



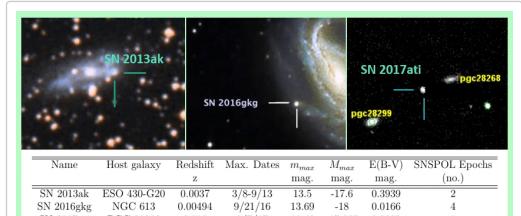
Multi-Epoch Spectropolarimetry Reveals Asphericity in Type IIb Supernova Explosions

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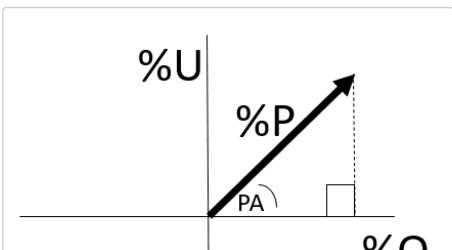
Project Overview



SN Spectropolarimetry Basics

Net Polarization and Position Angle

The Stokes Q and U are components of the net percent polarization, P (or %P). Direct measurements of Stokes U and Q can be used to derive the net polarization, P, and the "position angle" (or PA) that the net polarization vector (pseudovector) makes with respect to the +U axis as projected onto the sky.



SN 2013ak: A Clumpy Aspherical Explosion

H α line polarization

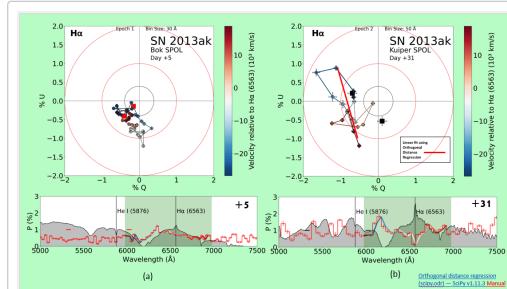
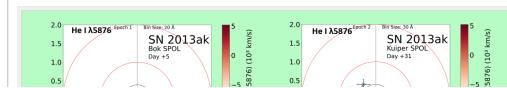
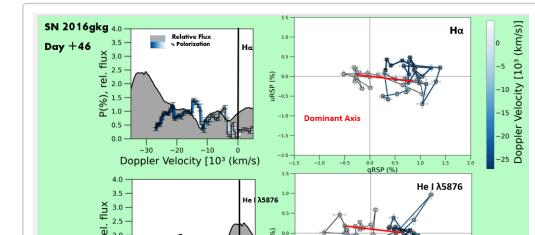


Figure 9. QU diagrams of H α line polarization for SN 2013ak. Figure 9a (left) and 9b (right) correspond to Day +5 and Day +31 respectively. The two thin red circles centered at the origin mark the 1% and 2% net polarization levels, respectively. The thin black circle has a radius of $\sim 0.4\%$, a lower limit to the ISP, from the estimated E(B-V) from interstellar extinction in the Milky Way [14, 15, 16, 17]. The orange lines are linear fits to the data using the orthogonal distance regression (ODR) method (Python code, `scipy.odr`). The continuum polarization is shown as large red squares and black squares in Day +5 and Day +31, respectively. Line regions (shaded green) and continuum regions (red and black horizontal lines) are marked in the bottom spectra. A zero points to the color map for the Doppler velocities for the line polarization are the rest wavelengths of the atomic transitions.

He I 5876 line polarization



A Comparison of 2016gkg and SN 2017ati: IIb Clumpy or Not IIb Clumpy?



Summary and Next Steps

Our Main Results

In this poster, we demonstrate that wavelength-dependent (and thus velocity-dependent) "dominant axes" and/or "loops" in QU diagrams for particular spectral lines associated with increased line polarization are commonly found in these SNe IIb. Such findings are evidence for two principle structures:

- a preferred explosion direction, hinting at a bipolar envelope, or axial jets, and
- non-axisymmetric geometry (such as "clumps").

Comparing these three SNe IIb, we find interesting spectropolarimetric diversity and similarity:

- **Increased Polarization at P-Cygni Profiles:** The global spectra for all three SNe show strong H α and He I line polarization associated with P-Cygni absorption. In the cases of SN 2013ak and SN 2016gkg, we see a temporal increase in the strength of the polarization of these lines. This effect is