Polarized Light of SN 2014J

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**Introduction**

SN 2014J exploded in the nearby M82 at a distance of \( \sim 3.5 \) Mpc. It was a spectroscopically normal Type Ia explosion with high velocity features, but suffered from extreme extinction. The Supernova Spectropolarimetry (SNSPOL) Project obtained multi-epoch observations of this SN’s polarized light to capture its aspherical nature using the 90\(^°\) Bok and 6.5-m MMT telescopes. Spectropolarimetric observations can reveal two characteristics:

- Continuum emission describes the overall asymmetry of the explosion.
- Polarization detected at the same wavelengths as certain absorption features (known as line polarization) illustrates the geometry of those ions within the ejecta.

Polarization vectors of a spherical photosphere cancel completely leading to null polarization detection. Meanwhile, incomplete cancellation of an asymmetric photosphere’s vectors will produce a non-zero polarization in the continuum emission. Ions ejected in a clumpy manner unevenly block the underlying photospheric light resulting in line polarization.

**Interstellar Polarization (ISP)**

ISP must be determined correctly in order to find the level of polarization intrinsic to the SN, but it may also hold clues about the dust of the host environment.

- Observed degree of polarization of SN 2014J decreases steadily from \( \sim 6.5\% \) at 4000 Å to below 2\% at 7000 Å.
- The peak in polarization is not at optical wavelengths (\( \lambda_{\text{max}} \sim 4000 \) Å), but we find that the data can be fit by a Serkowski law with unusual parameters.
- The wavelength at which the polarization peaks, \( \lambda_{\text{max}} \sim 570 \) Å, is much shorter than the 5500 Å typical of Galactic dust. If the Serkowski law is valid, this would imply that the average radius of dust grains in M82 is smaller than in the Milky Way: \( \lambda_{\text{max}} = 0.015 \mu \text{m} \) as compared to the Galactic \( \lambda_{\text{max}} = 0.15 \mu \text{m} \). However, if the polarization arises due to circumstellar rather than interstellar scattering, we might expect an exponential law to explain the linear polarization. Further study of polarization originating in a circumstellar dust cloud is necessary.

**Summary**

+ A Serkowski fit to the ISP shows interstellar dust in M82 is quite different from our galaxy, however the possibility that circumstellar scattering creates the observed polarization needs to be investigated further.
+ Continuum polarization of SN 2014J is low indicating a low level of global asymmetry
+ Si II 6355 Å shows a significant line polarization and change in polarization angle near maximum light indicating that it has most likely been ejected in a clumpy manner

**Spectropolarimetry Results**

Four epochs of SN 2014J’s ISP-corrected degree of polarization and polarization angle are displayed below.

**SiII Q-U diagram**

Plotting the polarized Si II line in the plane of the normalized q and u Stokes vectors is a better way to visualize the data.

+ Overplotted in dashed lines are the 0.5% and 1.0% polarization levels
+ Si II clearly displays a loop behavior in Ep.1 and Ep.2 showing how its polarization angle changes across the line
+ Line polarization disappears by Ep.3

**References**


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