The Reddenings of Red Supergiants: When Smoke Gets In Your Eyes

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Deriving the physical properties of red supergiants (RSGs) depends upon accurate corrections for reddening by dust. We use our recent modeling of the optical spectra of RSGs to address this topic. First, we find that previous broad-band studies have underestimated the correction for extinction in the visible, and hence the luminosities (if derived from V); the shift in the effective wavelengths of the standar B and V bandpasses necessitates using an {\it effective} value of the ratio $R'_V=4.2$ to correct broad-band photometry of RSGs if $R_V=3.1$ for early-type stars viewed through the same dust, where we have assumed the standard reddening law of Cardelli, Clayton, \& Mathis (1989). Use of the Fitzpatrick (1999) reddening law would lead to $R'_V=3.8$, as well as slightly lower values of extinction derived from spectrophotometry, but results in slightly poorer fits. Second, we find that a significant fraction of RSGs in Galactic OB associations and clusters show up to several magnitudes of excess visual extinction compared to OB stars in the same regions; we argue that this is likely due to circumstellar dust around the RSGs. We also show that the RSG dust production rate (as indicated by the 12-μm excess) is well-correlated with bolometric luminosity, contrary to what has been found by earlier studies. The stars with the highest amount of extra visual extinction also show significant near-UV (NUV) excesses compared to the stellar models reddened by the standard reddening law. This NUV excess is likely due to scattering of the star's light by the dust and/or a larger average grain size than that typical of grains found in the diffuse interstellar medium. Similar excesses have been attributed to circumstellar dust around R Coronae Borealis stars. Finally, we estimate that the RSGs contribute dust grains at the rate of $3 \times 10^{-8} M_\odot$ yr^{-1} kpc^{-2} in the solar neighborhood, comparable to what we estimate for late-type WCs, $1 \times 10^{-7} M_\odot$ yr^{-1} kpc^{-2}. In the solar neighborhood this represents only a few percent of the dust production (which is dominated by low-mass AGBs), but we note that in low-metallicity starbursts, dust production by RSGs would likely dominate over other sources.

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Comments:

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