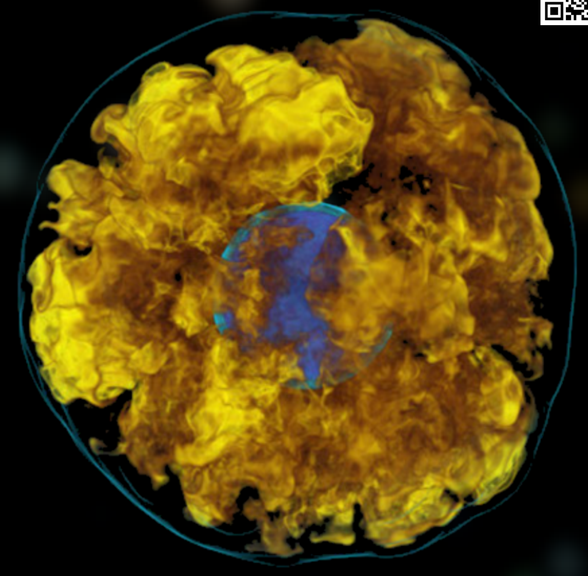
Constraining the Core Structure of Core-Collapse Supernovae

Brandon Barker[1], MacKenzie Warren[2], Sean Couch[1]

[1]Department of Physics and Astronomy, Michigan State University, East Lansing, MI 48824, USA
[2]Department of Physics, North Carolina State University, Raleigh, NC 27695, USA



Introduction

- Observations of core-collapse supernovae (CCSNe) reveal a wealth of information about the supernova ejecta, but tell little of the progenitor star.
- Most 1D explosion models do not accurately treat physics of the core (namely, neutrinos) and require artificial explosions.
- The explosion and its dynamics are dominated by the core structure and are sensitive to turbulence and convection.

Goals

- Make connections between observables of CCSNe and key properties of the progenitor's core.
- Provide a prescription for extracting these core properties from observations

Methods

- Use a new model for driving explosions in 1D [STIR, 1] to simulate 200 progenitors for 5 seconds past collapse.
- Use this as the input to the SuperNova Explosion Code [SNEC, 2] to simulate 300 days and obtain lightcurves.

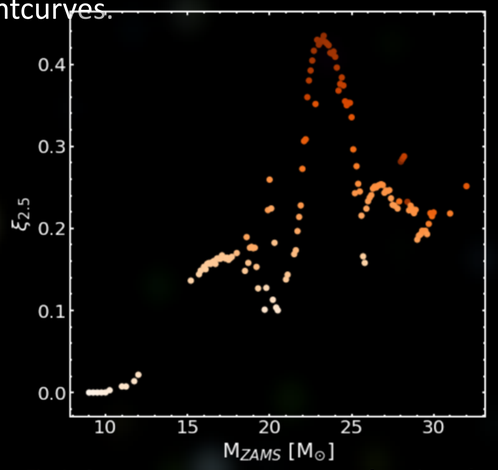


Fig 1: Compactness parameter as a function of progenitor mass, colored by resulting explosion energy.

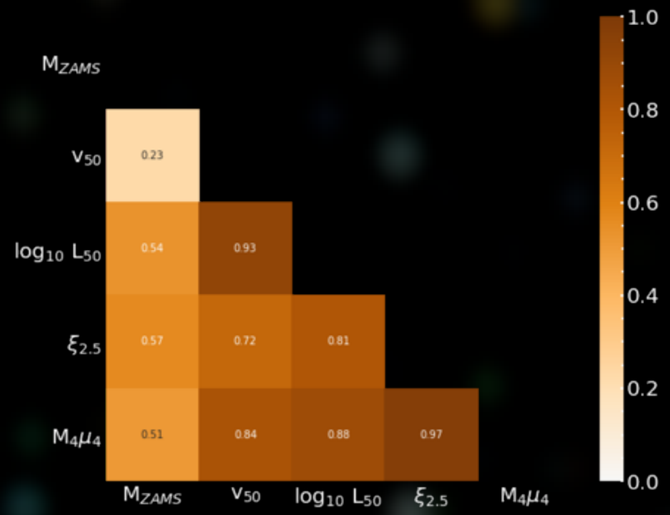


Fig 2: Correlation matrix for various observations and core properties.

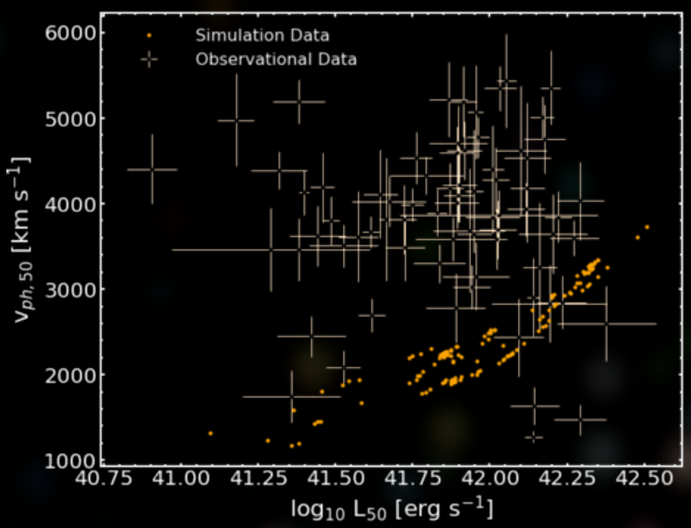


Fig 3: Photospheric velocity vs plateau luminosity (at day 50) for observations (crosses) [3] and simulation data (dots).

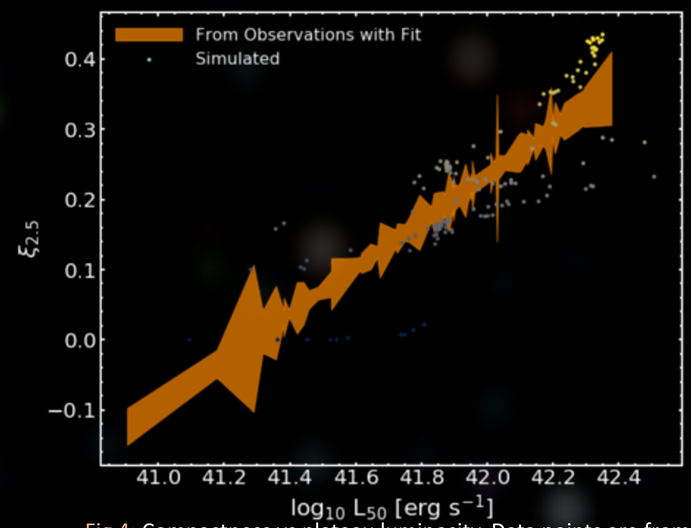


Fig 4: Compactness vs plateau luminosity. Data points are from simulation data and shaded region is compactness extracted from observations.

Conclusions

- Type IIP lightcurve observables are sensitive to properties of the progenitor core.
- We may use observations to put constraints on the supernova progenitor

Moving Forward

- Fit photospheric velocity and iron core mass
- Compare observations to theory (e.g., a Tertl plot)
- Extend to synthetic spectra
- Look out for Barker et al 2020 coming soon to a journal near you!

References

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@AstroBarker
barker49@msu.edu