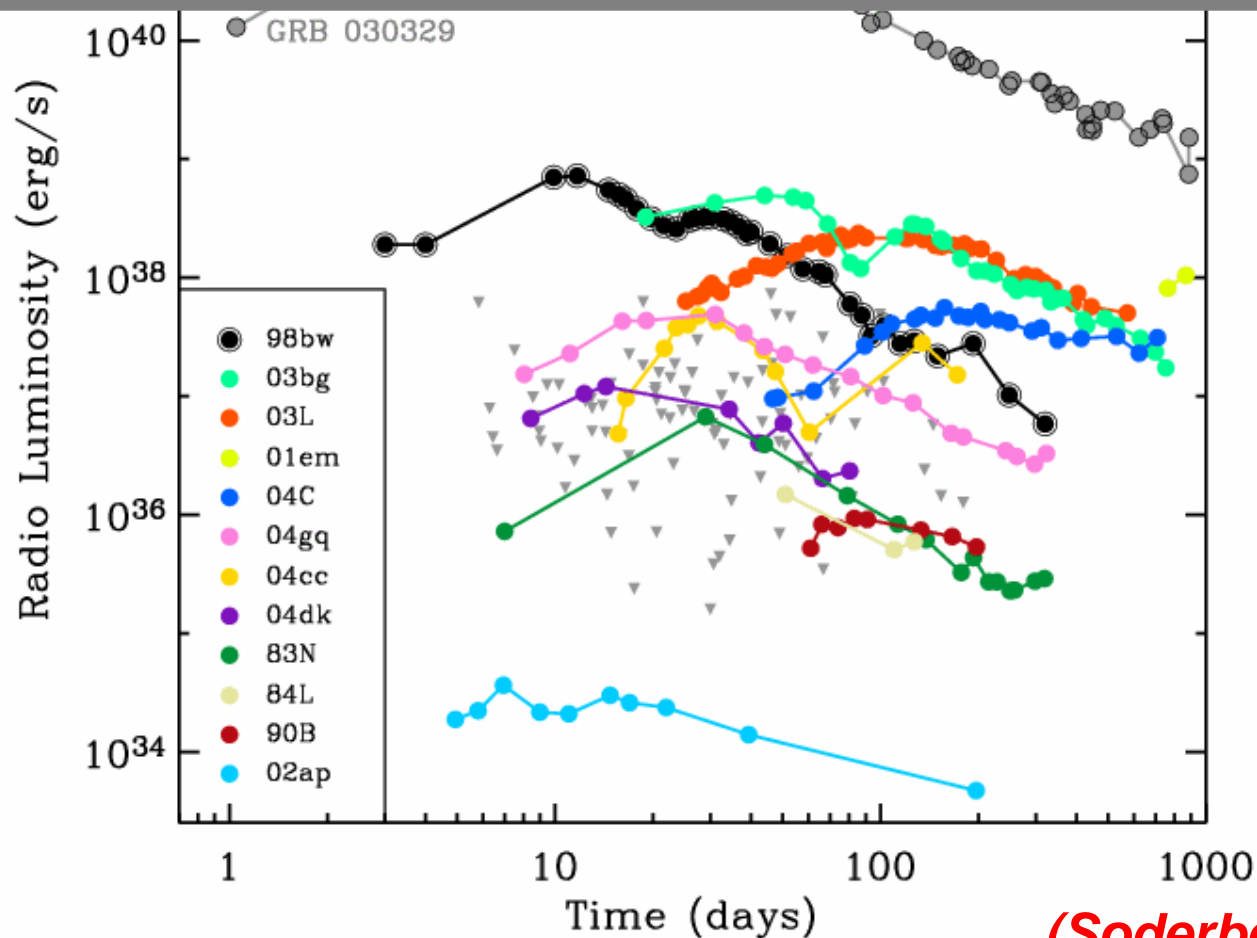
(Weiler 1986, Kulkarni 1998, Berger 2002, Soderberg 2004,2005a & in prep)

SINCE 2002, WE'VE OBSERVED EVERY TYPE IBC SN WITHIN 100 MPC WITH VLA.



Early Radio Data Constrain on-axis Ejecta ($< 30^\circ$)

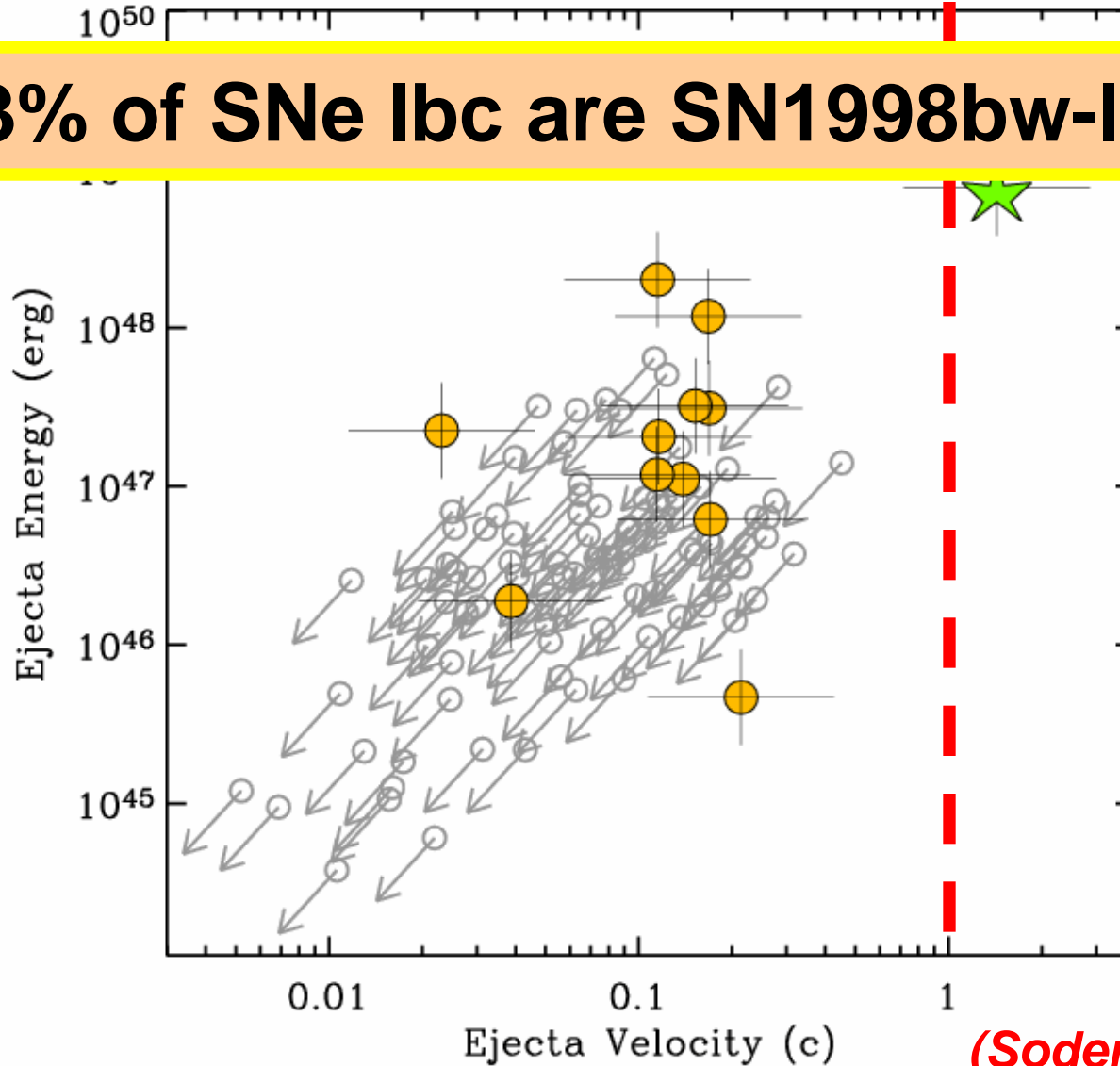
102 local SNe Ibc and NONE like 98bw



(Soderberg, in prep)

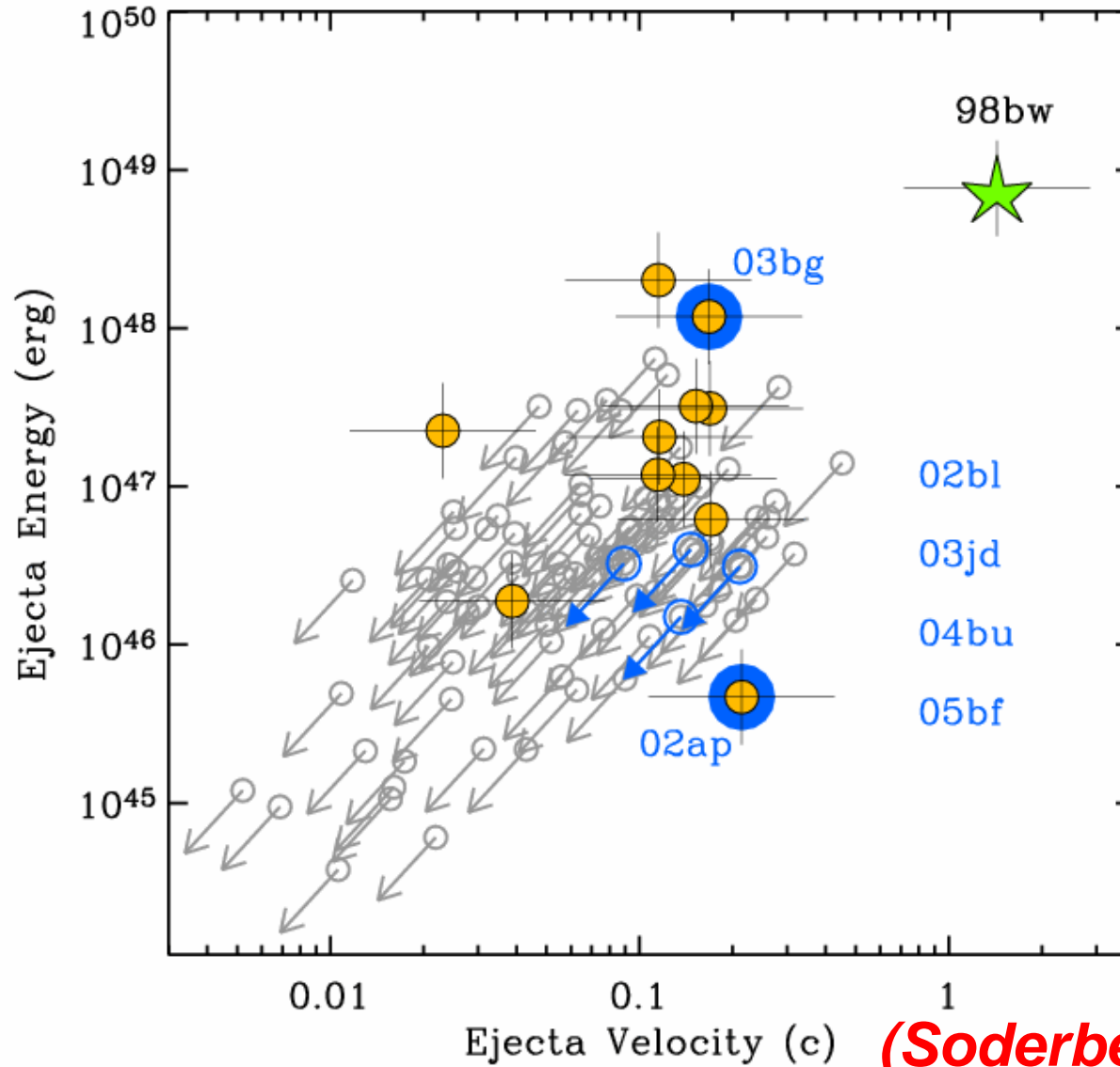
Early Radio Data Constrain on-axis Ejecta ($< 30^\circ$)

$< 3\%$ of SNe Ibc are SN1998bw-like

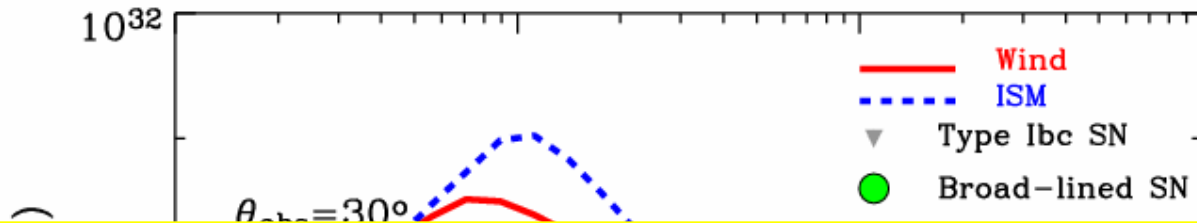


(Soderberg, in prep)

Early Radio Data Constrain on-axis Ejecta ($< 30^\circ$)

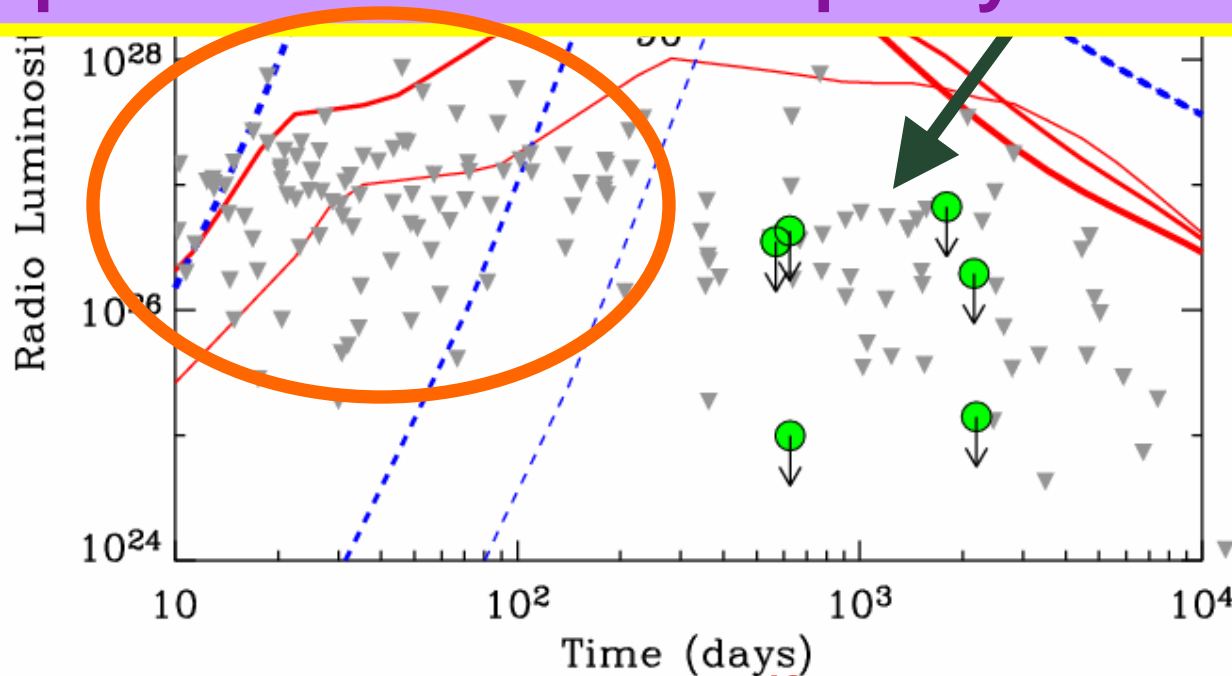


Late Radio Data Constrain Off-Axis GRBs



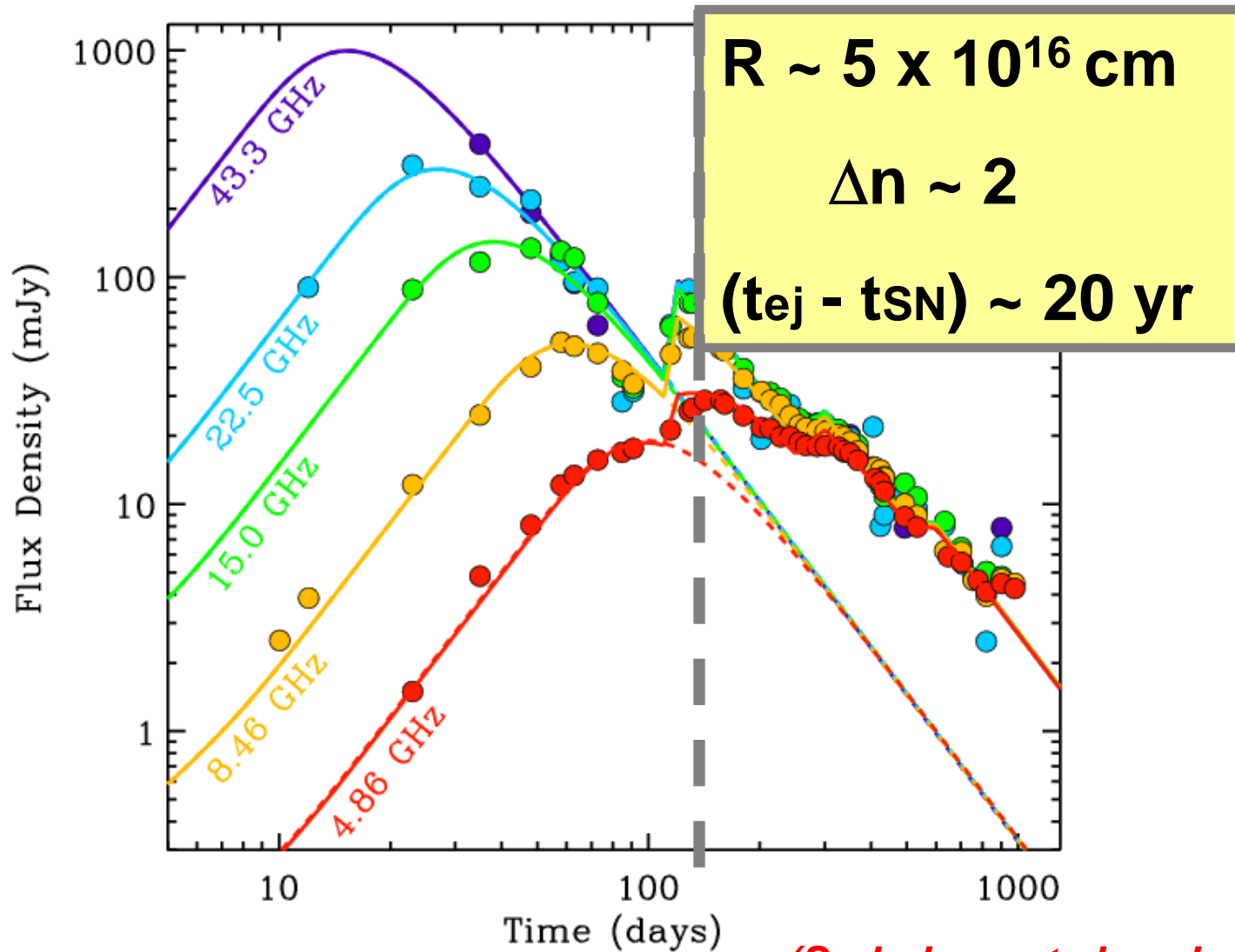
< 10% of SNe Ibc host off-axis GRBs

Broad optical lines are NOT a proxy for GRBs



(Soderberg et al, ApJ, in press)

Radio SNe Ibc as a Tool: Unique Probe of the CSM



(Soderberg et al., submitted)

The High Points

1. Optical data suggest **similar Nickel-56 production mechanisms** for both local and GRB-associated SNe Ibc.
2. Our dedicated radio survey shows that **~10%** of SNe Ibc are radio bright, **<3 %** are like 98bw, **<10%** host off-axis GRB jets.
3. “Hypernovae” do not serve as a proxy for bright optical luminosity, relativistic ejecta or off-axis GRB jets. **Asymmetries are not consistent with GRB jets.**

Optically Thin Variations:

Did **SN2001em** host an Off-Axis GRB?

Based on just two radio spectra:

→ **VLBA shows $v < 0.2 c$, NO GRB**

(Bietenholz & Bartel, 2005)

Optical Spectra show strong $H\alpha$

(Soderberg et al. 2005)

Simply a SN Ibc w/ CSM interaction

(Chugai & Chevalier, 2005)

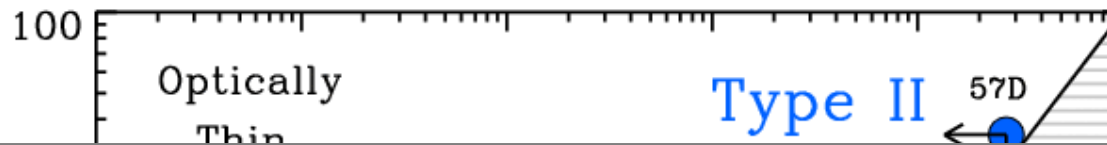
9.5

10

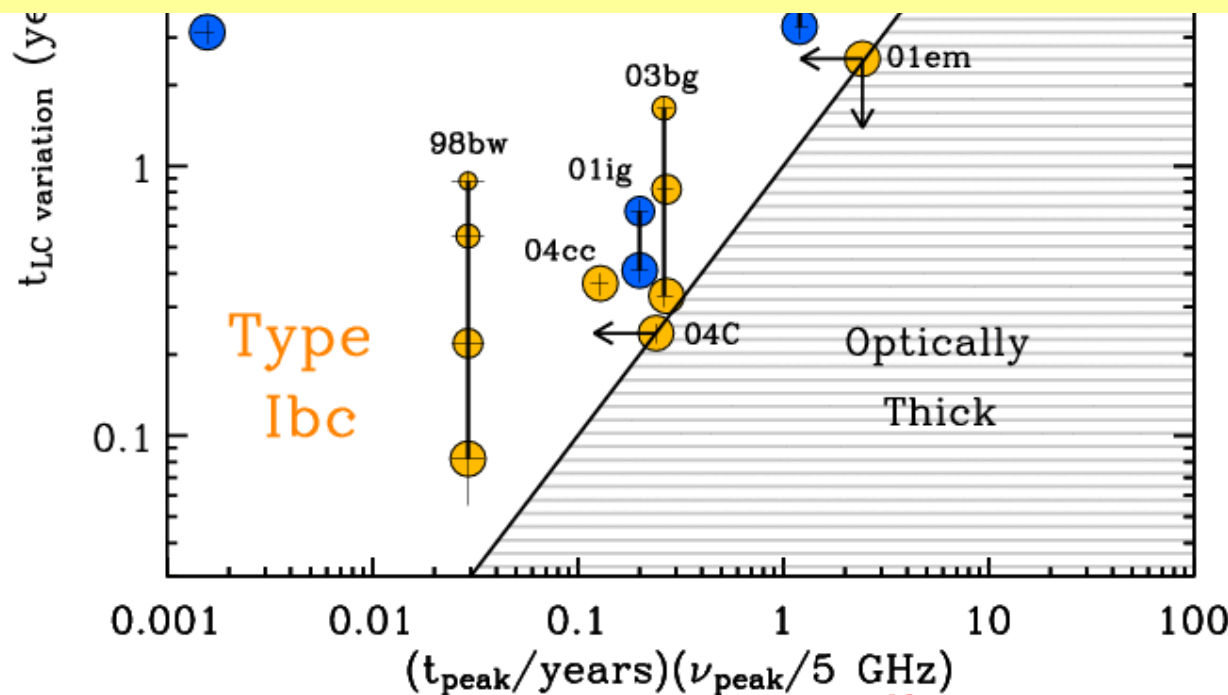
10.5

$\lg \nu$ (Hz)

Radio Variability Does NOT imply a Central Engine

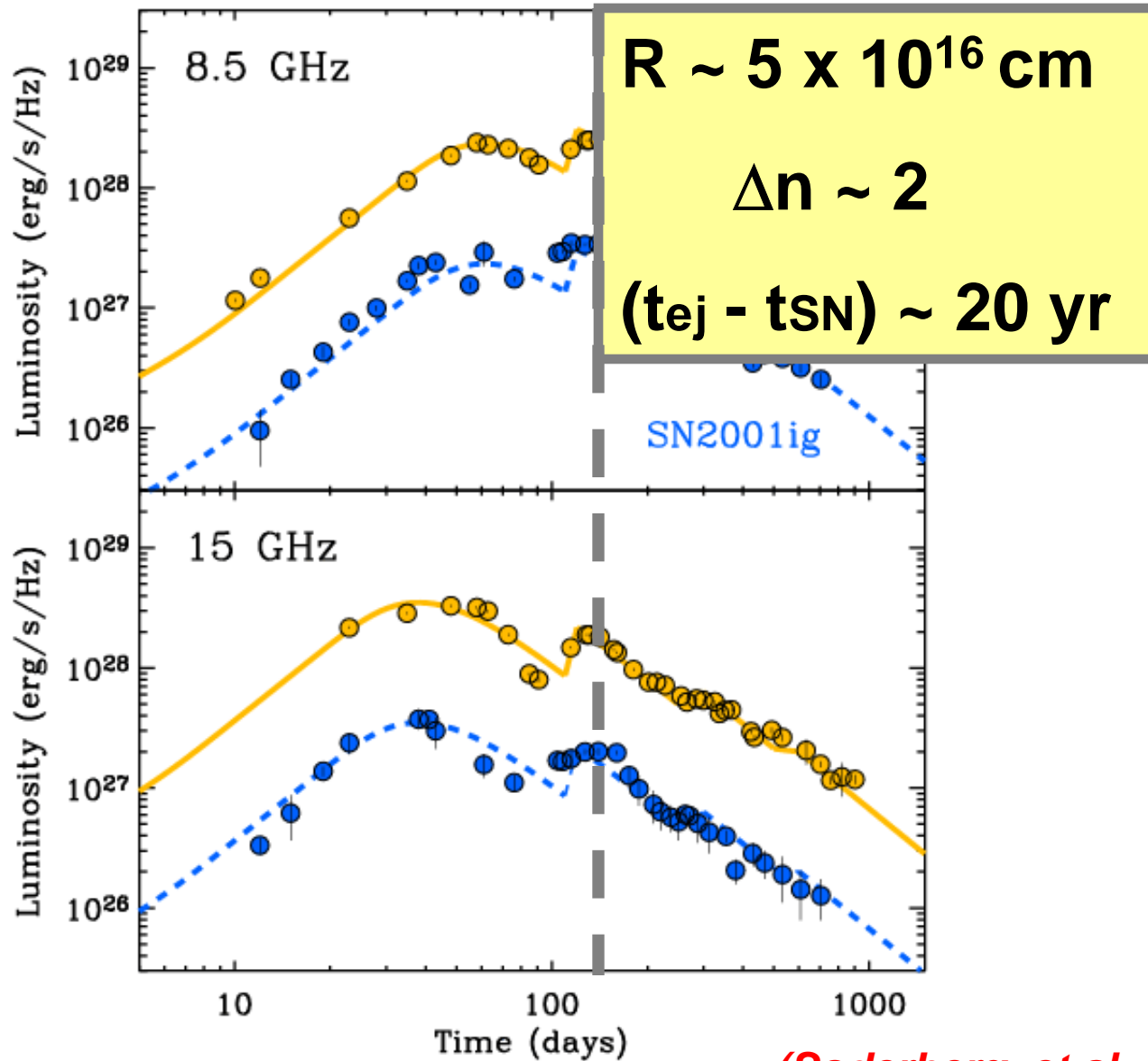


Radio variability is NOT a proxy for off-axis GRBs



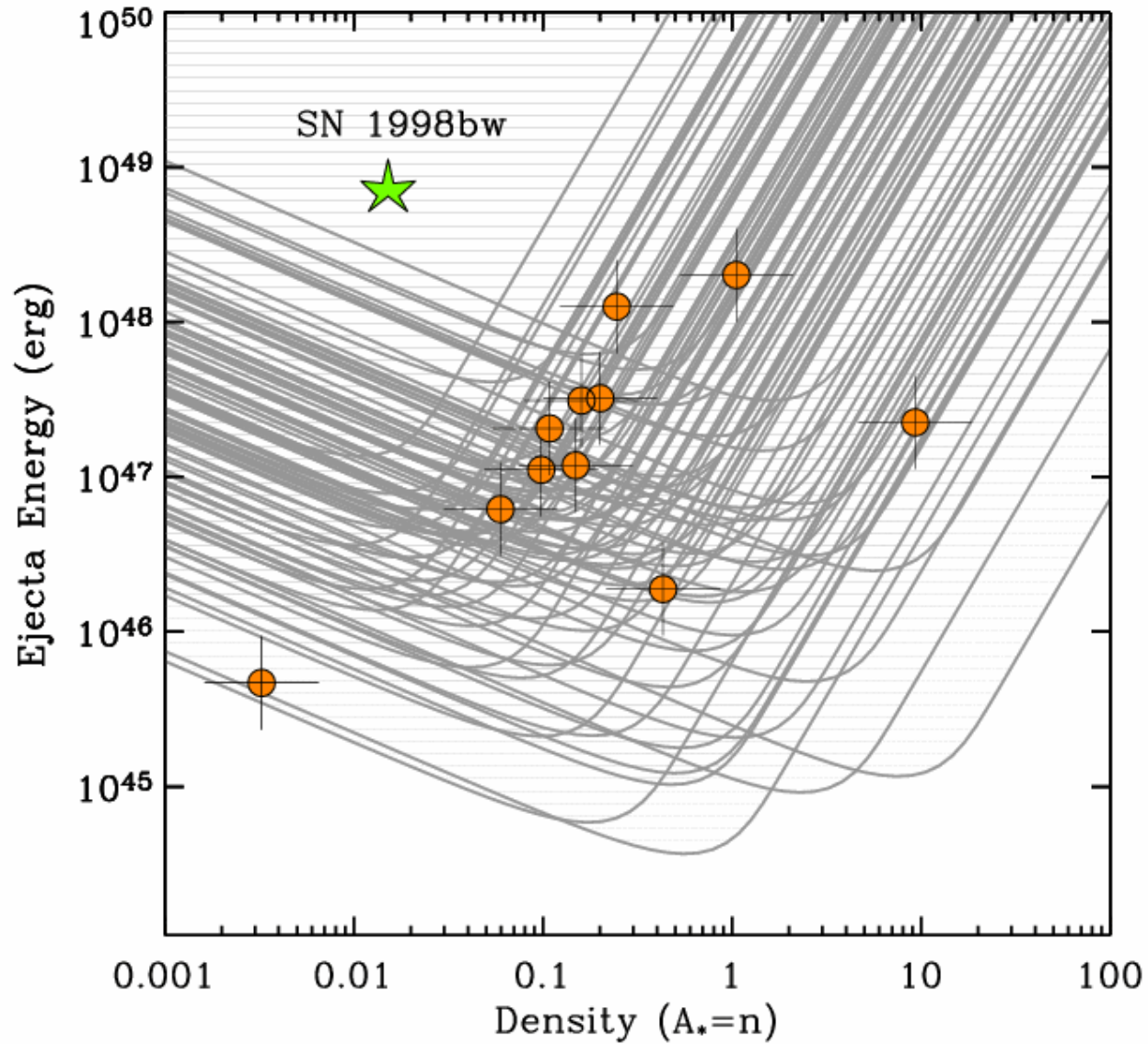
(Soderberg, et al., submitted)

SNe Ibc as a Probe of the CSM

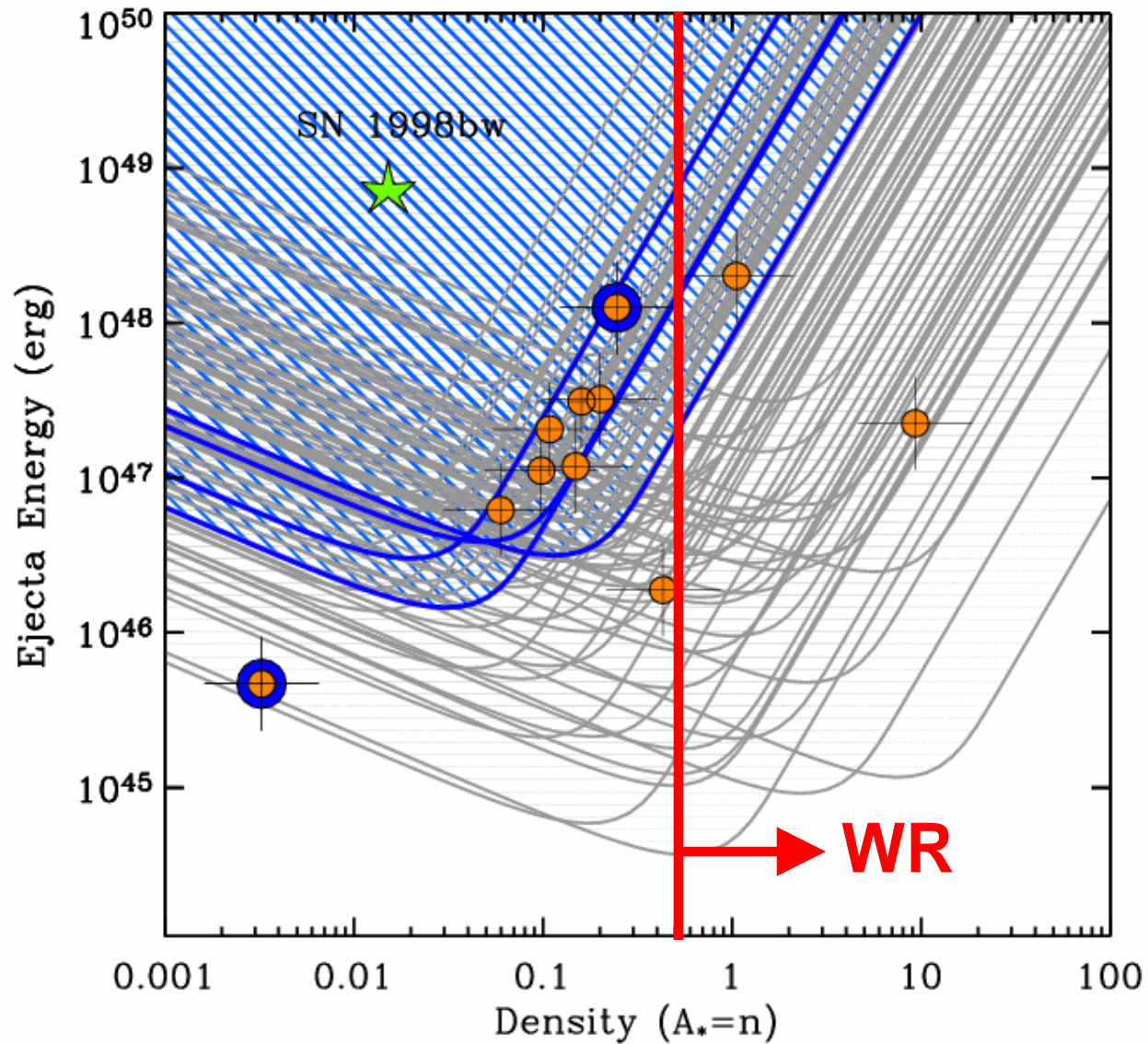


(Soderberg, et al., submitted)

Constraints on Energy & Density



Constraints on Energy & Density

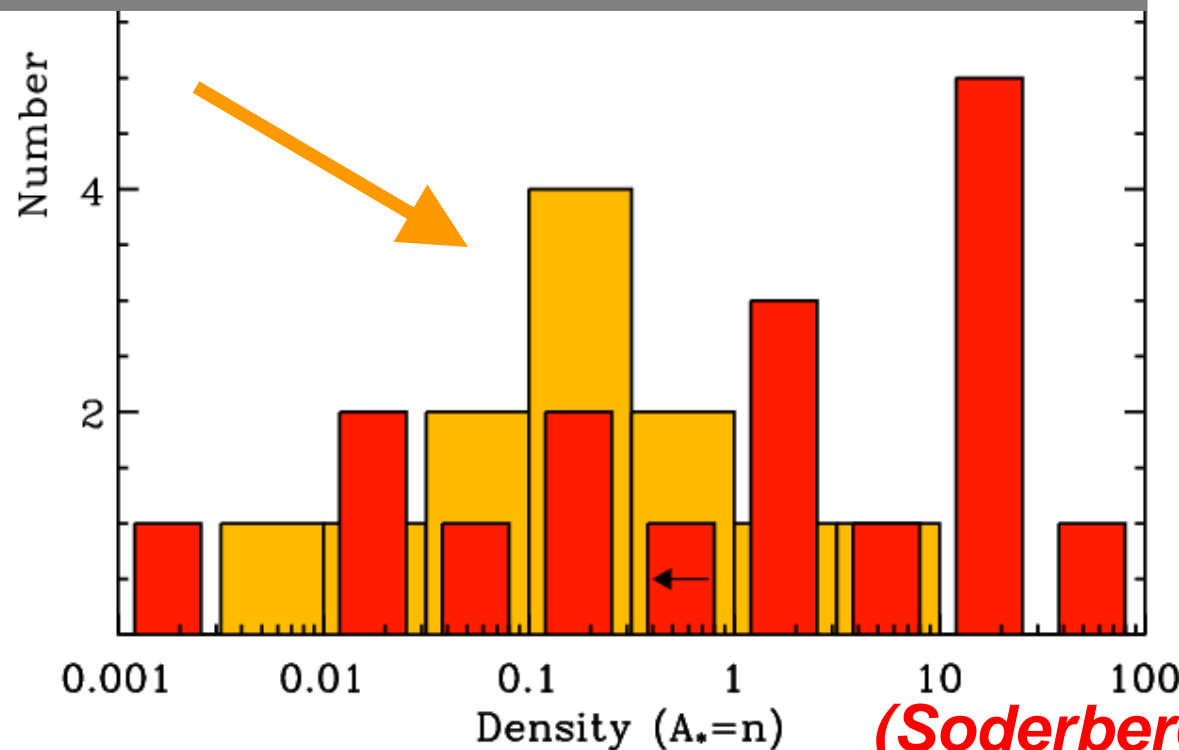


Density Measurements for GRBs and SNe Ibc

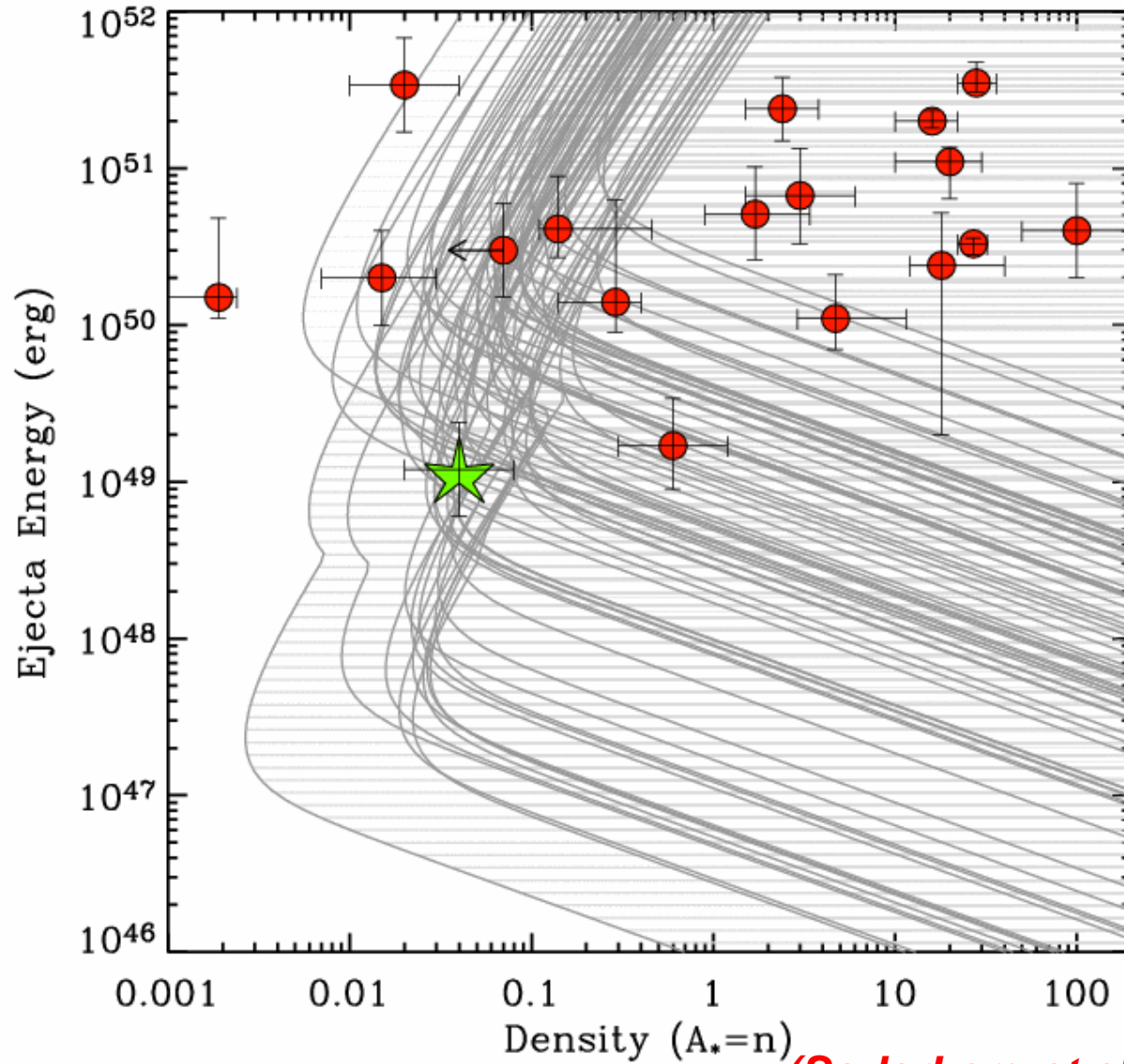


Radio SNe Ibc show $\sim 10^{-6} M_{\odot}/\text{yr}$

→ Overall consistent with local Wolf-Rayets



Constraints on Energy & Density

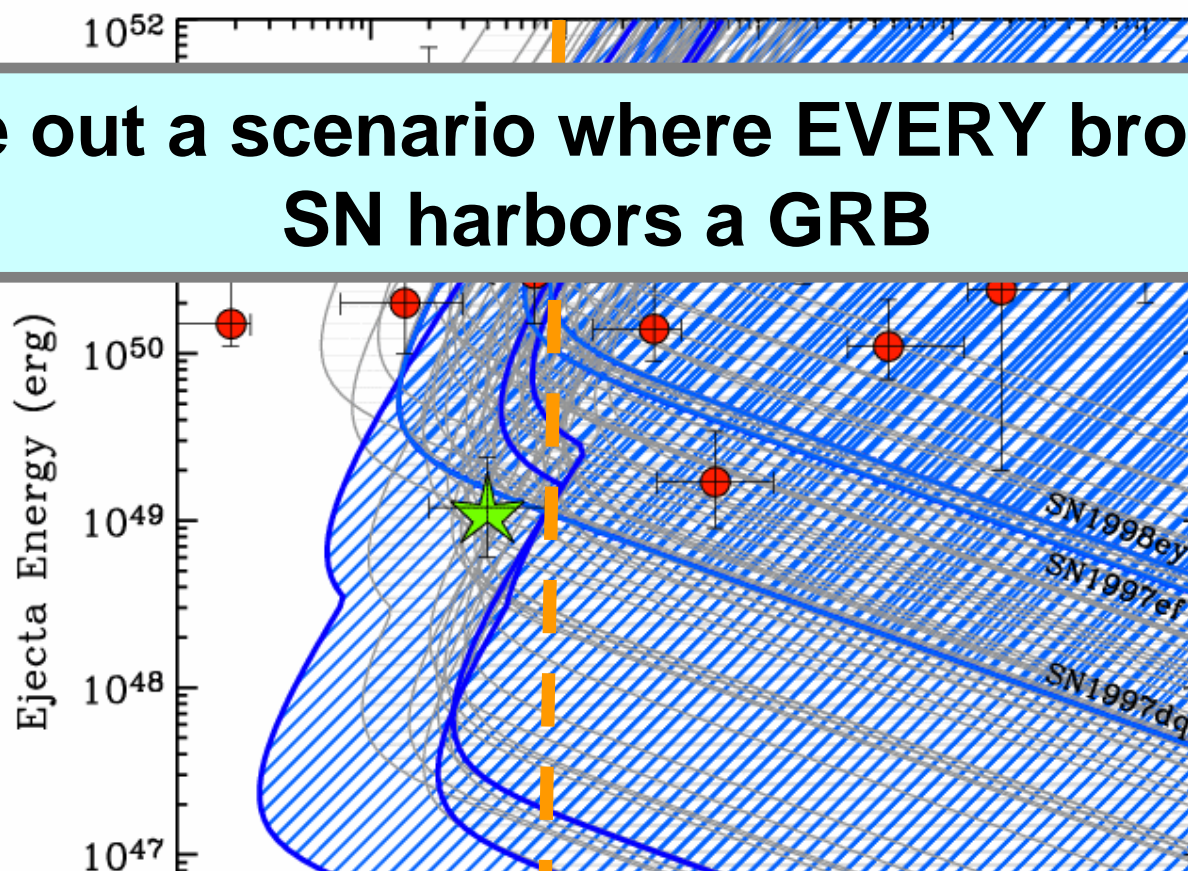


GRBs

(Soderberg et al, ApJ, in press)

Can Low Densities HIDE Off-Axis GRBs?

We rule out a scenario where EVERY broad-lined SN harbors a GRB



BUT: Low densities are inconsistent with radio modeling of local SNe Ibc

(Soderberg et al, ApJ, in press)