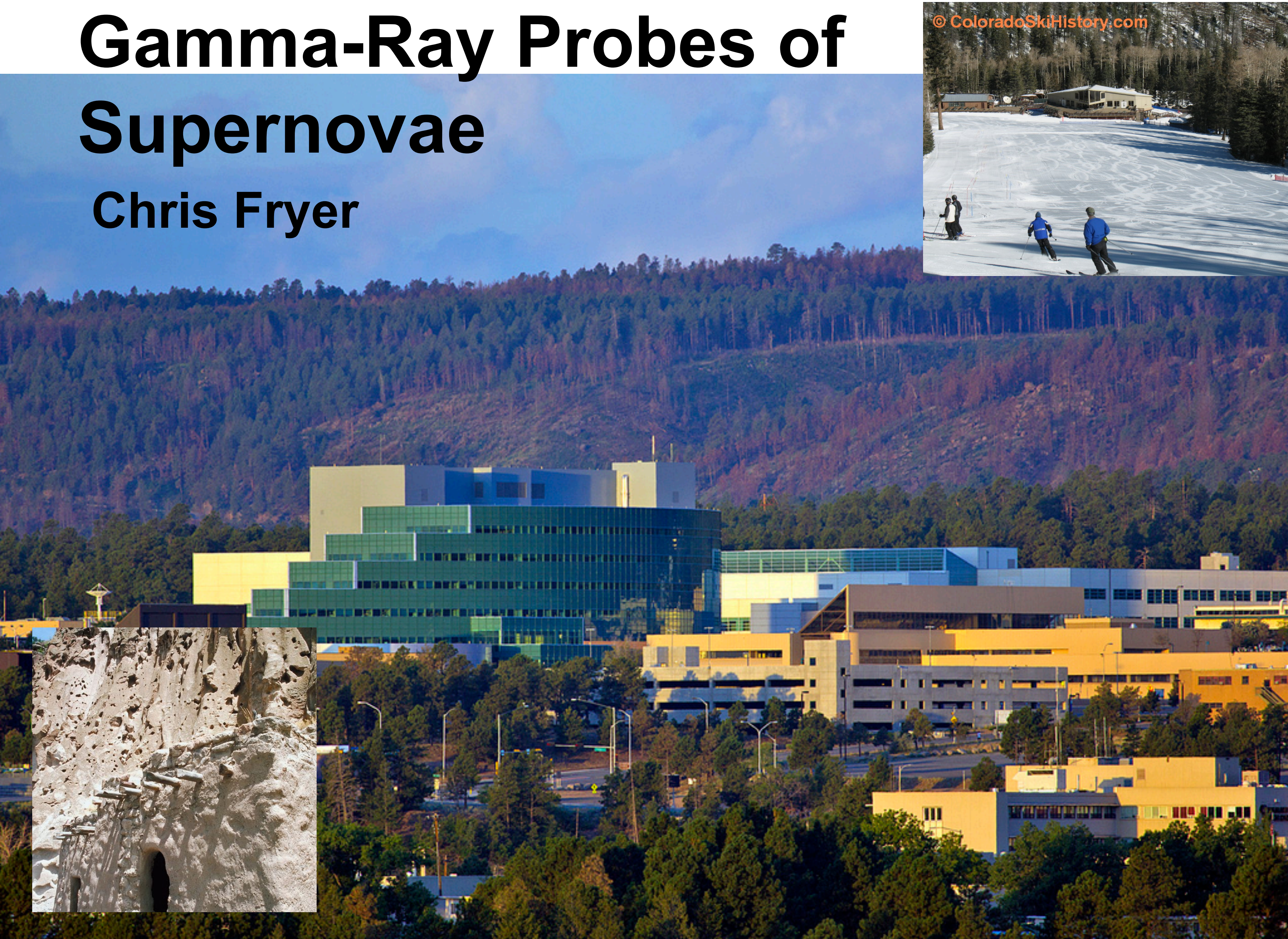
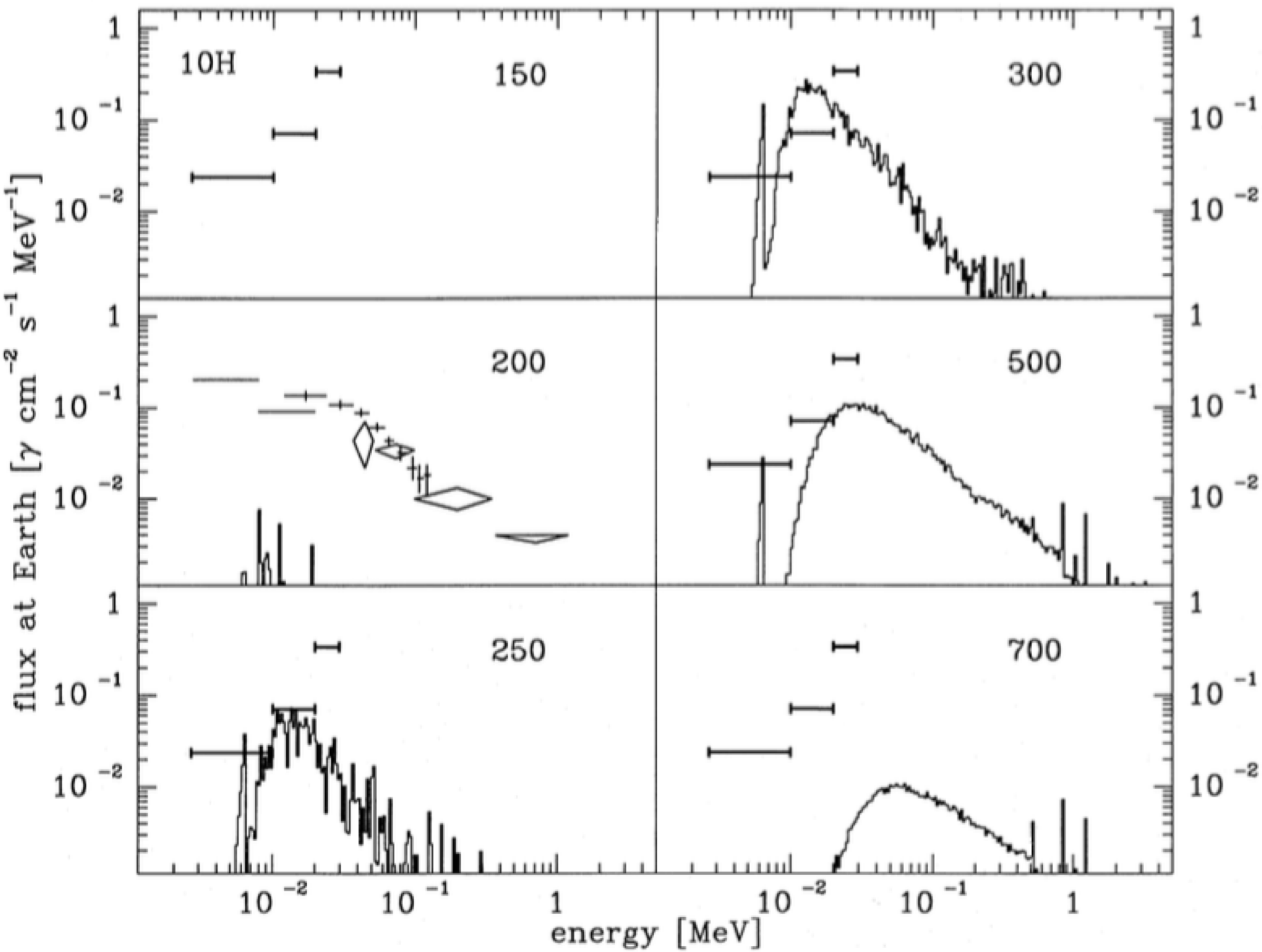
Gamma-Ray Probes of Supernovae

Chris Fryer

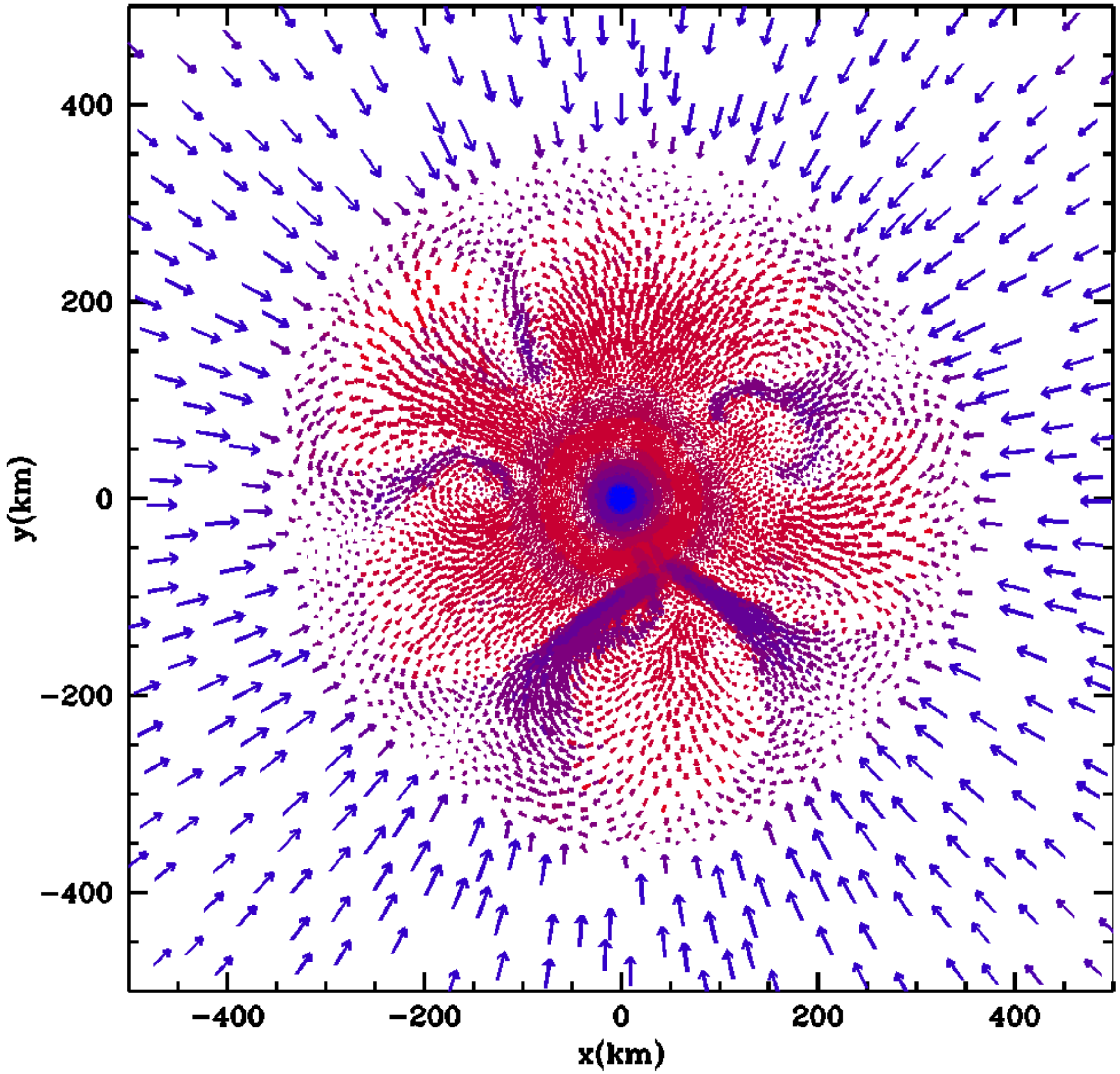


Gamma-Rays and SN 1987A

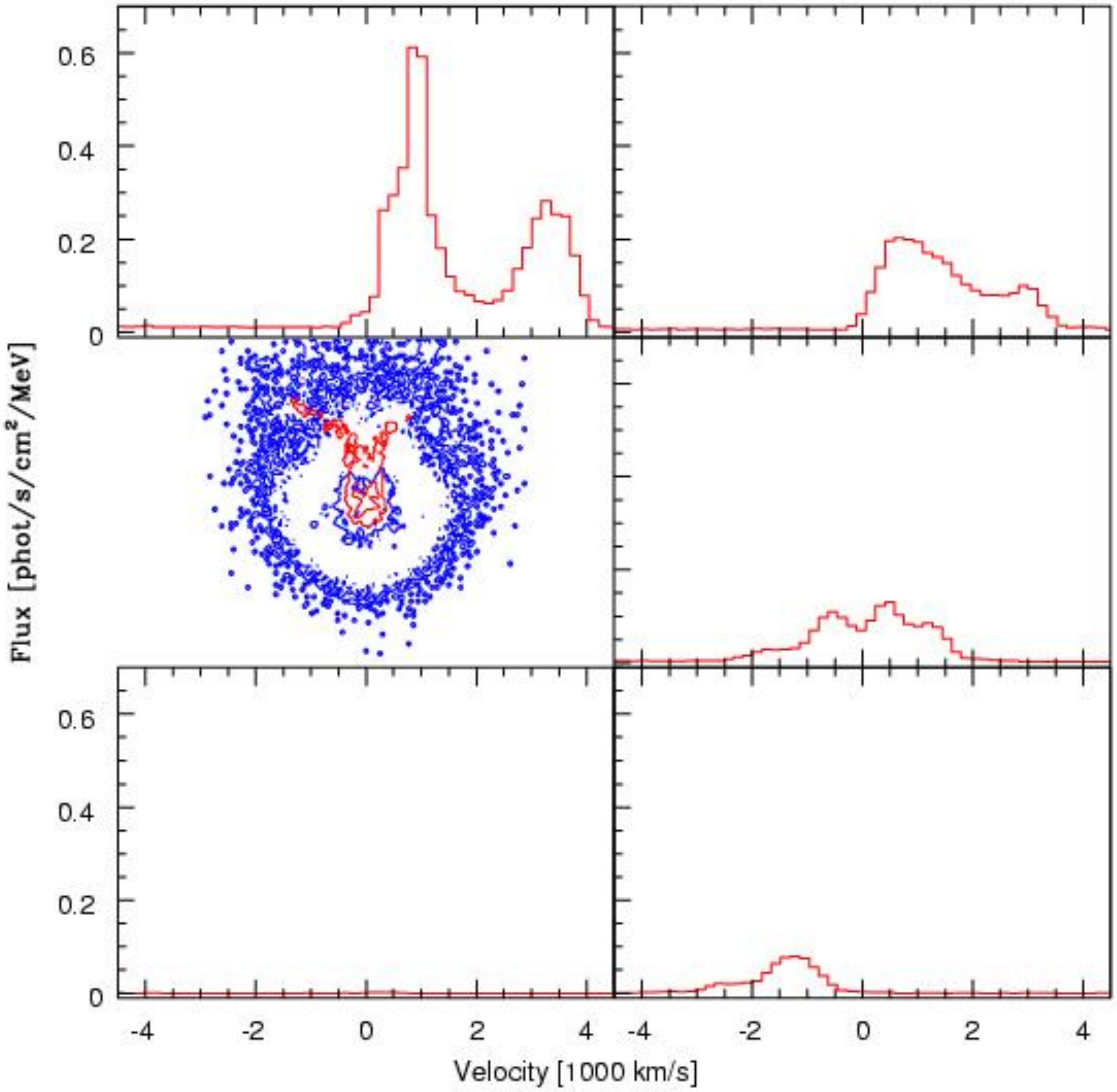


Pinto & Woosley 1988

- Early gamma-rays require the ^{56}Ni to be mixed out.
- Mixing was insufficient unless the explosion itself was asymmetric.
- This led theorists to the current convective paradigm behind core-collapse supernovae.



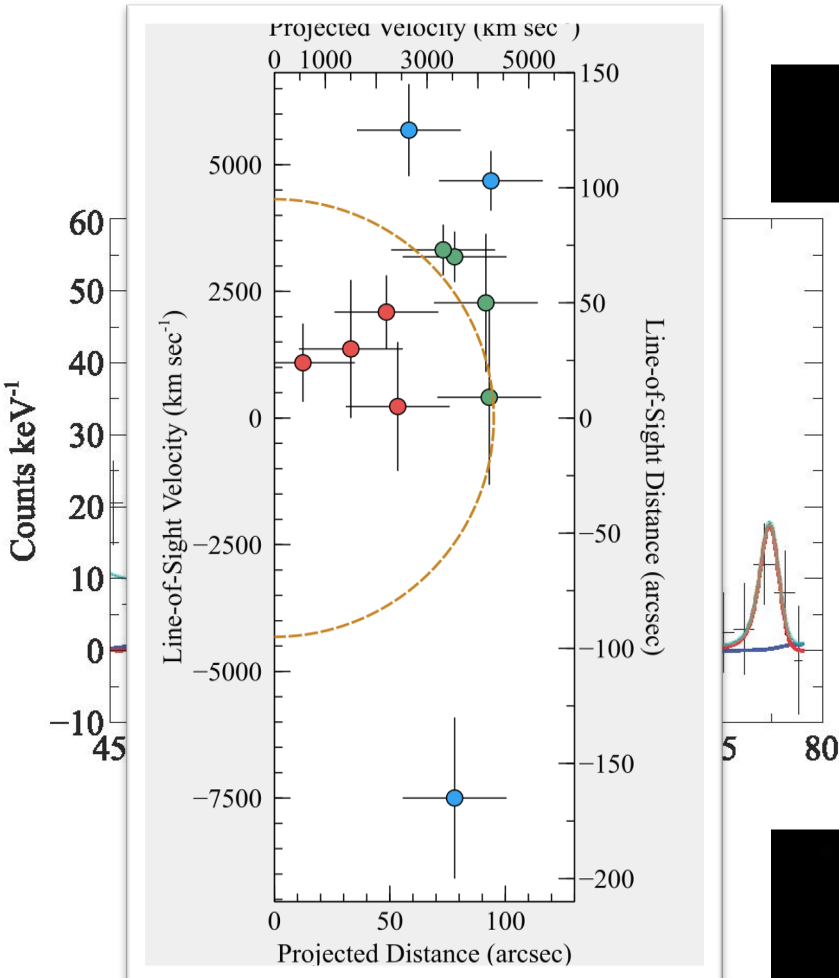
Fryer & Warren 2002

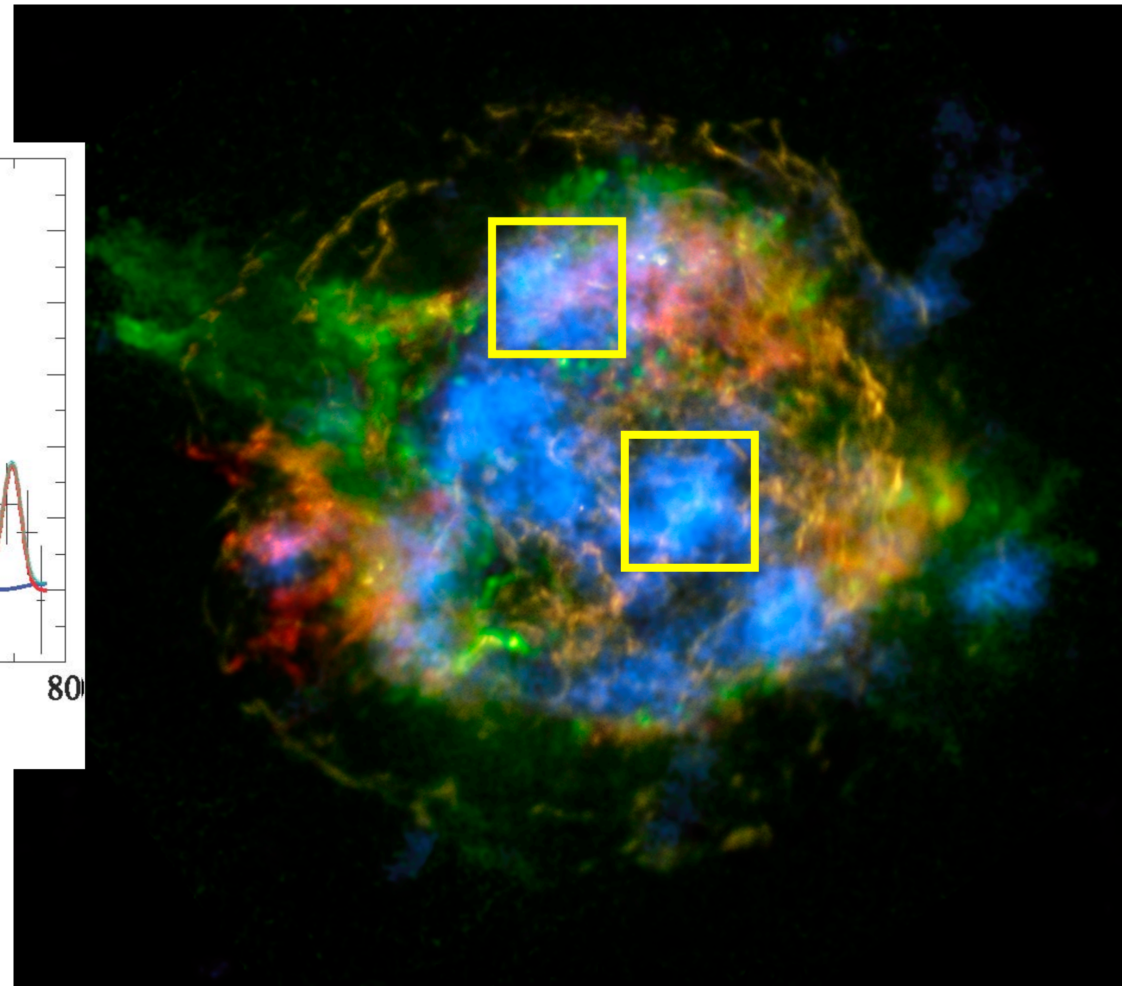


Redshifted lines in SN 1987a argued for an explosion that was stronger along one axis. Low mode convection! More of these observations are essential!

Hungerford et al. 2004

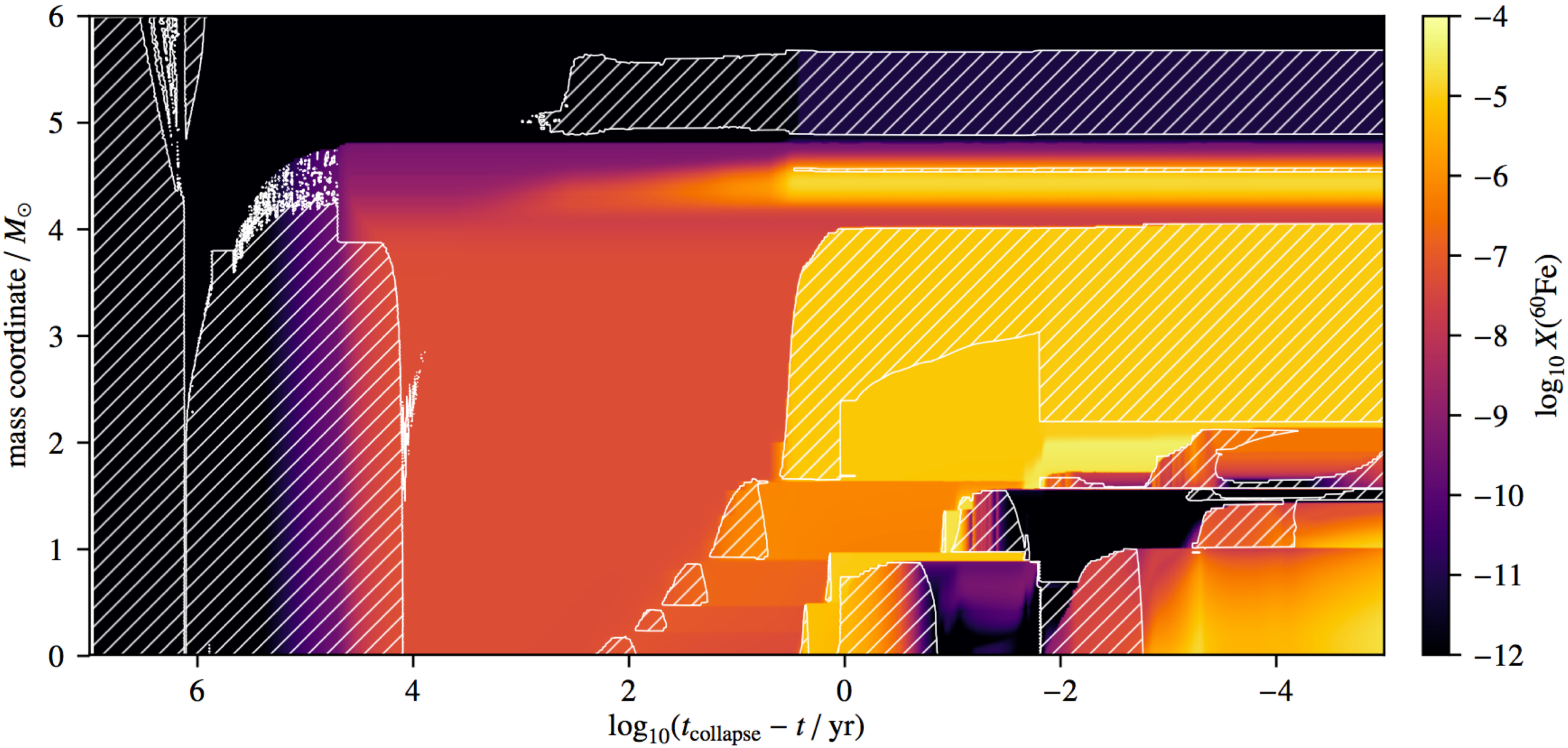
NuSTAR and Cassiopeia A



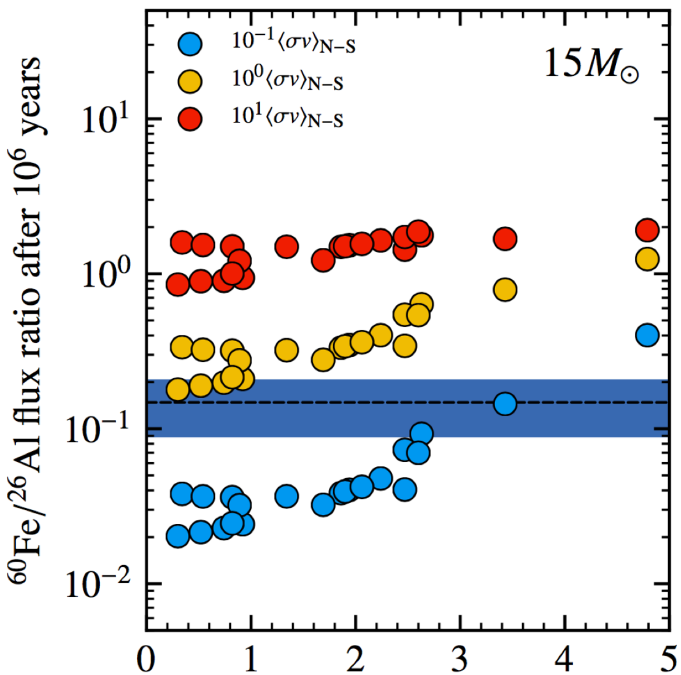


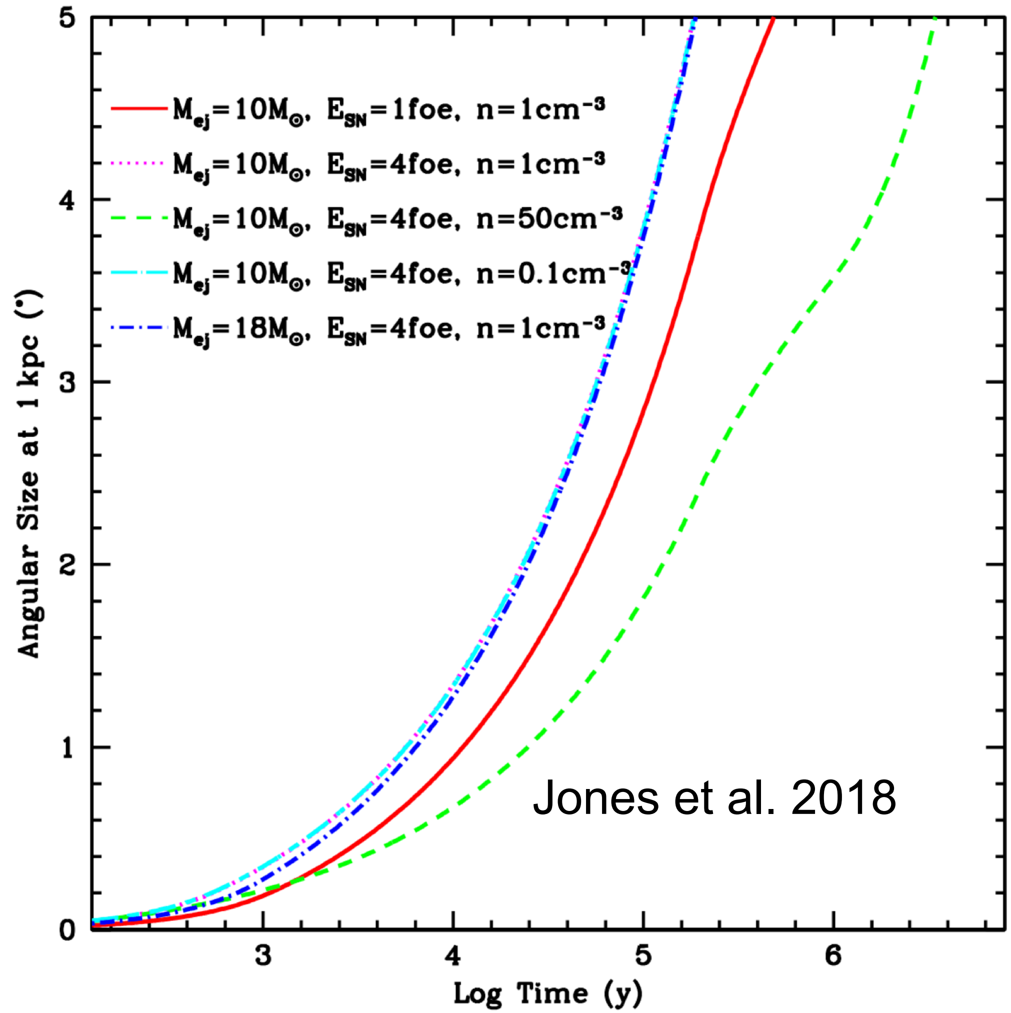
Grefenstette et al. 2017

^{26}Al and ^{60}Fe are produced in stellar burning layers and destroyed/produced in the SN explosion: probes of the progenitor, the explosion and nuclear rates.



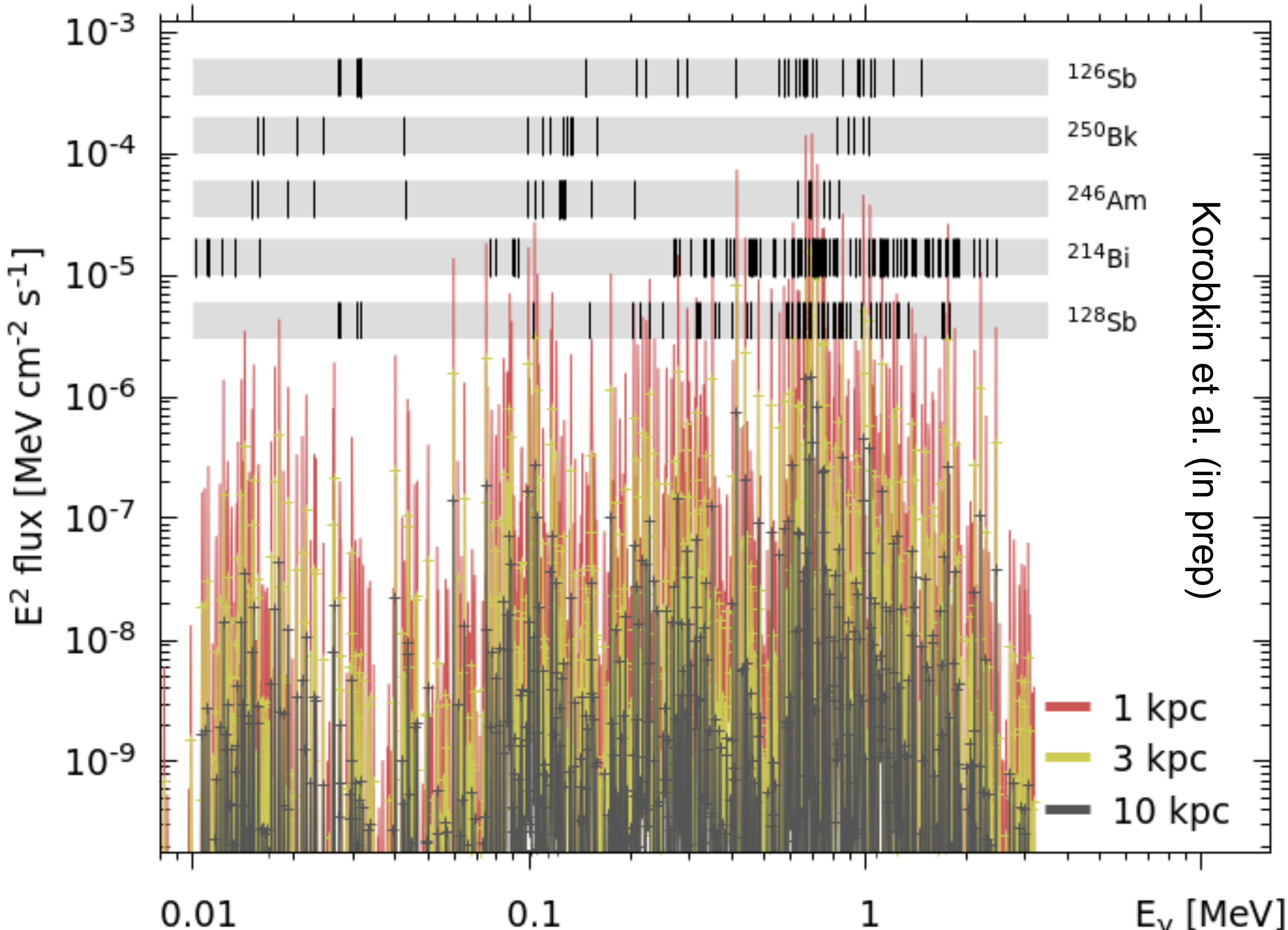
- Most observations measure diffuse emission.
- Can we observe an old remnant?





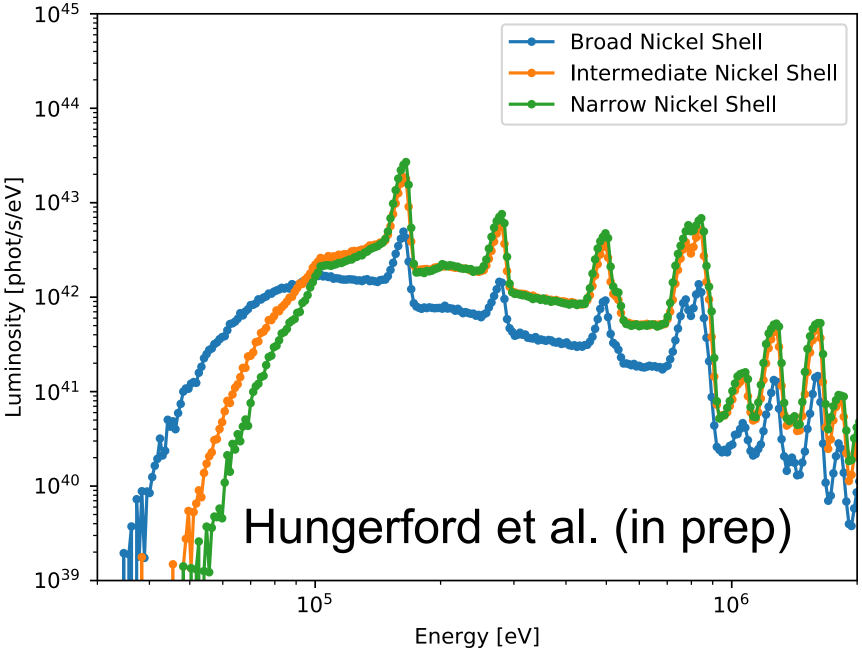
Possible probes of explosion energy and nuclear rates.

A nearby kilonova remnant would truly probe heavy element production

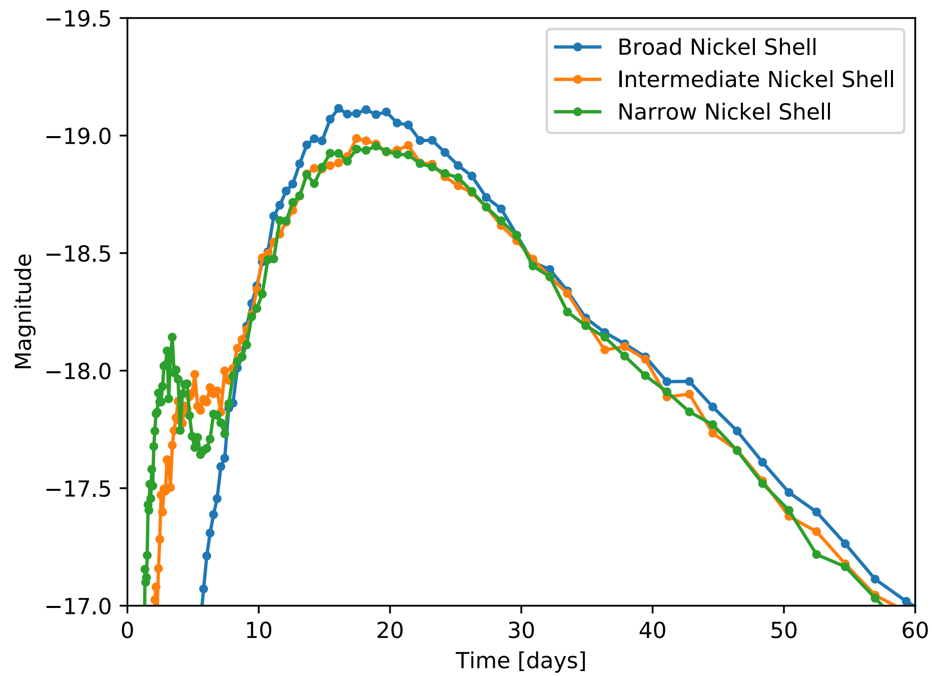


Korobkin et al. (in prep)

Type Ia supernovae: again, gamma-rays probe the engine.



- Gamma-ray observations of SN2014J showed that ^{56}Ni could be mixed at different levels than we previously assumed.
- This distribution can alter the light-curves.



- Gamma-rays are ideal probes of this distribution.

Gamma-rays are excellent probes of Supernovae

- Observations of SN87A and the Cas A supernova remnant were key observations behind the current supernova paradigm
- ^{26}Al and ^{60}Fe probe stellar burning layers, nuclear physics and, to a lesser extent, the supernova engine
- If we are lucky, gamma-rays can probe yields in kilonova remnants?
- Gamma-rays are important for SN Ia as well.