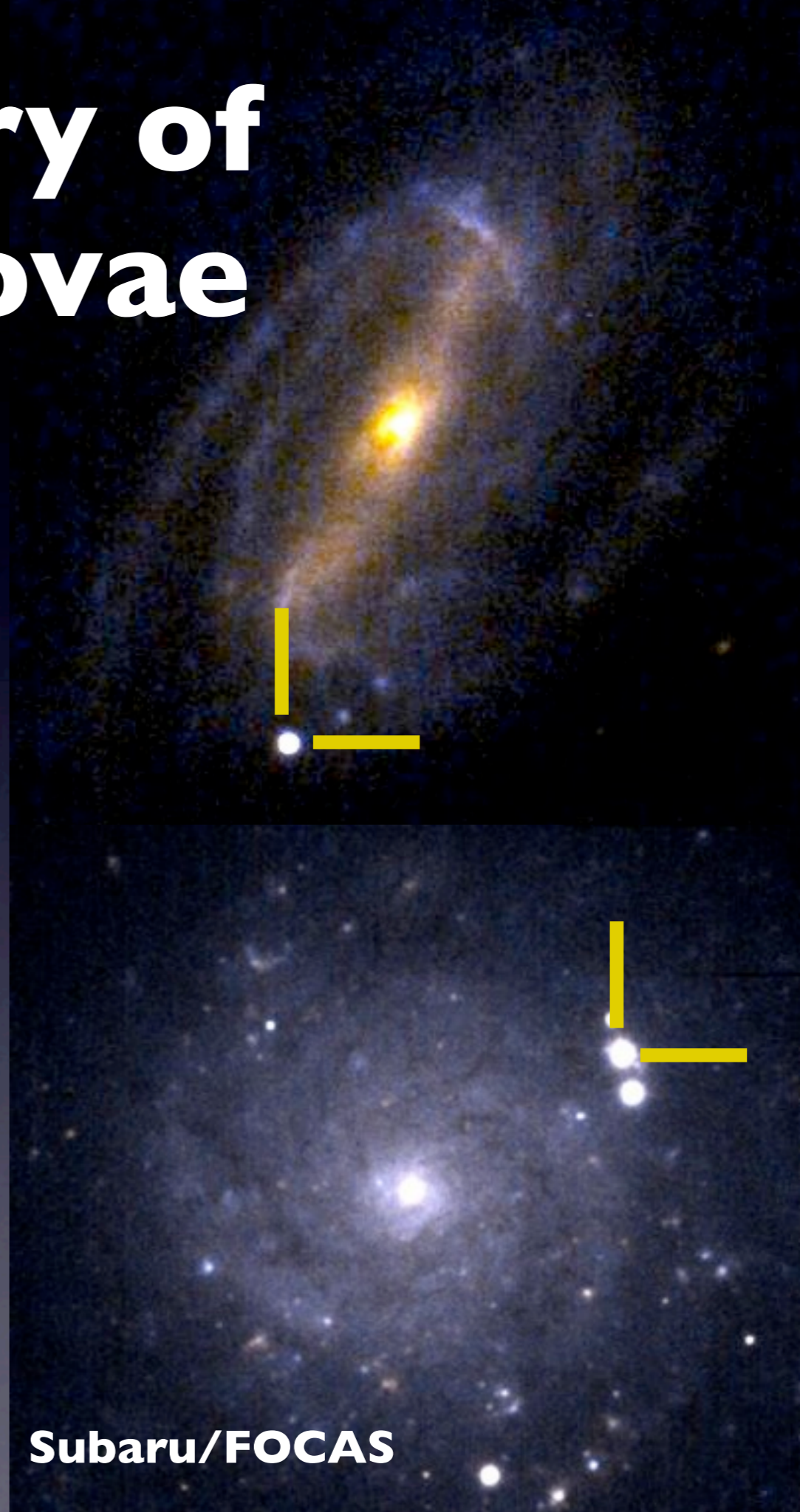


Spectropolarimetry of Type Ib/c Supernovae

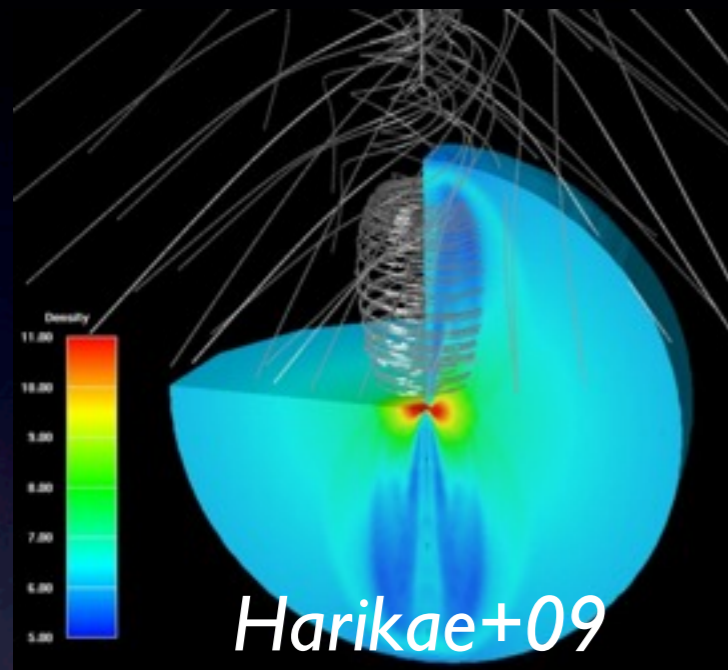
Masaomi Tanaka
(National Astronomical
Observatory of Japan)

Subaru/FOCAS

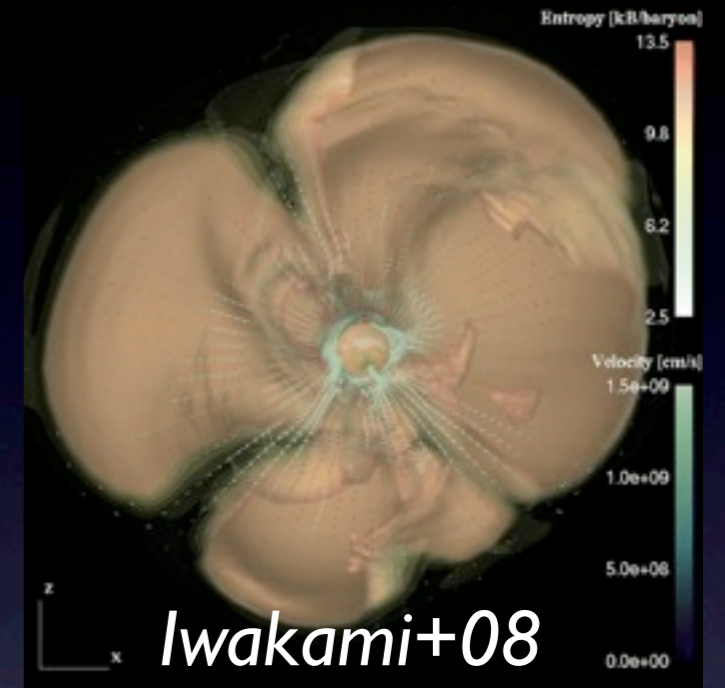


Multi-D Explosion Geometry of SNe

Rotation + magnetic field



Neutrino + convection



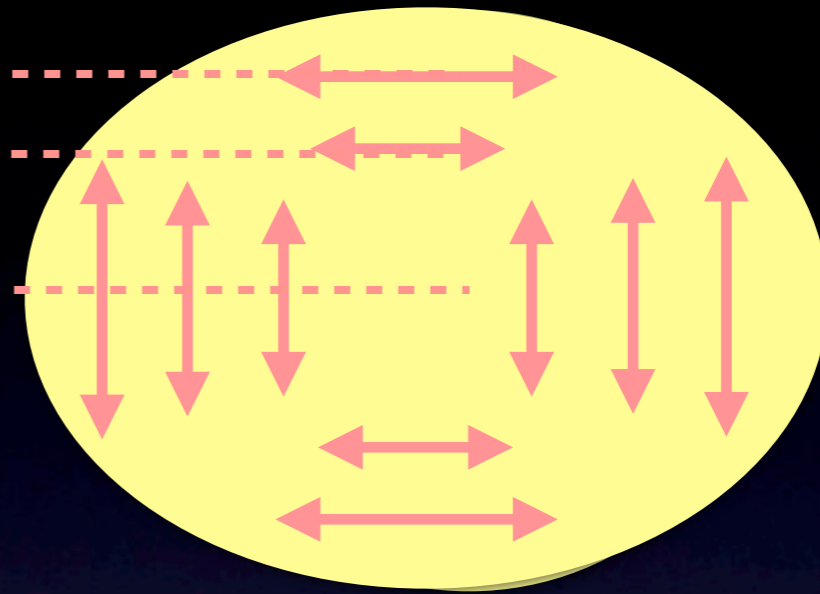
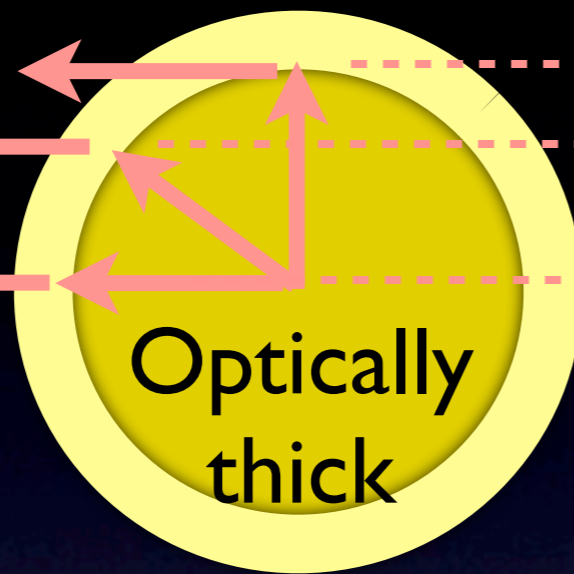
Observational test

- Line profile in nebular spectra
(=> talks by P. Mazzali and K. Maeda)
- Continuum polarization
- Line polarization

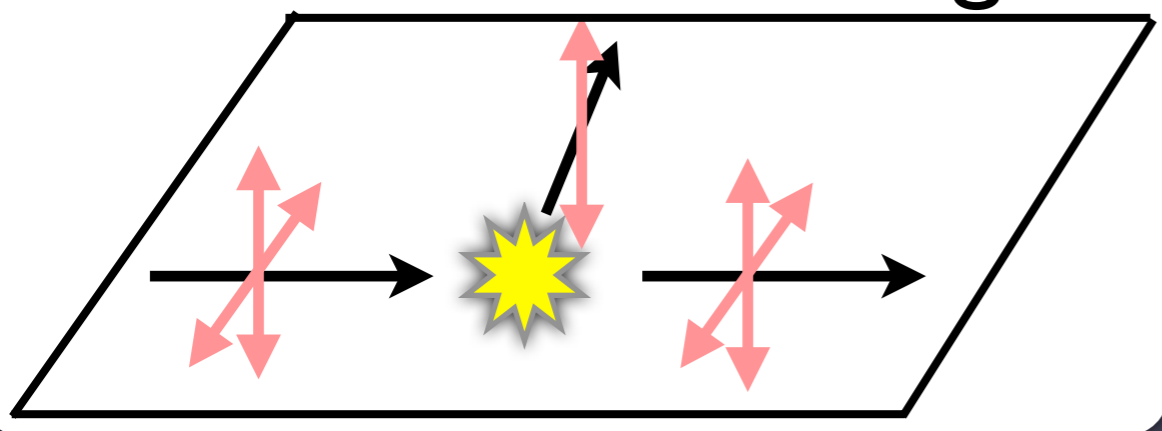
From the side

On the sky

Observer



Electron scattering



Flux



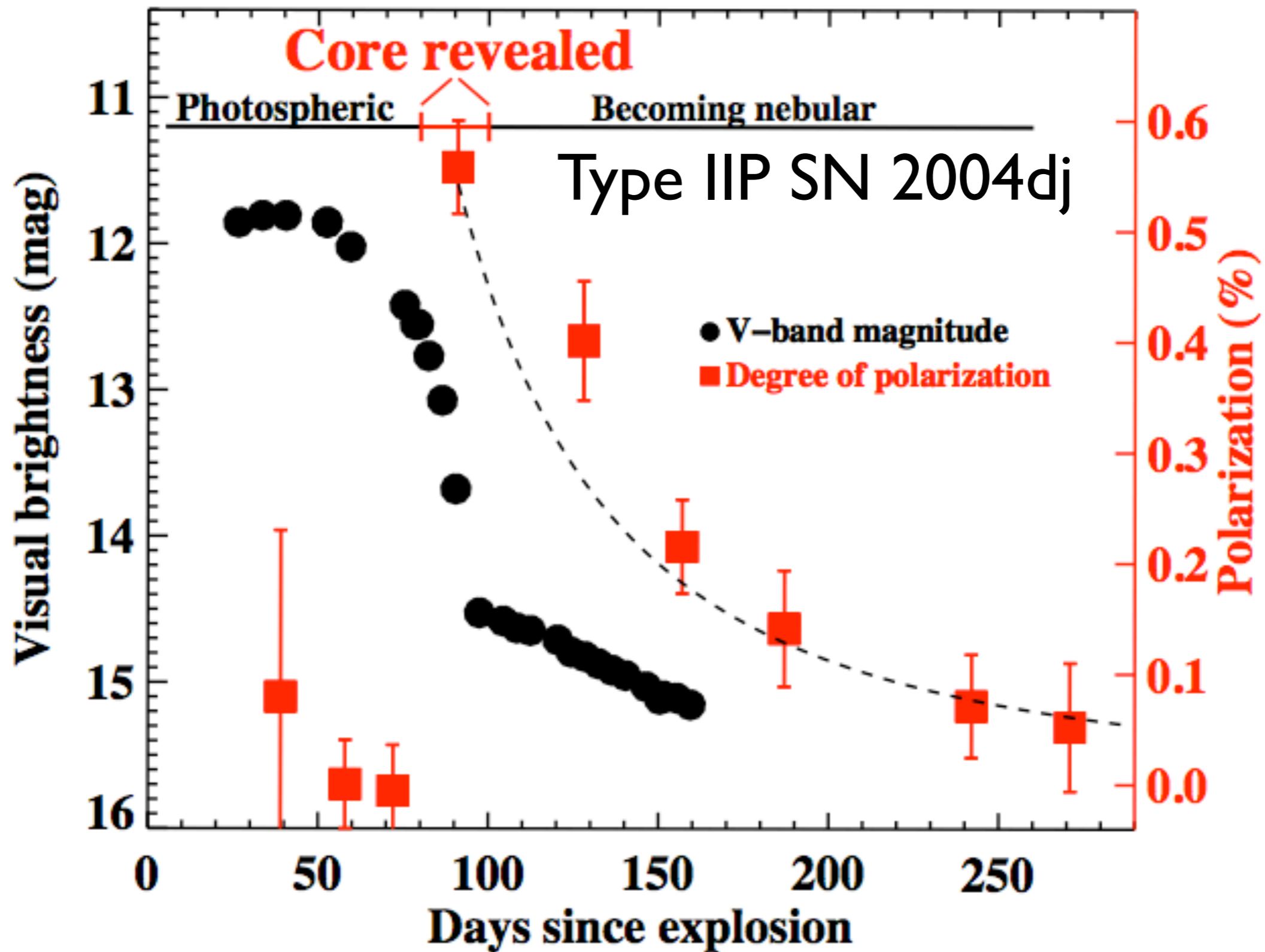
spherical

aspherical

P(%)



(Wang & Wheeler 08)



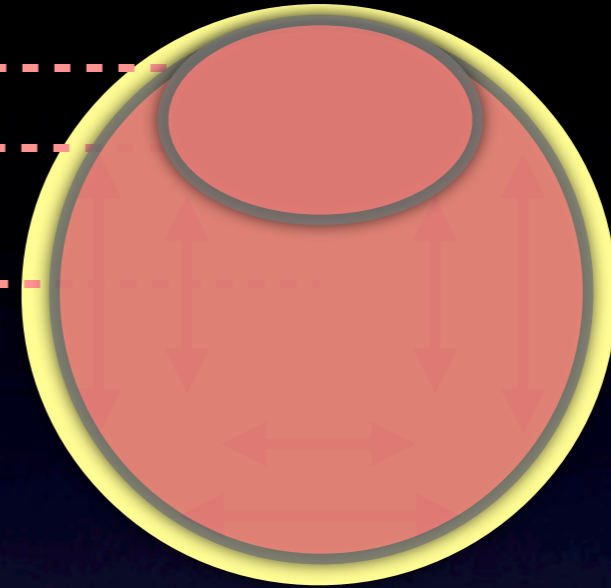
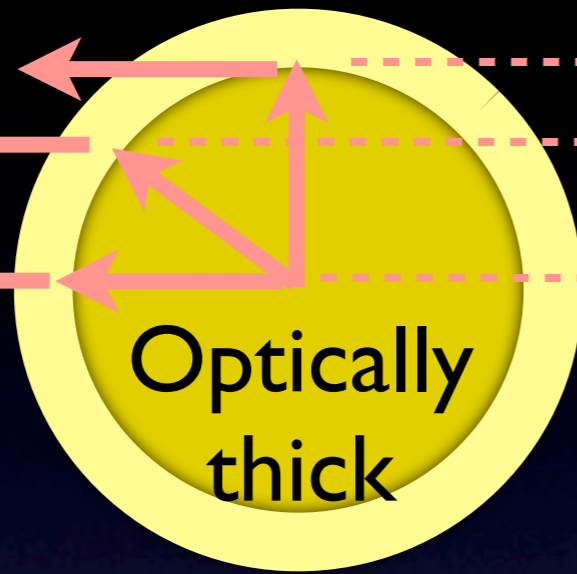
(Leonard+06, Chornock+10)

Confusion with interstellar polarization...

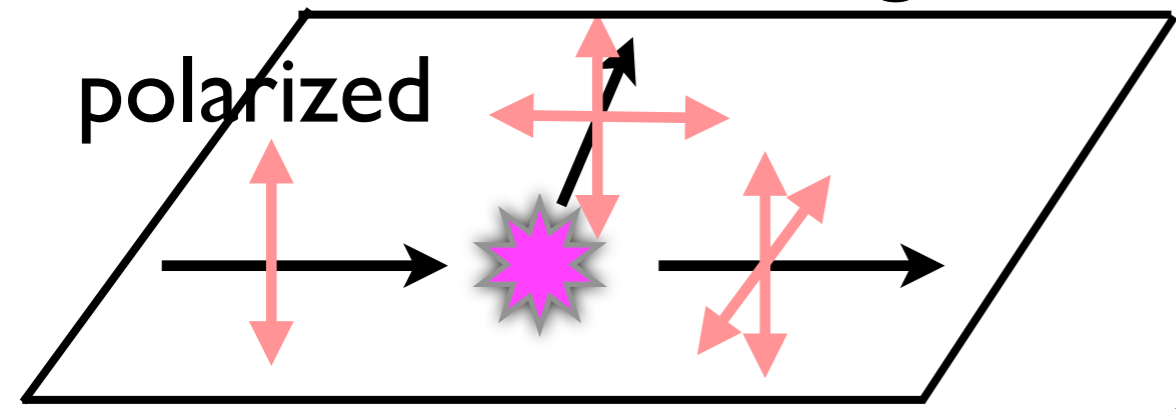
From the side

On the sky

Observer



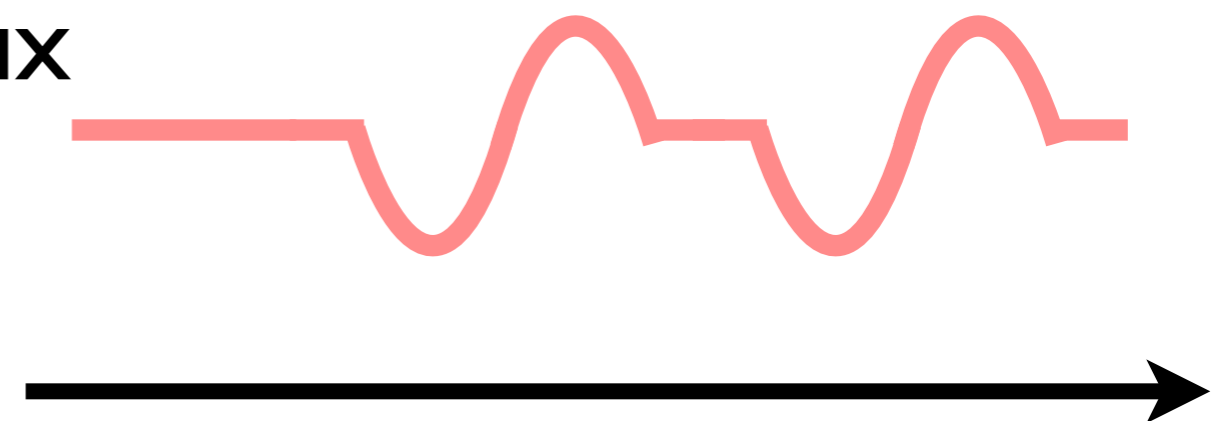
Line scattering



polarized

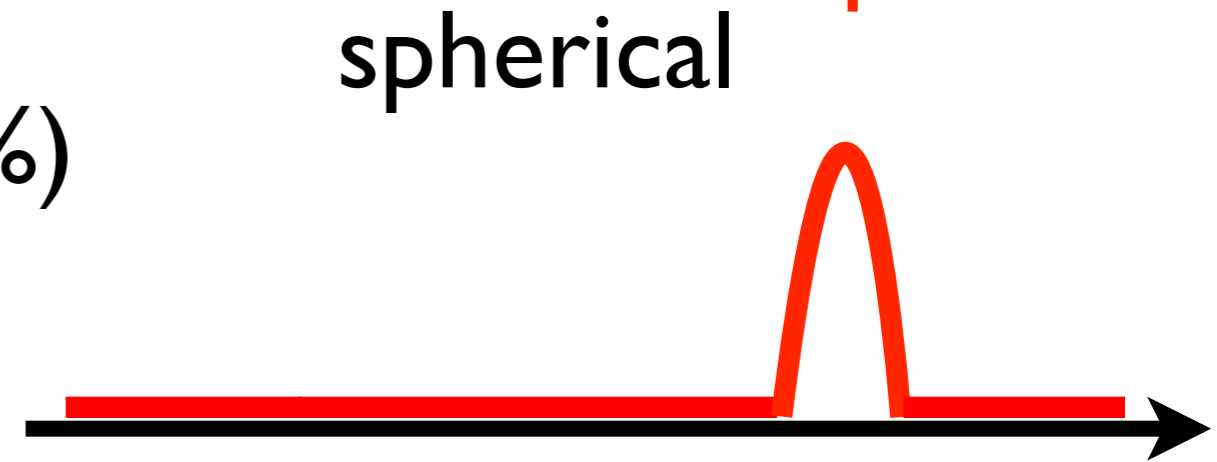
“de-polarizer”

Flux



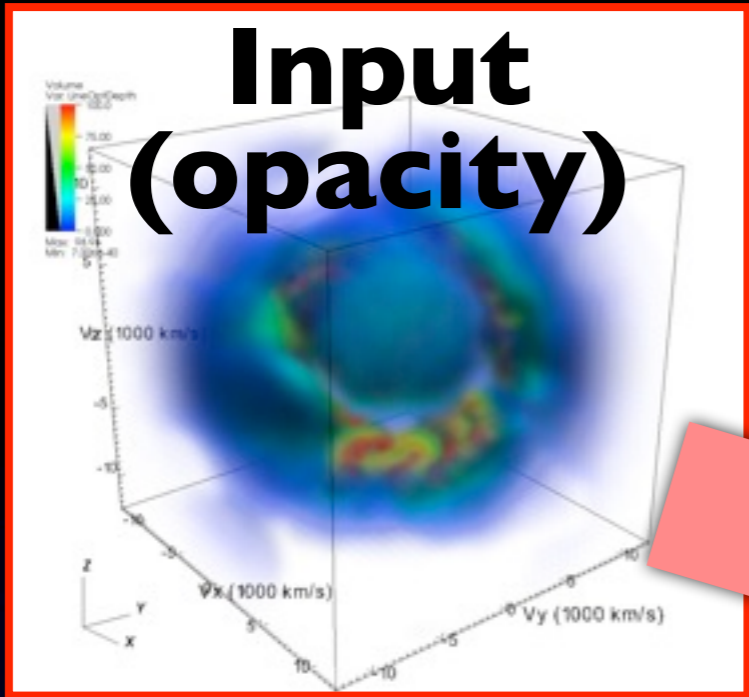
aspherical

P(%)



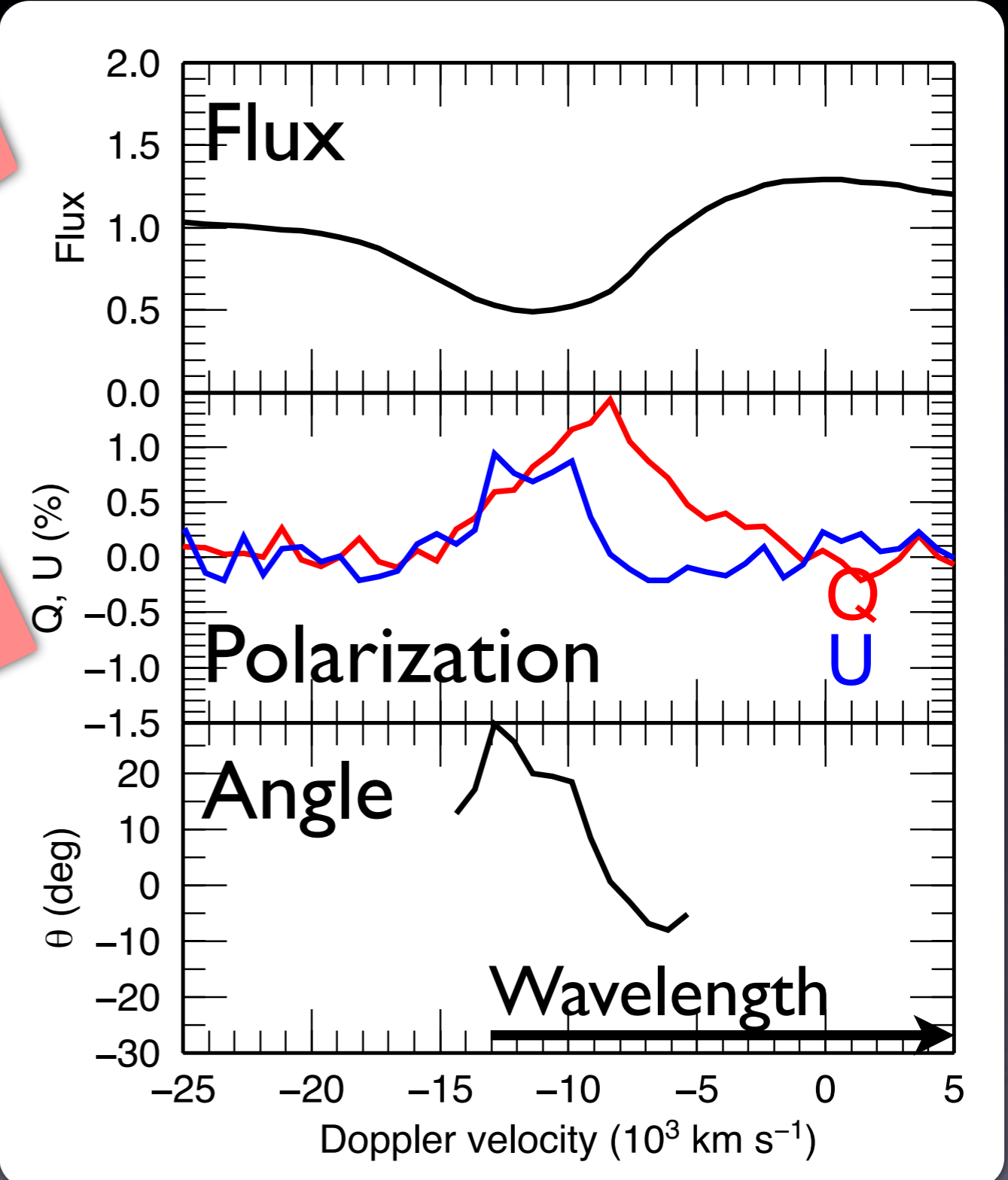
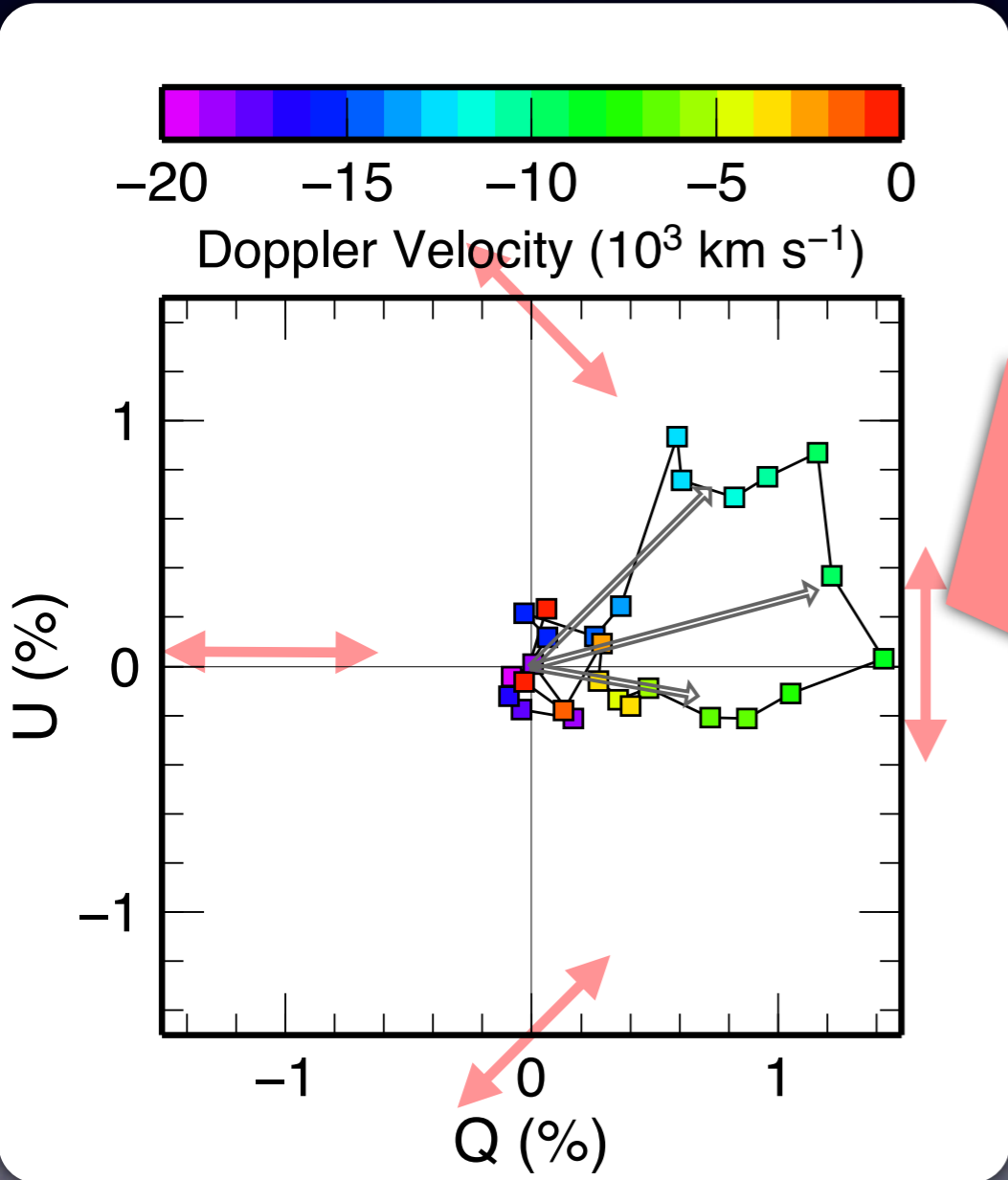
spherical

(Wang & Wheeler 08)



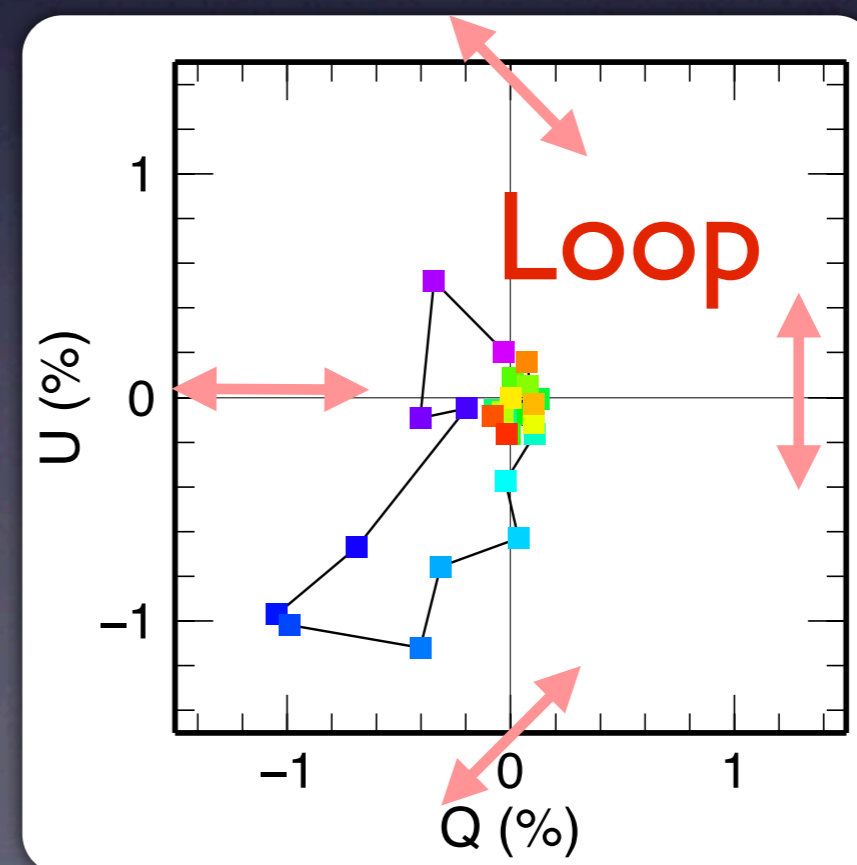
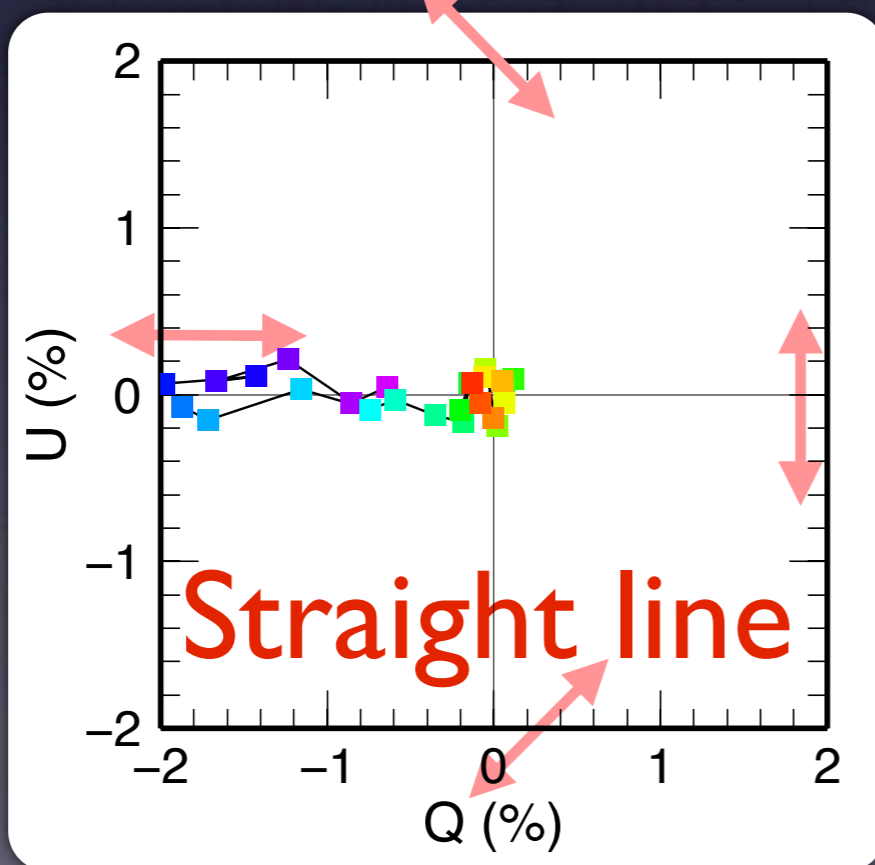
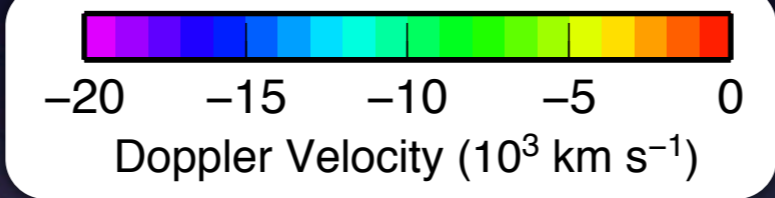
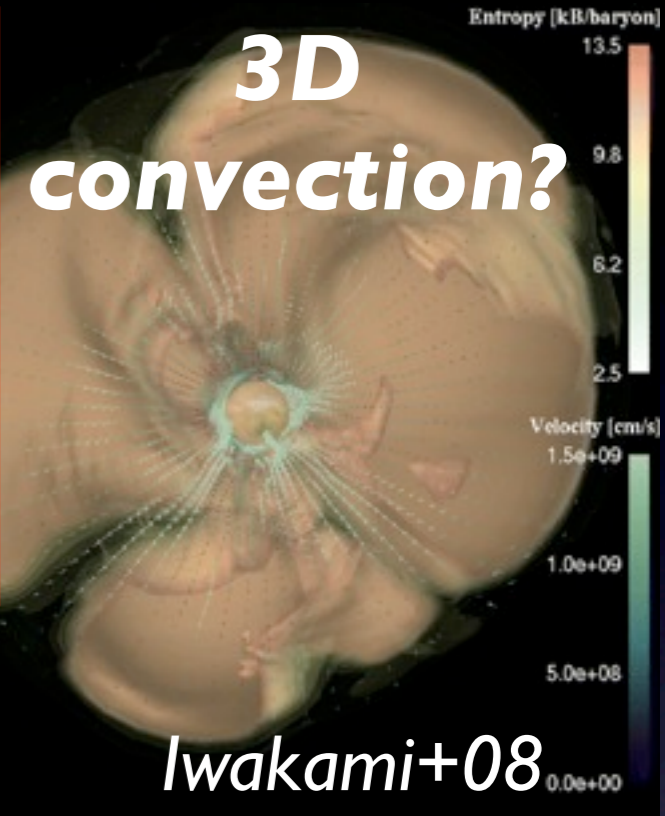
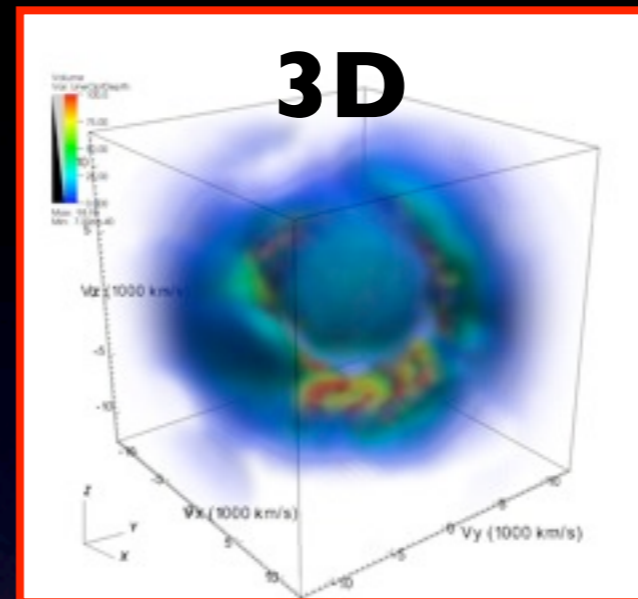
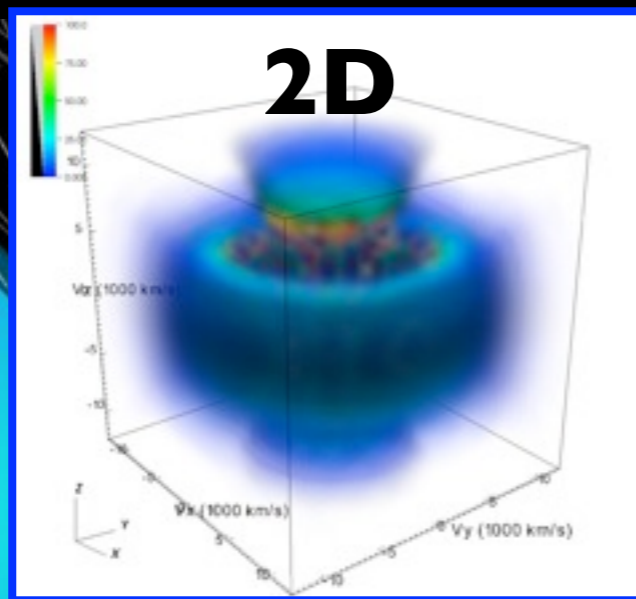
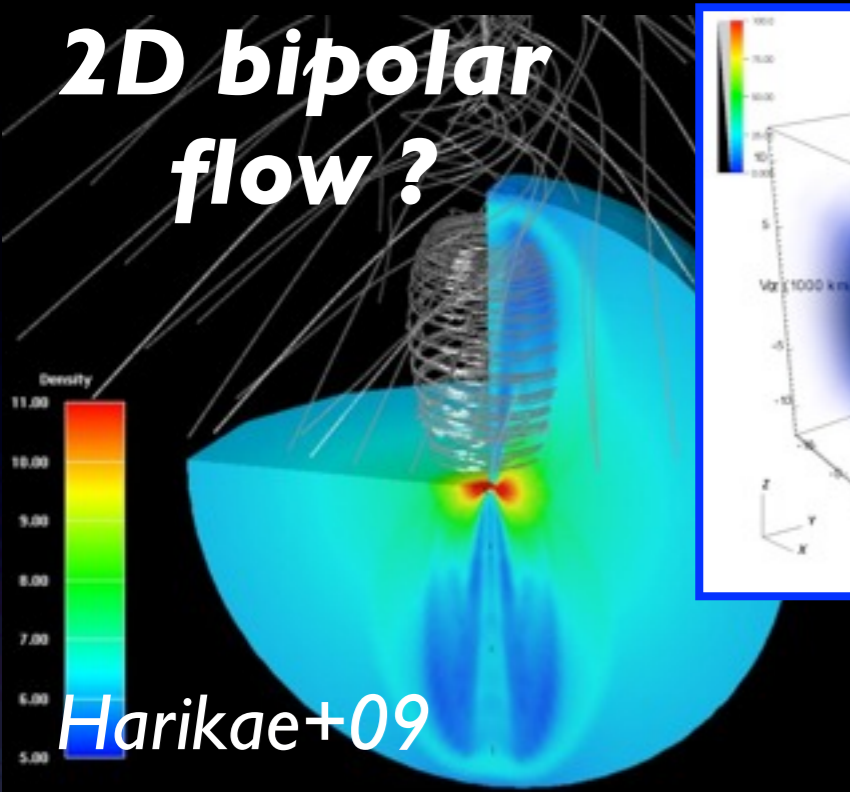
3D Radiative Transfer Simulation

MT+ in prep. (method similar to Kasen+03)



Diagnostic of the Geometry

2D bipolar flow?



Spectropolarimetry of SNe with Subaru/FOCAS

PI: M. Tanaka

Co-I: K. S. Kawabata, T. Hattori.

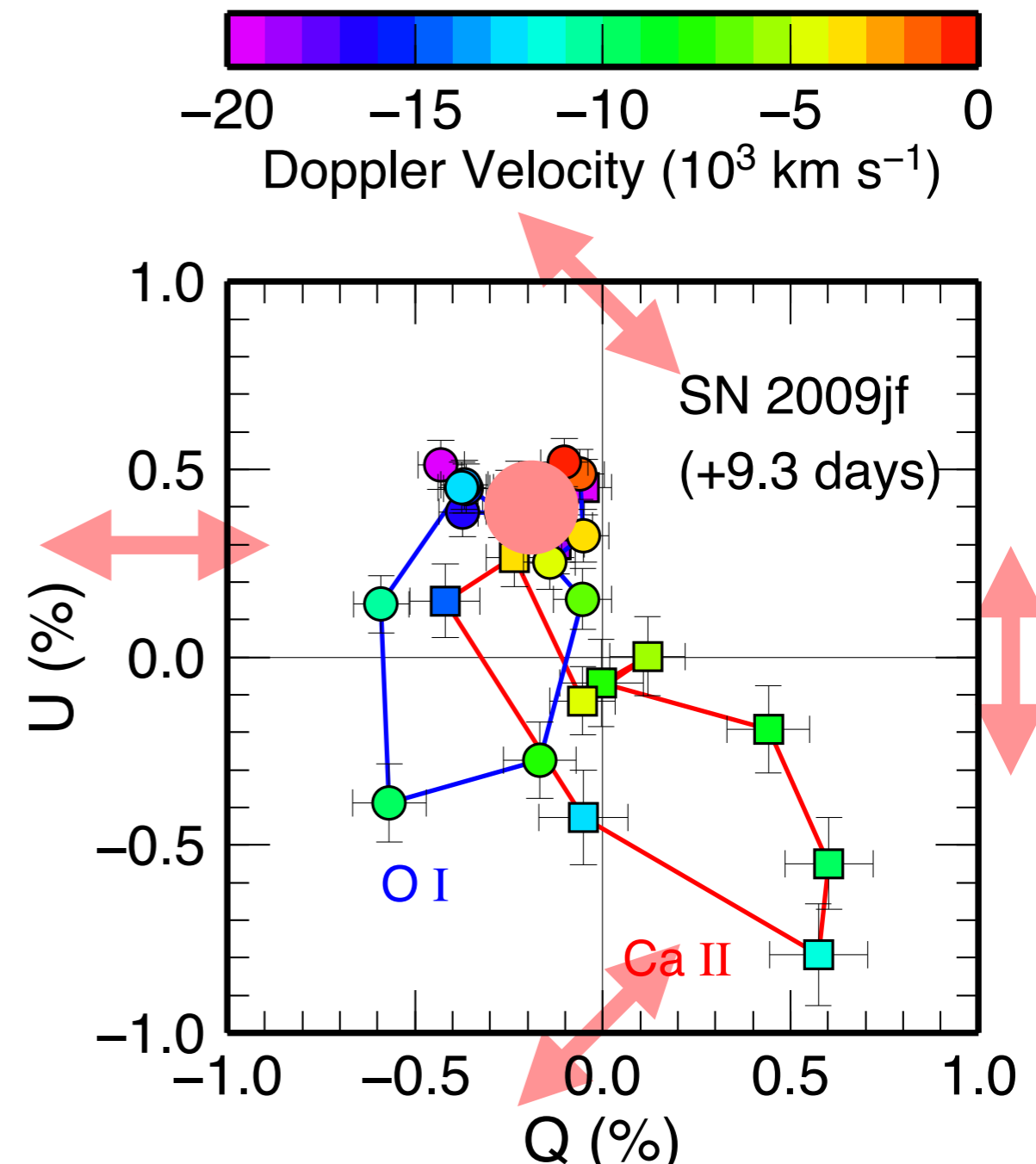
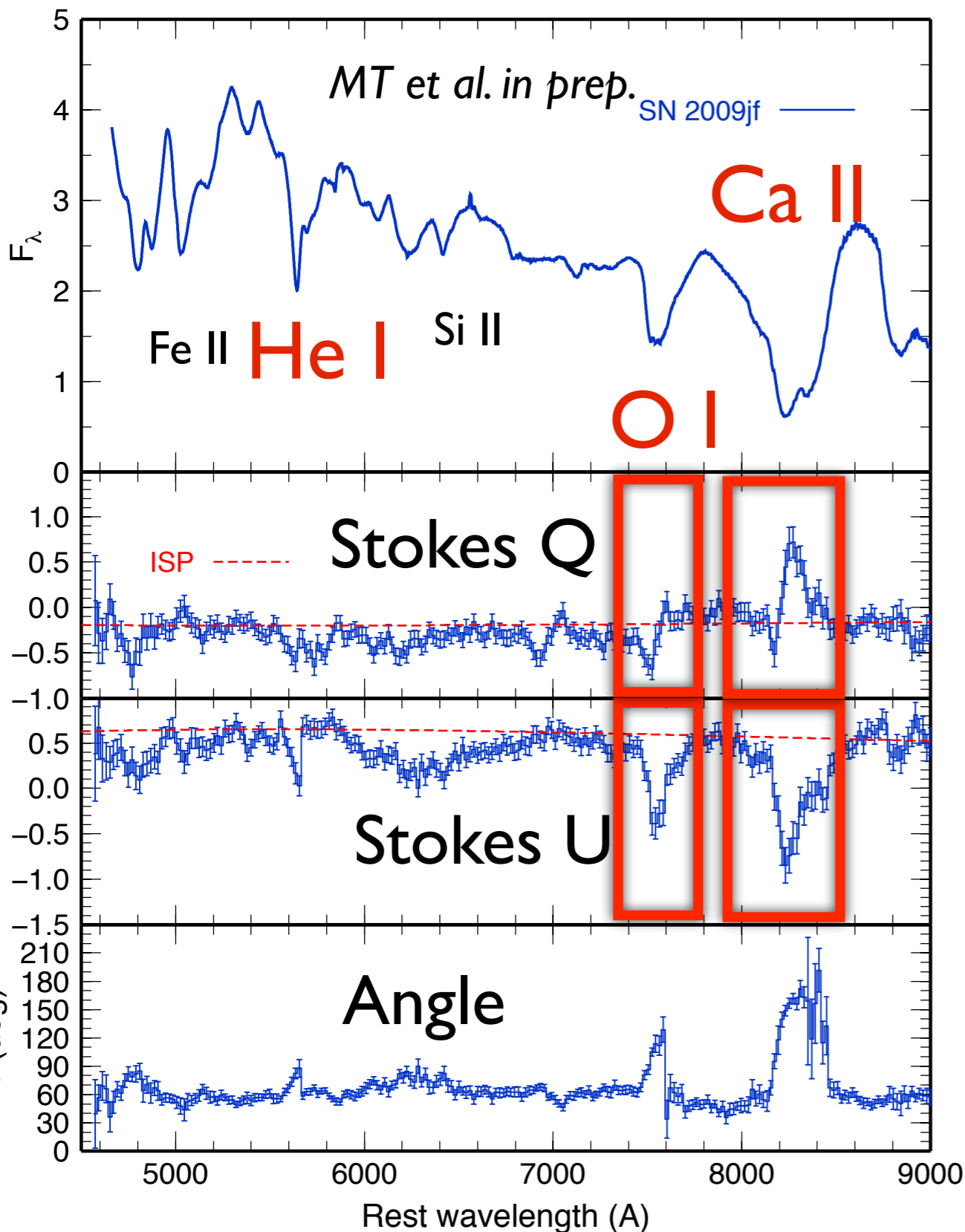
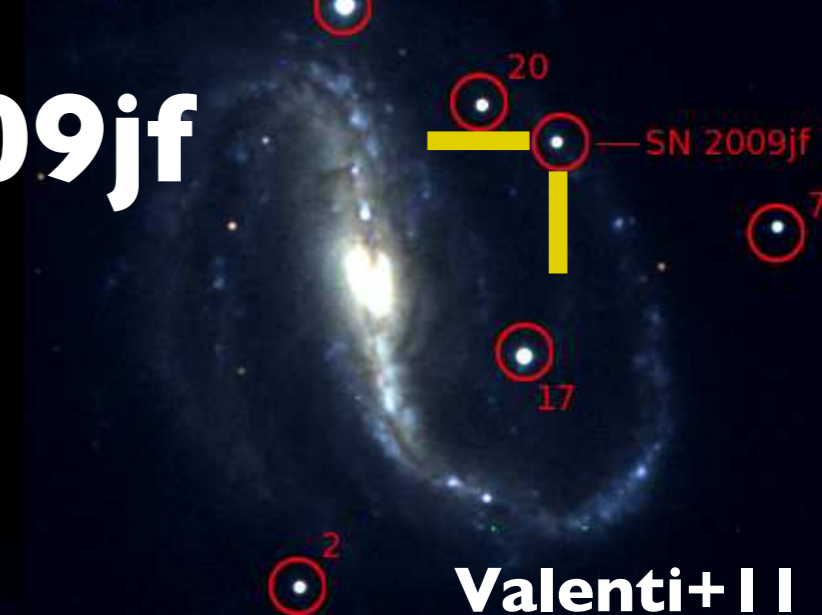
E. Pian, K. Maeda, M. Yamanaka, K. Nomoto,

P.A. Mazzali, K. Aoki, T. Sasaki, and M. Iye



Object	Type	Date	Epoch	Mag	Quality	Ref.
SN 2005bf	Ib	2005 May	+8	16	Good	MT+09
SN 2007gr	Ic	2007 Sep	+21	14	Good	MT+08
SN 2009dc	Ia (sp-Ch)	2009 Apr/Jul	+6/+90	15/17	Good	MT+10
SN 2009jf	Ib	2009 Oct	+9.3	15	Good	in prep.
OT U2773	LBV?	2009 Oct		17	ISP	...
SN 2009kk	Ia	2009 Oct	+2	15	Good	...
SN 2009mi	Ic	2010 Jan	+26.5	16	Good	in prep.
SN 2010ah	Ic broad	2010 Mar	~30 (disc)	19	Not good	...
SN 2010cn	Ic broad/IIb	2010 May	2 (disc)	18	Good	in prep.

SN 2009jf (1b)



3D geometry!

(see e.g., Maund+07, and many SNe Ia)

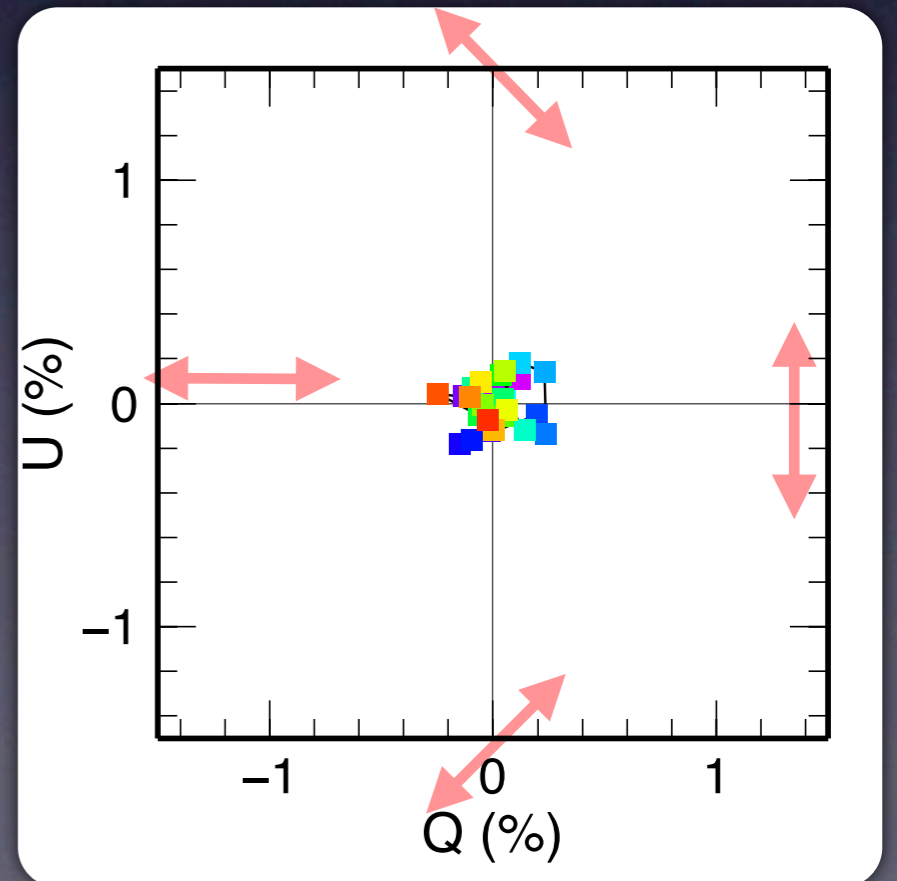
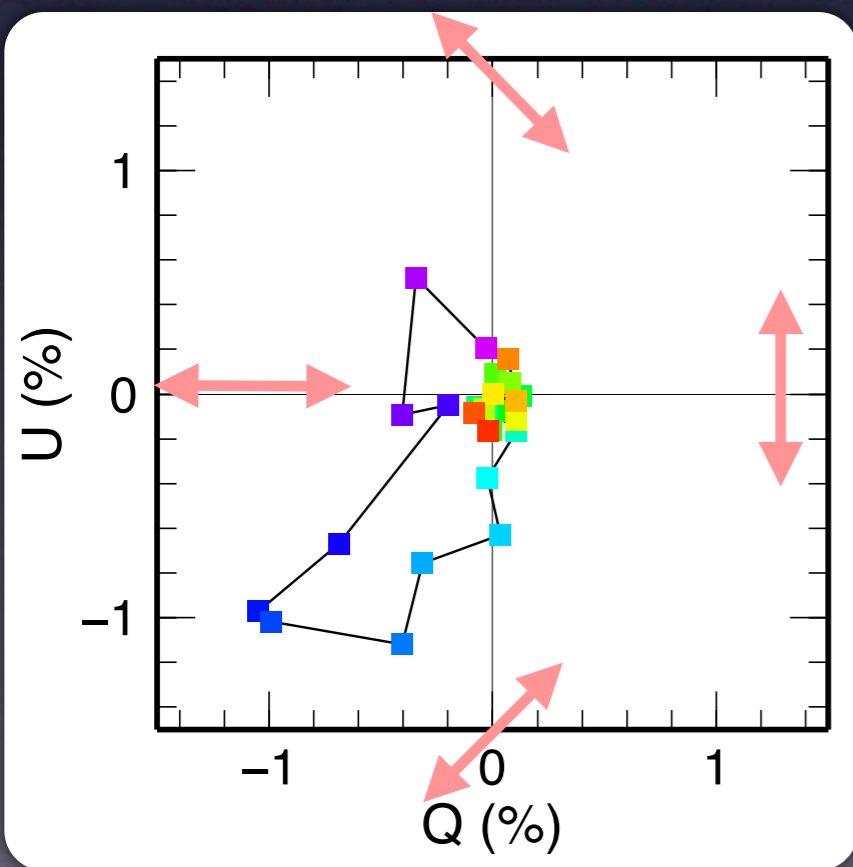
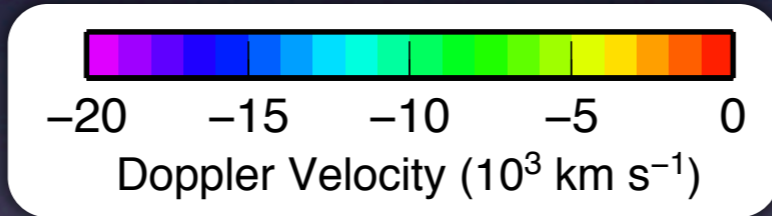
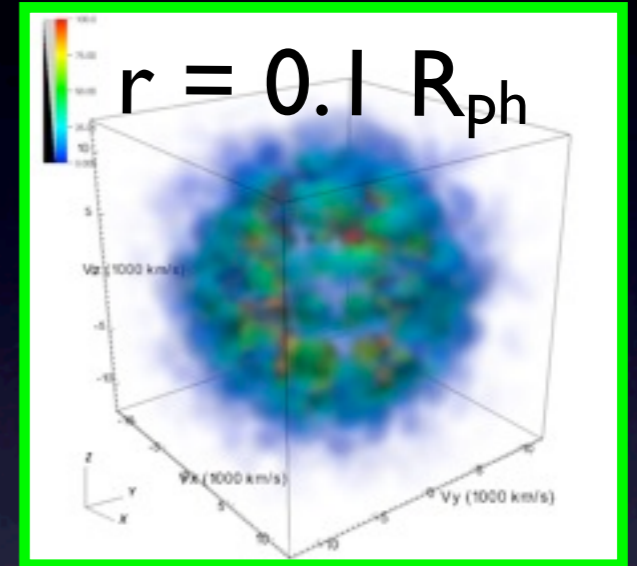
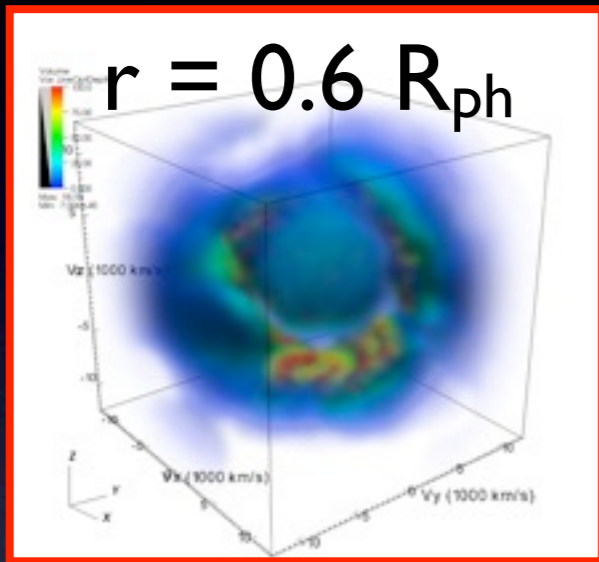
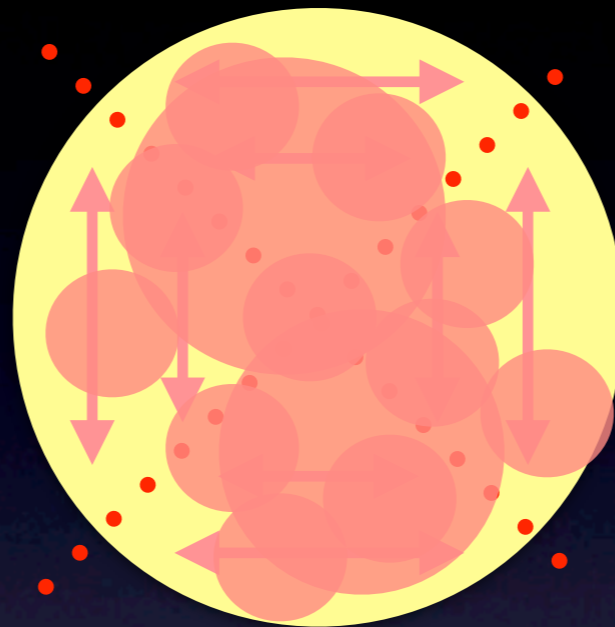
Object	Type	3D?	Ref.
SN 2002ap	Ic broad	YES	Kawabata+02, Leonard+02, Wang+03
SN 2005bf	Ib	YES	Maund+07, MT+09
SN 2007gr	Ic	No	MT+08
SN 2008D	Ib	YES	Maund+09
SN 2009jf	Ib	YES	MT+ in prep.
SN 2009mi	Ic	YES	MT+ in prep.

3D signature is quite common

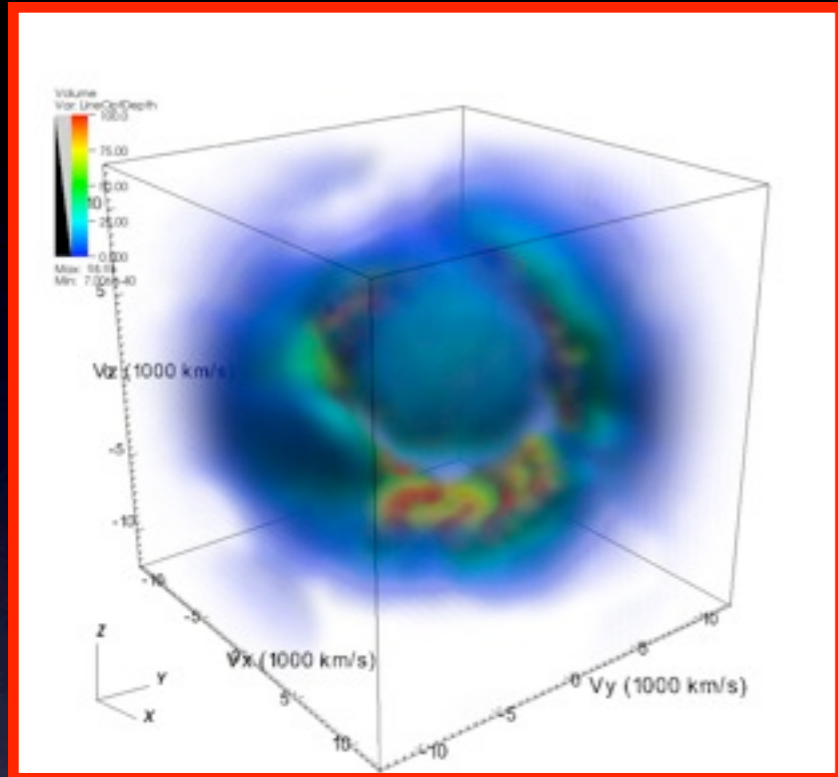
Convection



Size of clump?



Explosion Geometry: Spectropolarimetric View



- Not axisymmetric (not 2D, but 3D)
- **3D signature is common**
- Suppose 3D perturbation on 1D, the size of each clump is large ($>25\%$ of photosphere)

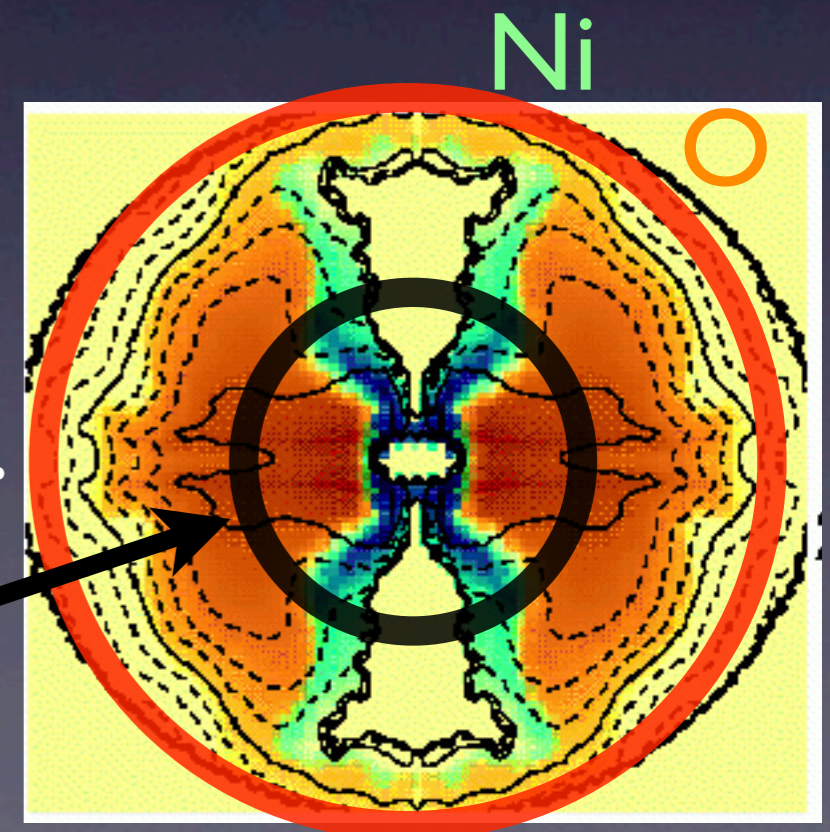
!! Caveats !!

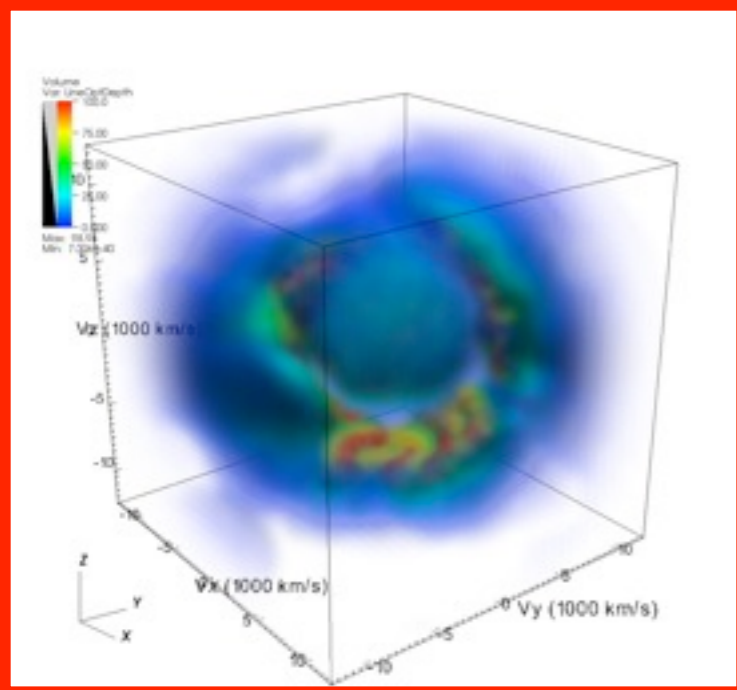
Overall 2D + 3D perturbation?

specpol.

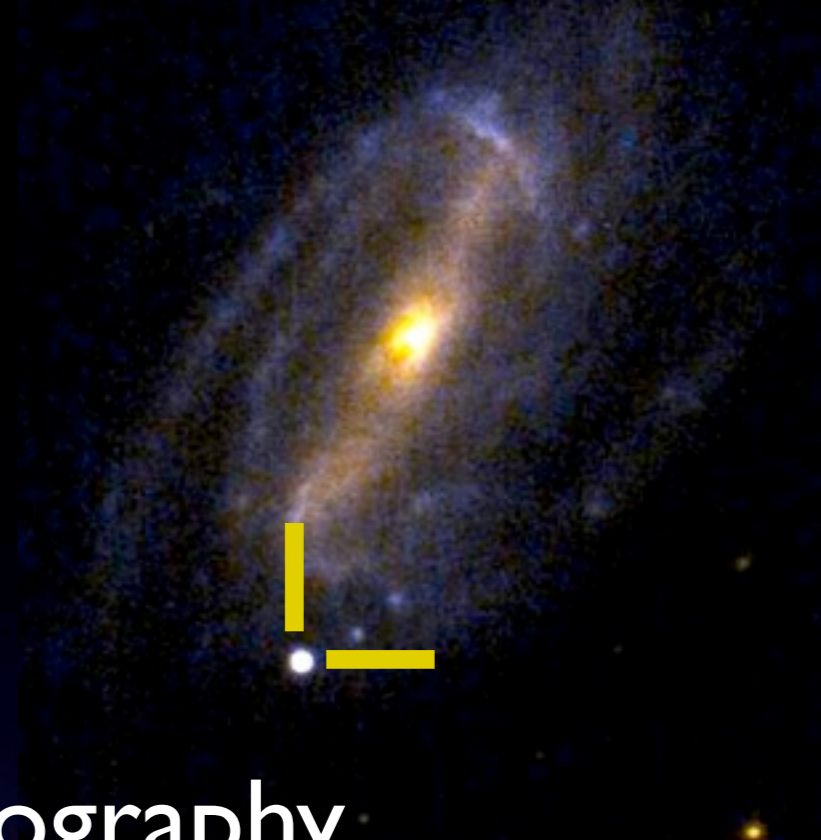
nebular line

(Mazzali+05, Maeda+08, Modjaz+08)





Summary



- Spectropolarimetry => 3D tomography
- Explosion geometry
 - Axisymmetry is broken
 - **3D signature is common**
- Implication for the explosion mechanism
 - **Large scale convection**
 - Overall 2D structure + 3D perturbation?