Optical and Near-Infrared Polarimetry of Reddened Type Ia Supernova 2014J: Peculiar Properties of Dust in M82

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We performed optical and near-infrared multi-band linear polarimetry for highly reddened Type Ia SN 2014J appeared in M82. SN 2014J exhibits large polarization at shorter wavelengths, reaching $p \cong 4.8\%$ in B band, and it steeply decreases with wavelength to $\cong 0.1\%$ in Ks band, while the position angle $\sim 40°$ is almost constant over the observed wavelength range.

The polarization is likely predominantly caused by the interstellar media within M82 because of i) no significant temporal variation, ii) small Galactic extinction toward SN 2014J, and iii) generally less polarization seen in continuum light of normal Type Ia supernova, although we cannot exclude the possibility by circumstellar media completely. The wavelength dependence of polarization can be explained by the empirical Serkowski-law at shorter wavelengths ($\lambda < 1\ \mu m$) and by an inverse power-law at longer wavelengths ($\lambda > 0.5 \mu m$). The peak polarization wavelength λ_{max} is quite short, $\leq 0.4\ \mu m$, suggesting the mean radius of aligned aspherical grains contributing to the polarization is small. The empirical law between K and λ_{max} for the Galactic interstellar polarization is apparently broken, although the positive correlation between $R_V = A_V/E_{B-V}$ and λ_{max} seems to still holds. These facts suggest the nature of the dust grains in M82 is essentially different from that in our Galaxy. The polarization property of SN 2014J is similar to those in other highly reddened Type Ia SNe 1986G and 2006X that have been polarimetrically observed, and this high probability suggests such dust grains are rather common in extragalaxies.