The morphology of the ejecta of SN1987A

Josefin Larsson
OKC, Stockholm

with help from Claes Fransson & Karina Kjaer
Supernova 1987A


It is located in the LMC, only about 50 kpc away.

It was the first supernova with a known progenitor.

The progenitor was a 20 solar mass blue supergiant.
The three rings of gas were ejected approximately 20,000 years before the explosion.
The morphology of the ejecta gives important information about the explosion.

• Is there a symmetry axis?

• What is the distribution of different elements?
Temporal evolution

HST R-band
The ejecta light curve

The light curve suggests a change in the dominant energy source.

Corrected for contamination from ring

Larsson et al. 2011
Radioactive decay. Dominated by $^{44}$Ti.
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Illumination of the ejecta by X-rays from the inner ring.
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Illumination of the ejecta by X-rays from the inner ring.

The observed ejecta morphology depends on
- distribution of material
- energy source
- dust
R-band contour plots

Radioactive input

2770 d

4001 d

5012 d

X-ray illumination

6122 d

7226 d

8328 d
R-band contour plots

Radioactive input

2770 d

4001 d

5012 d

X-ray illumination

6122 d

7226 d

8328 d
‘Shrinking’ the last image does not reproduce early morphology.
Early morphology reflects distribution of $^{44}$Ti

Late morphology reflects external illumination and hydrogen density.

Fransson et al. in prep
3D-info from spectra

Hα with HST/STIS

2004
Integral field spectroscopy with VLT/SINFONI

[Si I]/[Fe II] at 1.64µm

Kjaer et al. 2010
Ejecta profiles 2010/2011

Hα

Si I/Fe II

 Flux (10⁻¹⁷ erg cm⁻² s⁻¹ Å⁻¹)

Velocity (1000 km s⁻¹)
Modelling

Modelling of the 2005 SINFONI data (Kjaer et al. 2010) suggests that the ejecta are elongated in the plane of the ring.

Looks like Hydrogen is similar...
Some preliminary conclusions

• The ejecta are clearly asymmetric.

• The morphology changes with time as a result of the change of the dominant energy source.

• Hydrogen and Si/Fe have similar line profiles ---> elements are well mixed.

• Ejecta elongated in the plane of the ring??