



# Constraining the Core Structure of Core-Collapse Supernovae

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## 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.

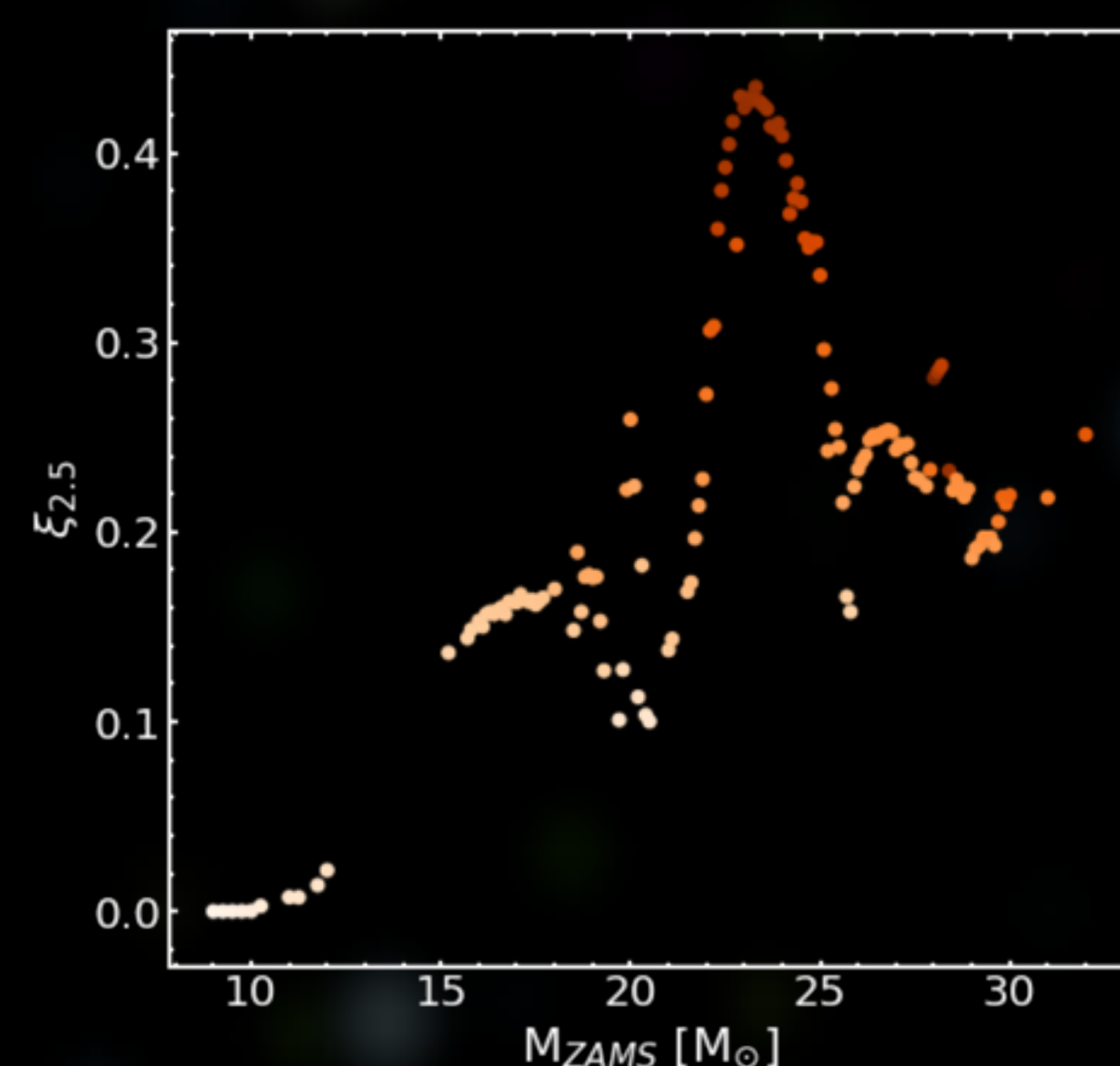


Fig 1: Compactness parameter as a function of progenitor mass, colored by resulting explosion energy.

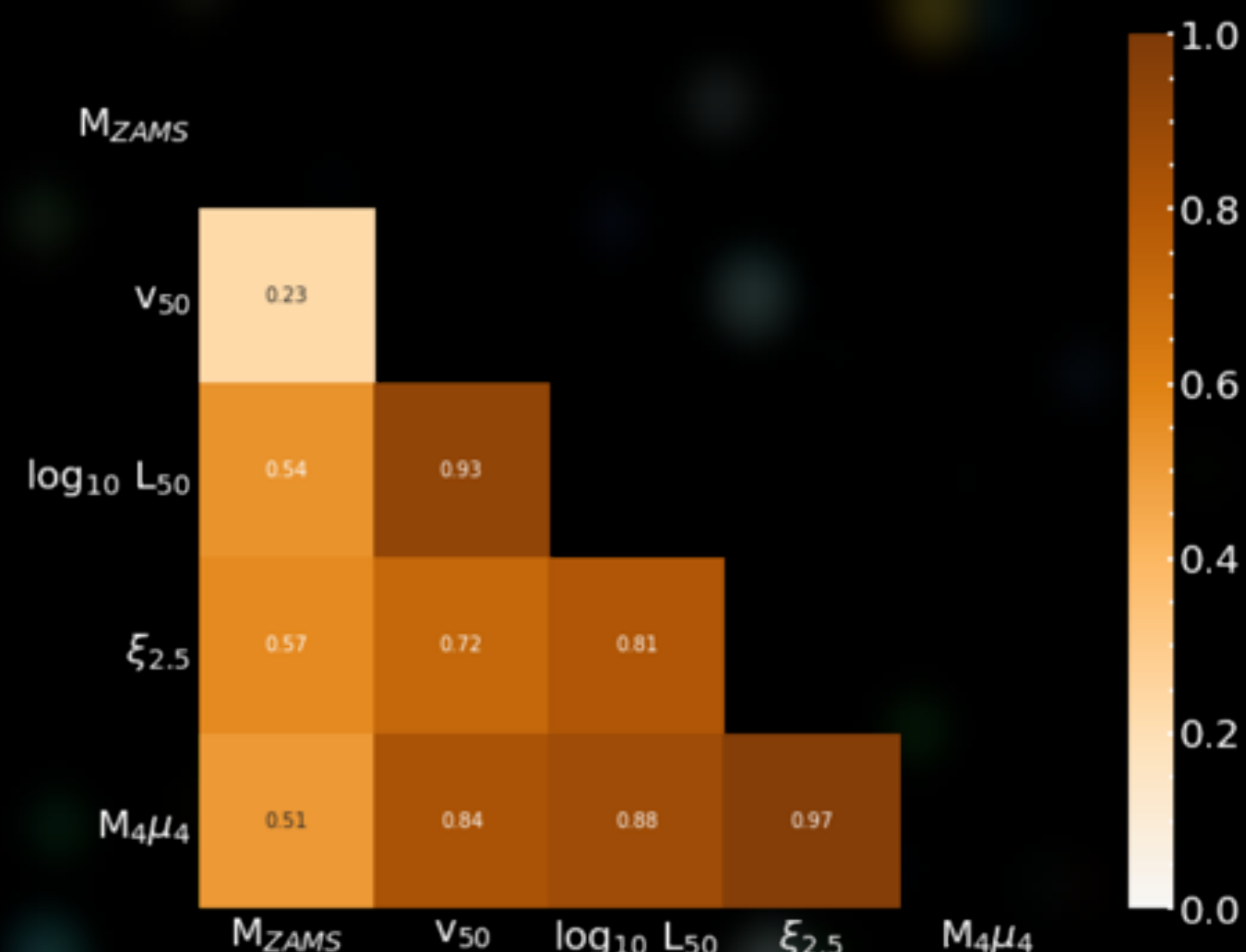


Fig 2: Correlation matrix for various observations and core properties.

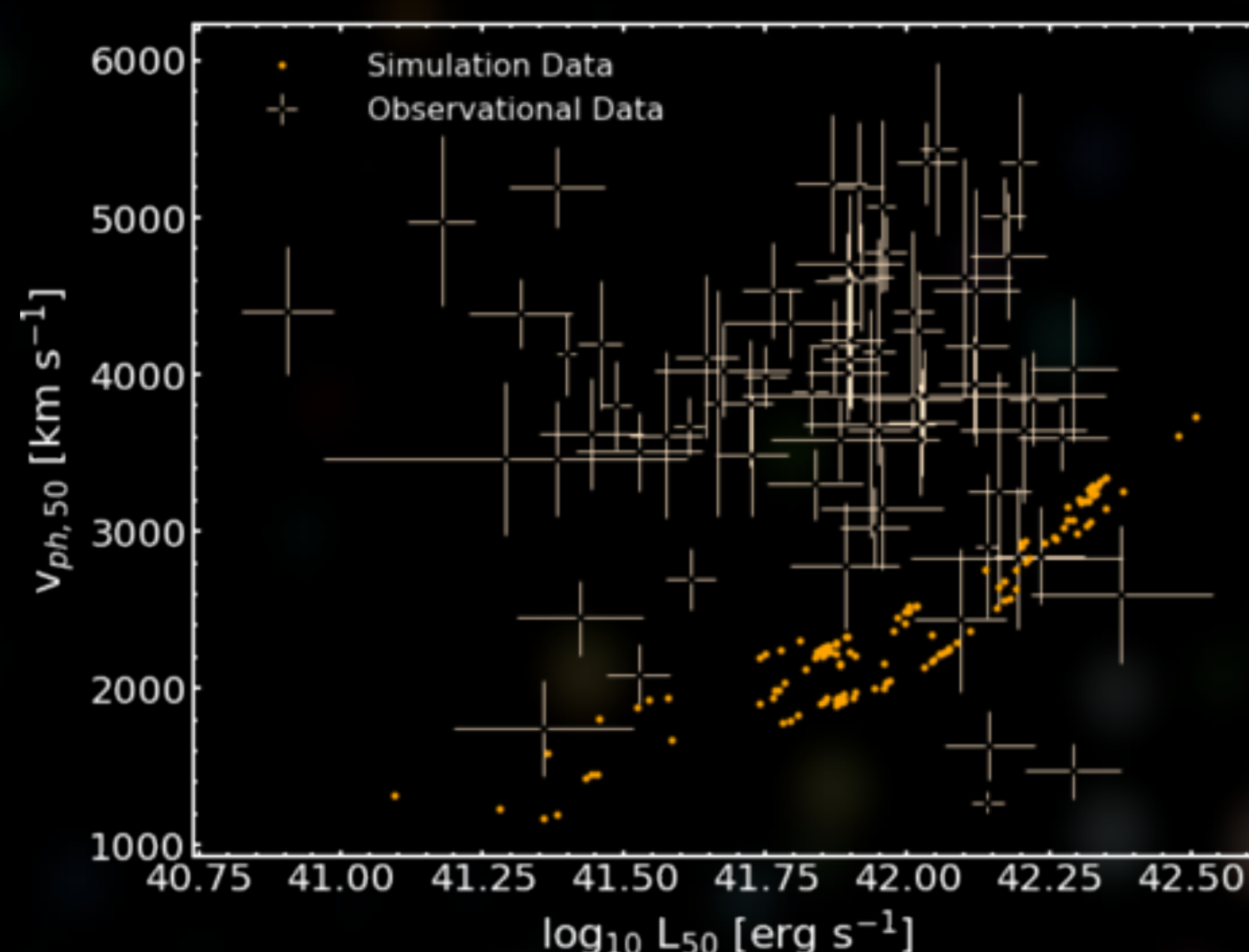


Fig 3: Photospheric velocity vs plateau luminosity (at day 50) for observations (crosses) [3] and simulation data (dots).

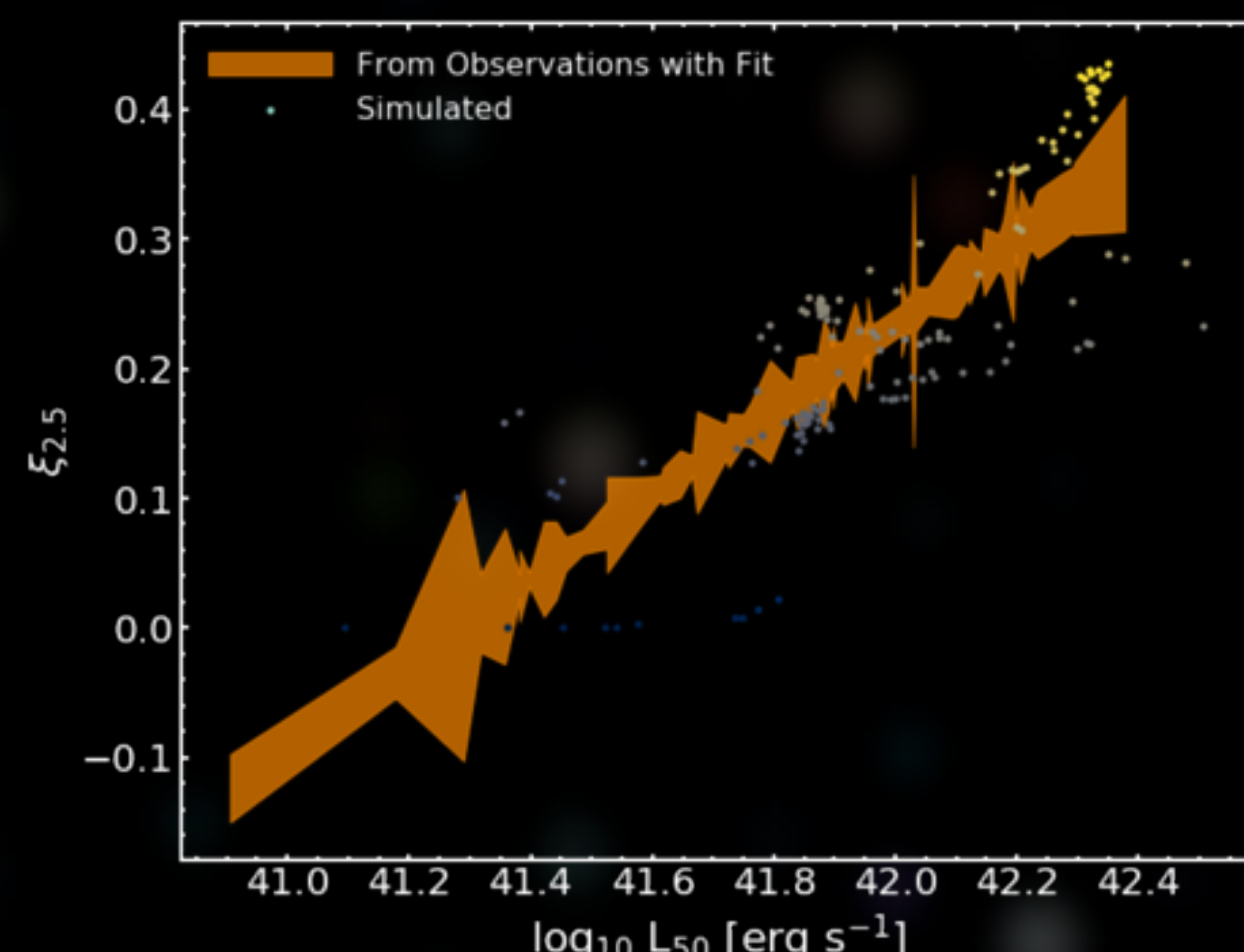
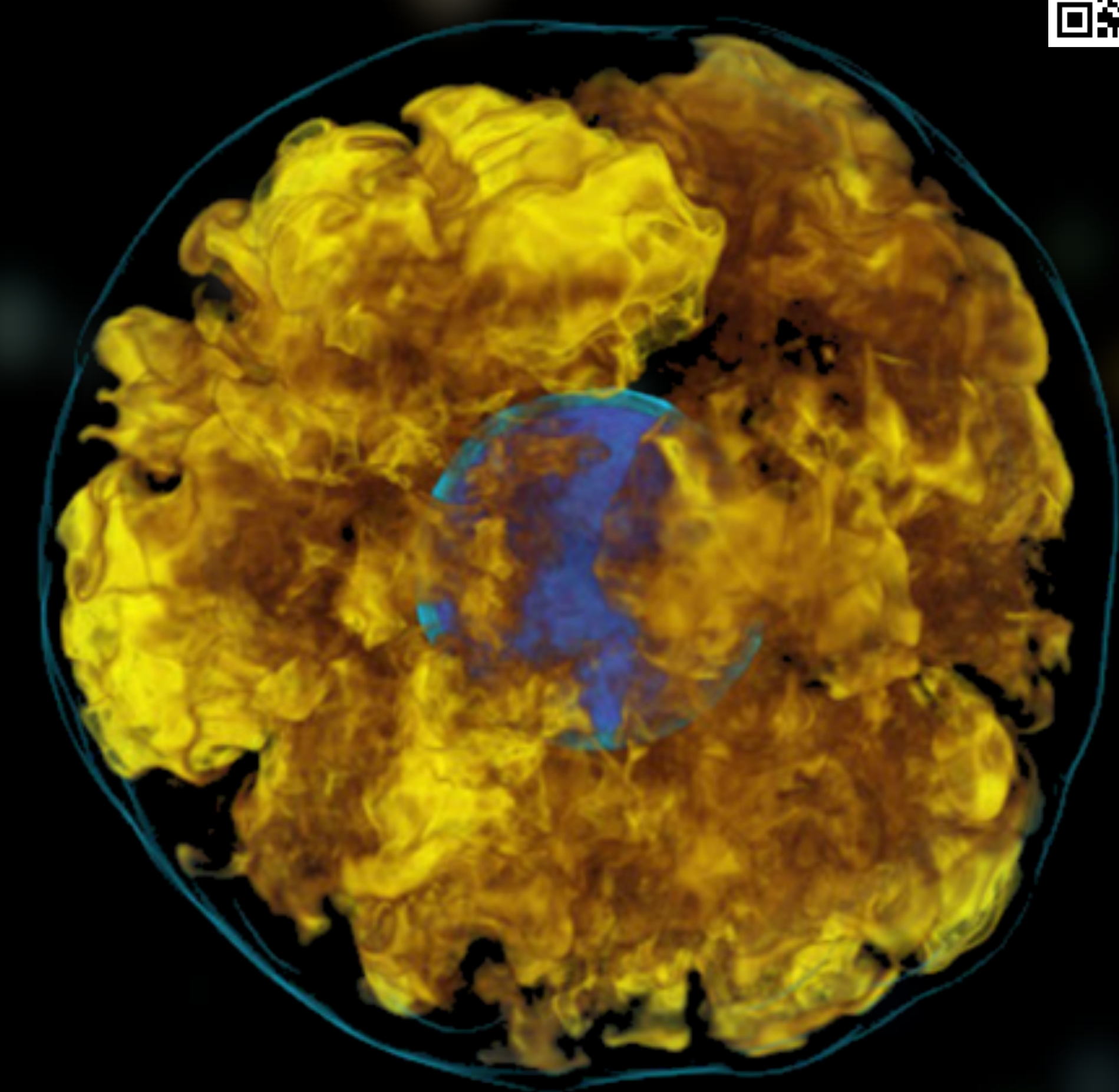


Fig 4: Compactness vs plateau luminosity. Data points are from simulation data and shaded region is compactness extracted from observations.



## 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 Terpl plot)
- Extend to synthetic spectra
- Look out for Barker et al 2020 coming soon to a journal near you!

## References

1. Couch, S. M., Warren, M. L., & O'Connor, E. P. 2019, arXiv:astro-ph/[1902.01340](https://arxiv.org/abs/1902.01340), submitted
2. Morozova, V., Piro, A. L., Renzo, M., et al. 2015, ApJ, 814, 63, doi: [10.1088/0004-637X/814/1/63](https://doi.org/10.1088/0004-637X/814/1/63)
3. Gutiérrez, C. P., Anderson, J. P., Hamuy, M., et al. 2017, [ApJ,850,90](https://arxiv.org/abs/1708.07250)

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