Physical Properties of II Zw 40's Super Star Cluster and Nebula: New Insights and Puzzles from UV Spectroscopy

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We analyze far-ultraviolet spectra and ancillary data of the super star cluster SSC-N and its surrounding H II region in the nearby dwarf galaxy II Zw 40. From the ultraviolet spectrum, we derive a low internal reddening of E(B-V) = 0.07 +/- 0.03, a mass of (9.1 +/- 1.0) x 10^5 Lsol, a bolometric luminosity of (1.1 +/- 0.1) x 10^9 Lsol, a number of ionizing photons of (6 +/- 2) x 10^52 s^-1, and an age of (2.8 +/- 0.1) Myr. These parameters agree with the values derived from optical and radio data, indicating no significant obscured star formation, absorption of photons by dust, or photon leakage. SSC-N and its nebulosity are an order of magnitude more massive and luminous than 30 Doradus and its ionizing cluster. Photoionization modeling suggests a high ionization parameter and a C/O ratio where C is between primary and secondary. We calculate diagnostic emission-line ratios and compare SSC-N to local star-forming galaxies. The SSC-N nebula does not coincide with the locus defined by local galaxies. Rather, it coincides with the location of "Green Pea" galaxies, objects which are often considered nearby analogs of the galaxies reionizing the universe. Most stellar features are well-reproduced by synthetic spectra. However, the SSC-N cluster has strong, broad, stellar He II 1640 emission that cannot be reproduced, suggesting a deficit of He-enhanced stars with massive winds in the models. We discuss possible sources for the broad He II emission, including very massive stars and/or enhanced mixing processes.

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