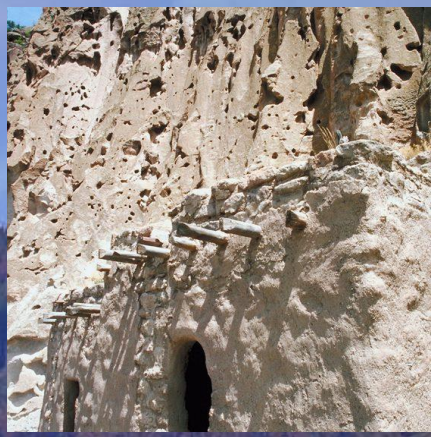
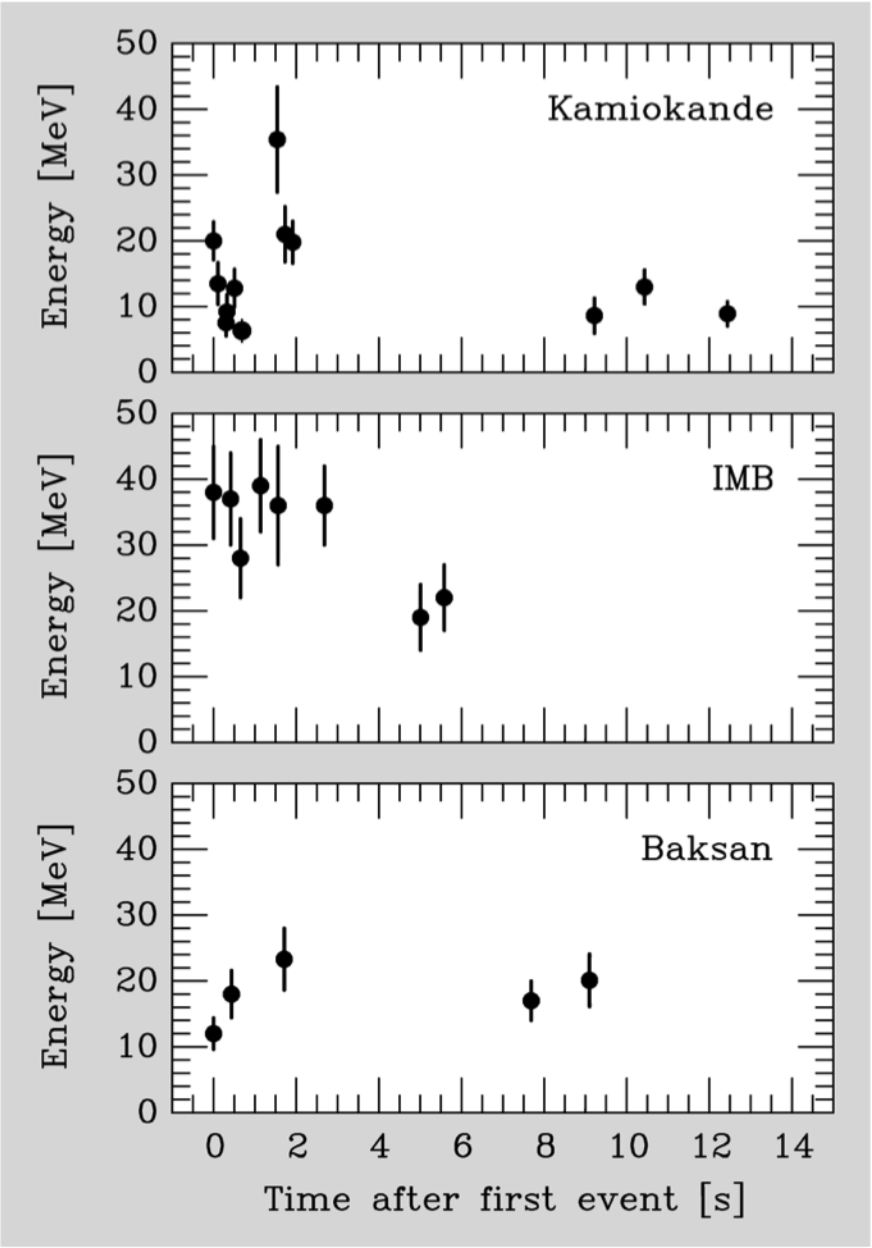
Multi-messenger Astronomy and Core-Collapse Supernovae

Chris Fryer



SN 1987A – A Plethura of Firsts

- Sanduleak -69 202 (Blue Supergiant!)
- Neutrinos – proof that some supernovae arise from stellar collapse
- Gamma-Rays probed the production of ^{56}Ni (It is mixed out… solving this led to the current engine paradigm)



Multi-messenger Signals in the 2020s

New Discoveries

- Expanding survey and and follow-up telescopes observe more progenitors and new types of transients

Probes of the Engine

- Neutrinos – Diffuse detection, detailed signals in the MW, trace detections further out
- GWs – turbulence in MW, rotation rates further out

Multi-messenger Signals in the 2020s

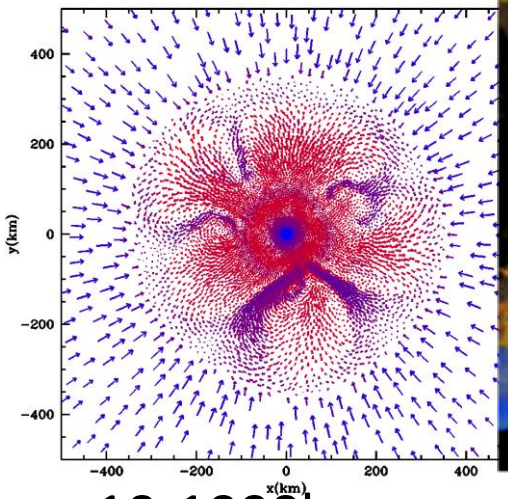
Nucleosynthetic Yields:

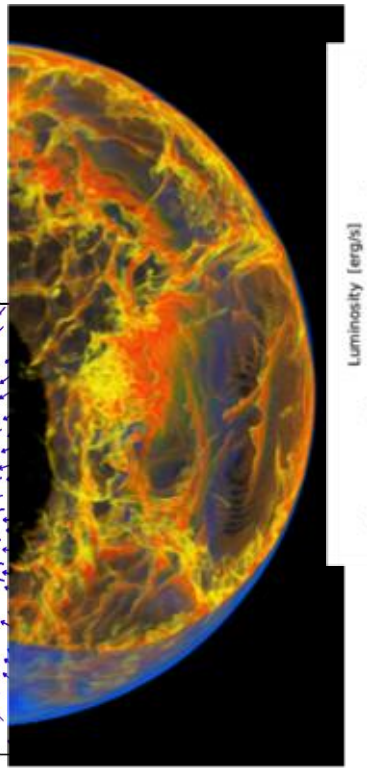
- Nebular Spectra:
- Gamma-rays probe radioactive isotopes produced in the star and the engine
- Dust Grains: new instruments are allowing measurements of multiple isotopes for a single micron-sized grains.
- Supernova Remnants (shocked abundances)

Different Messengers and Wavelengths Probe Different Parts of the Supernova

Stellar Mixing Probed by Yields

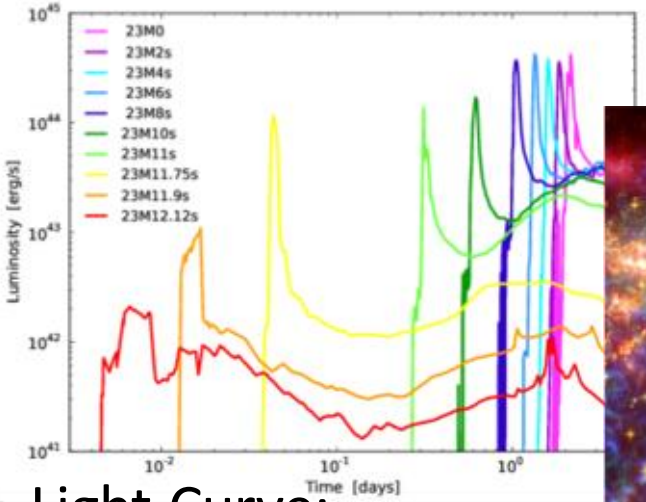
Engine: Probed by GWs, ν's and Yields





10-1000km

1000-10^6km



Light-Curve: EM probe star, CSM and SN

10^7-10^{11}km

Remnant: CRs and EM probe shocks, yields and and SN

>10^{12}km