The flux-weighted gravity-luminosity relationship of blue supergiant stars as a constraint for stellar evolution

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The flux-weighted gravity-luminosity relationship (FGLR) of blue supergiant stars (BSG) links their absolute magnitude to the spectroscopically determined flux-weighted gravity log(g/Teff^4). BSG are the brightest stars in the universe at visual light and the application of the FGLR has become a powerful tool to determine extragalactic distances.

Observationally, the FGLR is a tight relationship with only small scatter. It is, therefore, ideal to be used as a constraint for stellar evolution models. The goal of this work is to investigate whether stellar evolution can reproduce the observed FGLR and to develop an improved foundation of the FGLR as an extragalactic distance indicator. We use different grids of stellar models for initial masses between 9 and 40 Msun, for metallicities between Z=0.002 and 0.014, with and without rotation, computed with various mass loss rates during the red supergiant phase. For each of these models we discuss the details of post-main sequence evolution and construct theoretical FGLRs by means of population synthesis models which we then compare with the observed FGLR.In general, the stellar evolution model FGLRs agree reasonably well with the observed one. There are, however, differences between the models, in particular with regard to the shape and width (scatter) in the flux-weighted gravity-luminosity plane. The best agreement is obtained with models which include the effects of rotation and assume that the large majority, if not all the observed BSG evolve towards the red supergiant phase and only a few are evolving back from this stage. The effects of metallicity on the shape and scatter of the FGLR are small. The shape, scatter and metallicity dependence of the observed FGLR are well explained by stellar evolution models. This provides a solid theoretical foundation for the use of this relationship as a robust extragalactic distance indicator.

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