

Physical Dust Models for the Extinction toward Supernova 2014J

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Type Ia supernovae (SNe Ia) are powerful cosmological standardizable candles and the most precise distance indicators. However, the ultimate limiting factor in their use for precision cosmology rests on our ability to correct for the dust extinction toward them. SN 2014J in the starburst galaxy M82, the closest detected SN Ia in three decades, provides unparalleled opportunities to study the dust extinction toward this SN. In order to derive the extinction as a function of wavelength, we model the color excesses toward SN 2014J observationally derived over a wide wavelength range in terms of dust models consisting of a mixture of silicate and graphite. The resulting extinction laws steeply rise toward the far ultraviolet, even steeper than that of the Small Magellanic Cloud (SMC). We infer a visual extinction of $A_V \approx 1.9$ mag, a reddening of $E(B - V) \approx 1.1$ mag, and a total-to-selective extinction ratio of $R_V \approx 1.7$, consistent with that previously derived from photometric, spectroscopic and polarimetric observations. The size distributions of the dust in the interstellar medium toward SN 2014J are skewed toward substantially smaller grains than that of the Milky Way and the SMC.