On the nature of the prototype LBV AG Carinae II. Witnessing a massive star evolving close to the Eddington and bistability limits

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We show that the significantly different effective temperatures (Teff) achieved by the luminous blue variable AG Carinae during the consecutive visual minima of 1985-1990 (Teff= 22,800 K) and 2000-2001 (Teff=17,000 K) place the star on different sides of the bistability limit, which occurs in line-driven stellar winds around Teff ~ 21,000 K. Decisive evidence is provided by huge changes in the optical depth of the Lyman continuum in the inner wind as Teff changes during the S Dor cycle. These changes cause different Fe ionization structures in the inner wind. The bistability mechanism is also related to the different wind parameters during visual minima: the wind terminal velocity was 2-3 times higher and the mass-loss rate roughly two times smaller in 1985-1990 than in 2000-2003. We obtain a projected rotational velocity of 220 +- 50 km/s during 1985-1990 which, combined with the high luminosity (L=1.5x10^6 Lsun), puts AG Car extremely close to the Eddington limit modified by rotation (Omega-Gamma limit): for an inclination angle of 90 deg, Gamma_Omega > 1.0 for M< 60 Msun. Based on evolutionary models and mass budget, we obtain an initial mass of ~ 100 Msun and a current mass of 60-70 Msun for AG Car. Therefore, AG Car is close to, if not at, the Omega-Gamma limit during visual minimum. Assuming M=70 Msun, we find that Gamma_Omega decreases from 0.93 to 0.72 as AG Car expands toward visual maximum, suggesting that the star is not above the Eddington limit during maximum phases.

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