What kind of observations can help to distinguish between explosion models?

The classical approach: light curves & spectral time series

- Analytical light-curve modelling (e.g. Scalzo+ 2012)
  Points to a variety of ejecta masses
  All systematics taken into account?
  What if some parameters that Scalzo et al. marginalise over are correlated?
- Spectral modelling / abundance tomography (e.g. Mazzali+ 2014)
  Allows to infer the composition, degree of mixing, …
  Problems: physical simplifications, assumption of a density profile
- 3D radiative transfer of 3D explosion models (e.g. Roepke+ 2012)
  Problems: limited number of models, no perfect match so far, not fully conclusive
- Do we need to probe other wavelength regimes (UV, IR, ...)?
- What can we learn from statistical model-observation comparisons with PCA etc?

Late-time spectra

- Probe innermost ejecta: composition, ionisation state, asymmetries
- Backward engineering (e.g. Mazzali+ 2011) suffers from degeneracies between e.g. central density and composition
- 3D nebular spectrum synthesis of 3D explosion models missing → ARTIS
- Constrain amount of stripped material from non-degenerate companion (e.g. Maguire+ 2015)

Very early observations

- Hot topic: fast initial rise and/or early UV excess observed in some SNe Ia
- Problem: different mechanisms can account for it
  companion interaction, CSM interaction, surface radioactivity

Spectropolarimetry

- Probes global asphericity (continuum polarisation) and compositional inhomogeneities (line polarisation)
- We know that SNe Ia are globally round, but show some smaller-scale inhomogeneities
- Only recently (Bulla+ 2016) theoretical 3D polarisation spectra of 3D explosion models have become available

CSM environment

- High-resolution multi-epoch spectroscopy of Na D, K I, …
- Only very few examples with observed time evolution (e.g. Patat+ 2007)
- Predominantly blueshifted absorption → CSM (e.g. Maguire+ 2013)
- Can have CSM in different scenarios: SD, merger (CE ejection)