Spectropolarimetry of Superluminous Supernova

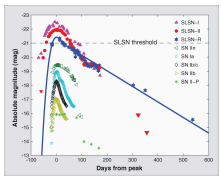
Sei Saito (Tohoku University)

Summary

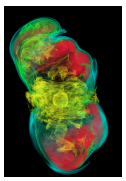
- Energy source of superluminous supernovae is unclear => Some models predict aspherical explosion
- Late-phase spectropolarimetric observations of a Type I superluminous supernova to probe geometry
- Accurate estimate of interstellar polarization from strong Ca emission line in late-phase spectrum
- Intrinsic supernova polarization at early phase ~ 0.2 % => spherical outer ejecta
  Intrinsic supernova polarization at late phase ~ 0.8 % => aspherical inner ejecta
- Energy source of Type I superluminous supernovae should be something providing inner asphericity

Superluminous supernovae (SLSNe)

- 10-100 times more luminous than normal supernovae (SNe)
- Absolute magnitude $\lesssim$ -21 mag
- Unclear power source
  => Some models predict **aspherical explosion**
  => Important to **study geometry**

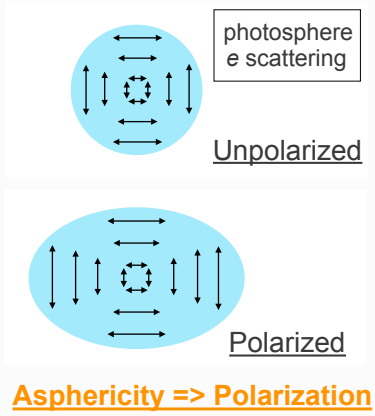


Gal-Yam et al. 2012



Most et al. 2014

Polarization & Geometry



Asphericity => Polarization

Stokes parameters (%)

$$Q = \updownarrow - \leftrightarrow$$

$$U = \nwarrow\!\!\searrow - \nearrow\!\!\swarrow$$

Polarization (%)

$$P = \sqrt{Q^2 + U^2}$$

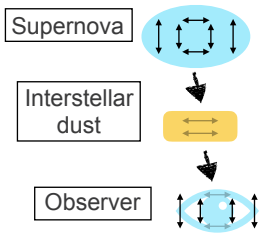
Polarization	Axial ratio (a/b)
~ 0.5 %	~ 1.1
~ 1.0 %	~ 1.2
~ 2.0 %	~ 1.5

Hoflich 1991

This study

Problem in previous studies => This study

- Interstellar polarization (ISP) has not been accurately estimated
  => Accurately estimate ISP in this study



Intrinsic SN polarization : electron scattering on photosphere

ISP : absorption by dust

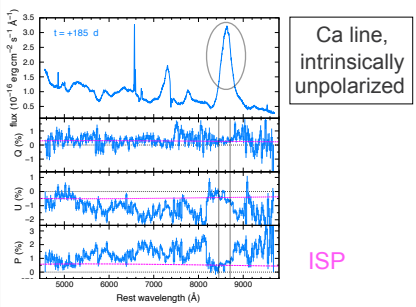
Observed polarization = Intrinsic SN polarization + ISP

Data

- Object : SN 2017 egm,
  Nearby SLSN-I (hydrogen poor)
  at z = 0.0307, d_L ~ 140 Mpc
- Observation : Spectropolarimetry
- Date : 2017.12.29 (+185 days after peak),
  Latest phase for polarimetry of SLSN
- Telescope : Subaru (FOCAS)

Results & Discussions

ISP estimate from late phase



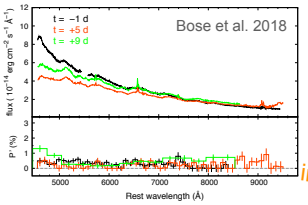
Ca line, intrinsically unpolarized

ISP

The first time to accurately estimate ISP

Intrinsic SN polarization (early & late phase) => Geometry

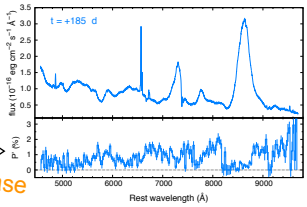
early (outer ejecta)



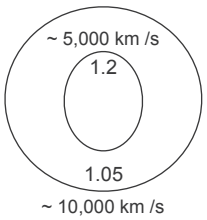
P ~ **0.2 %** => a/b ~ 1.05
small

increase

late (inner ejecta)



P ~ **0.8 %** => a/b ~ 1.2
large



Ejecta velocity & Axial ratio

More aspherical inner ejecta of SLSNe-I
=> **Power source producing inner asphericity**