The effect of rotation on the Schönberg-Chandrasekhar limit

Abstract

The evolution of a main-sequence star into a red giant is a known process since the studies of embedded polytropes. It was shown that an isothermal core embedded in a radiative envelope has an upper limit on its mass. If the core is less massive than this limit, the equilibrium exists and the star remains in the main-sequence. However, if the core is more massive, the equilibrium is not possible anymore and the core begins to contract and the star leaves the main-sequence and evolve into a red giant. This upper limit is called the Schönberg-Chandrasekhar limit (hereafter SC-limit).

In this work, we use the `DROP`-code (Basillais and Huré, 2021) that generates internal structures of polytropic stars in equilibrium under three forces : gravitational force, pressure forces and centrifugal force to study the effect of uniform rotation and various differential rotations on this SC-limit. We report that the rotation decreases this limit by up to 20% in the most extreme cases. We also investigated the effect of a massive companion. We show that there is a minor increase on the SC-limit.

References

Basillais, B. and Huré, J. (2021). A computational method for rotating, multi-layer spheroids with internal jumps. *Monthly Notices of the Royal Astronomical Society*, 506(3):3773–3790.