Monitoring Luminous Yellow Massive Stars in M33: New Yellow Hypergiant Candidates

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The evolution of massive stars surviving the red supergiant (RSG) stage remains unexplored due to the rarity of such objects. The yellow hypergiants (YHGs) appear to be the warm counterparts of post-RSG classes located near the Humphreys-Davidson upper luminosity limit, which are characterized by atmospheric instability and high mass-loss rates. We aim to increase the number of YHGs in M33 and thus to contribute to a better understanding of the pre-supernova evolution of massive stars. Optical spectroscopy of five dust-enshrouded YSGs selected from mid-IR criteria was obtained, with the goal of detecting evidence of extensive atmospheres. We also analyzed BVI photometry for 21 of the most luminous YSGs in M33 to identify changes in the spectral type. To explore the properties of circumstellar dust, we performed SED-fitting of multi-band photometry of the 21 YSGs. We find three luminous YSGs in our sample to be YHG candidates, as they are surrounded by hot dust and are enshrouded within extended, cold dusty envelopes. Our spectroscopy of Star 2 shows emission of more than one Hα components, as well as emission of Ca II, implying expanding structures associated with large outflow velocities. In addition, the long-term monitoring of the star reveals a dimming in the visual light curve of amplitude larger than 0.5 mag, which caused an apparent drop in the temperature that exceeded 500 K. We suggest the observed variability to be analogous to that of the Galactic YHG ρ Cas. Five less luminous YSGs are suggested as post-RSG candidates showing evidence of hot or/and cool dust emission. We demonstrate that mid-IR photometry, combined with optical spectroscopy and time-series photometry, provide a robust method for identifying candidate YHGs. Future discovery of YHGs in Local Group galaxies is critical for the study of the late evolution of intermediate-mass massive stars.

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