The Physical Properties of the Red Supergiant WOH G64: The Largest Star Known?

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WOH G64 is an unusual red supergiant (RSG) in the Large Magellanic Cloud (LMC), with a number of properties that set it apart from the rest of the LMC RSG population, including a thick circumstellar dust torus, an unusually late spectral type, maser activity, and nebular emission lines. Its reported physical properties are also extreme, including the largest radius for any star known and an effective temperature that is much cooler than other RSGs in the LMC, both of which are at variance with stellar evolutionary theory. We fit moderate-resolution optical spectrophotometry of WOH G64 with the MARCS stellar atmosphere models, determining an effective temperature of 3400 +/- 25 K. We obtain a similar result from the star's broadband V - K colors. With this effective temperature, and taking into account the flux contribution from the aysmmetric circumstellar dust envelope, we calculate log(L/L_sun) = 5.45 +/- 0.05 for WOH G64, quite similar to the luminosity reported by Ohnaka and collaborators based on their radiative transfer modeling of the star's dust torus. We determine a radius of R/R_sun = 1540, bringing the size of WOH G64 and its position on the H-R diagram into agreement with the largest known Galactic RSGs, although it is still extreme for the LMC. In addition, we use the Ca II triplet absorption feature to determine a radial velocity of 294 +/- 2 km/s for the star; this is the same radial velocity as the rotating gas in the LMC's disk, which confirms its membership in the LMC and precludes it from being an unusual Galactic halo giant. Finally, we describe the star's unusual nebula emission spectrum; the gas is nitrogen-rich and shock-heated, and displays a radial velocity that is significantly more positive than the star itself by 50 km/s.

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