Probing Pair-Instability Supernovae via ^{56}Ni Decay Signatures

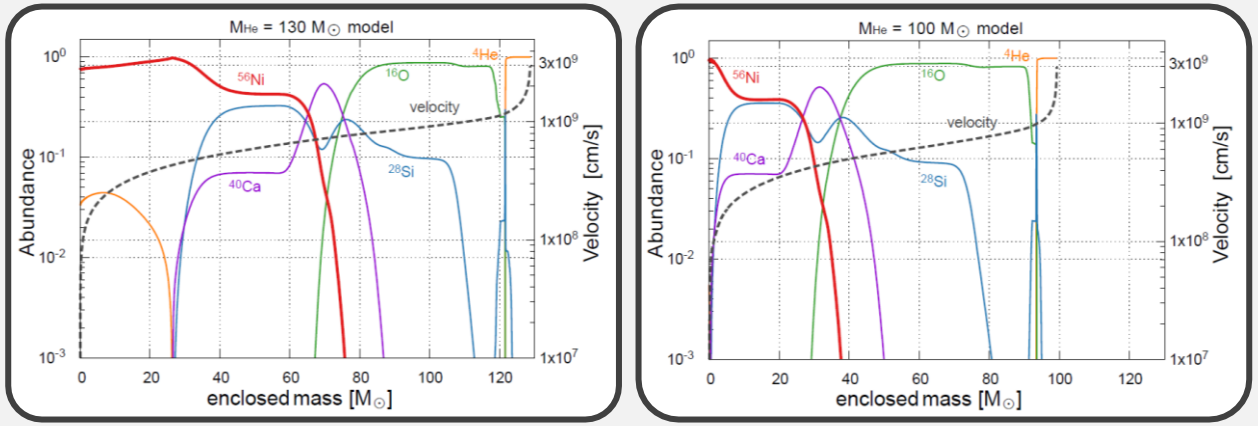
Ryo Sawada, (Institute for Cosmic Ray Research, The University of Tokyo)

1. Background

- PISNe: Thermonuclear explosions of very massive stars (He core ≥ 65 $M_\odot$)
- Extreme cases: up to ~60 M⊙ of 56Ni
  → strong γ-ray lines from decay chain
- No definitive detection yet;
  γ/hard X-ray observations can directly confirm?

2. PISN models:

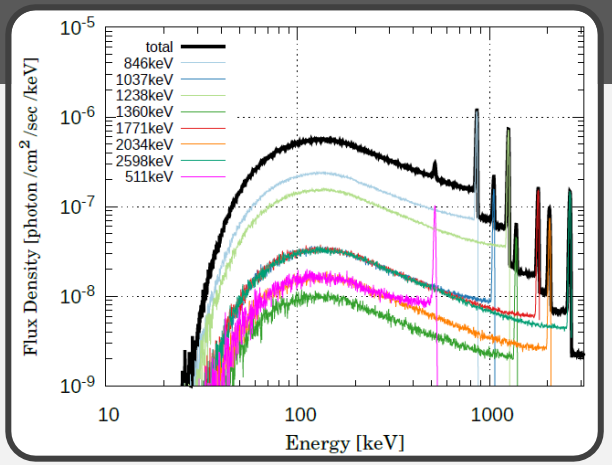
He-core masses 100 & 130 M⊙ (Z=10^{-5}), computed with MESA r24.08



available: arXiv:2503.21744

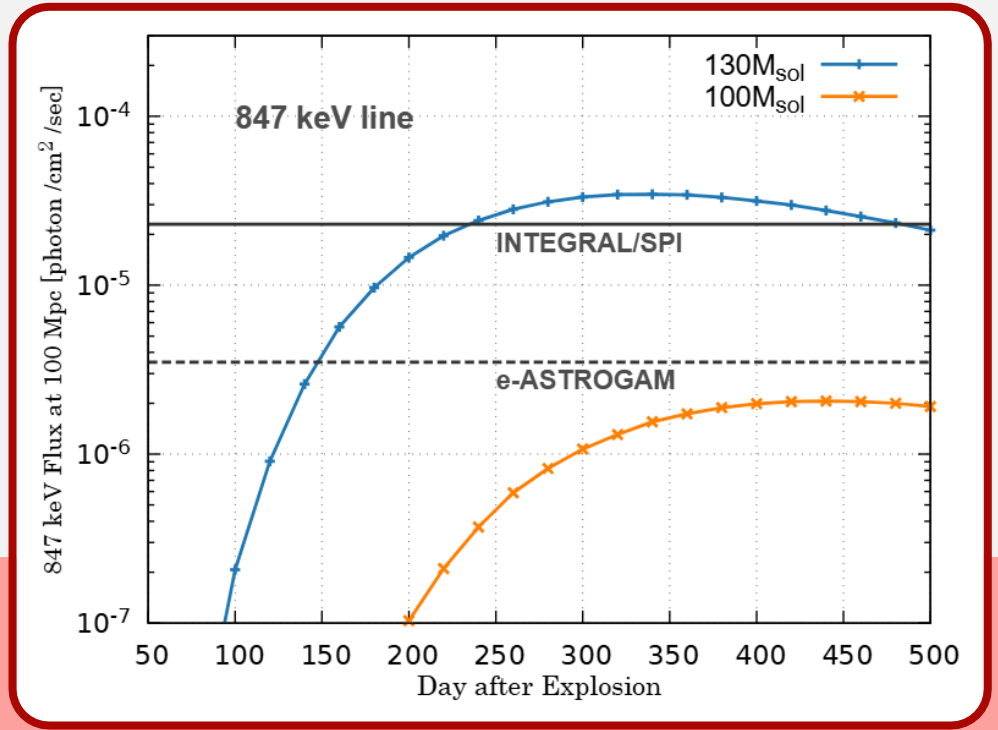
3. Monte Carlo γ-ray transport

- Compton scattering,
- Photoelectric absorption,
- Pair production,
- ex.) result;
  at 300 days after the explosion /w 130M⊙
  located at a distance of 100 Mpc.



4. Key Results

- Focus on key ^{56}Co lines: 847 keV



First γ/hard X-ray detectability study of PISNe; next-gen MeV missions can detect massive-core PISNe out to ~300 Mpc: event rate ~0.01–0.1 yr^{-1}.