Spectral type, temperature and evolutionary stage in cool supergiants

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In recent years, temperature scales in cool supergiants (CSGs) have been disputed, and the possibility that spectral types (SpTs) do not depend primarily on temperature has been raised. We explore the relations between different observed parameters and the capability of deriving accurate intrinsic stellar parameters from them through the analysis of the largest spectroscopic sample of CSGs to date from SMC and LMC. We explore possible correlations between different observational parameters, also making use of near- and mid-infrared colours and literature on photometric variability. Direct comparison between the behaviour of atomic lines (Fe I, Ti I, and Ca II) in the observed spectra and synthetic atmospheric models provides compelling evidence that effective temperature is the prime underlying variable driving the SpT sequence in CSGs. However, there is a clear correlation between SpT and luminosity, with later ones tending to correspond to more luminous stars with heavier mass loss. The population of CSGs in the SMC is characterised by a higher degree of spectral variability, early spectral types (centred on type K1) and low mass-loss rates (at least as measured by dust-sensitive mid-infrared colours). The population in the LMC displays less spectroscopic variability and later spectral types. The distribution of spectral types is not single-peaked. Instead, the brightest CSGs have a significantly different distribution from less luminous objects, presenting mostly M subtypes (centred on M2), and increasing mass-loss rates for later types. In conclusion, the observed properties of CSGs in the SMC and the LMC cannot be described correctly by standard evolutionary models. The very strong correlation between spectral type and bolometric luminosity, supported by all data from the Milky Way, cannot be reproduced at all by current evolutionary tracks.

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