Abstract

This work focuses on the search and study of pulsating hot subdwarf stars in two open clusters observed during the *Kepler* mission, NGC 6791 and NGC 6819. Both clusters are relatively old with ages of around 9 Gyr and 2.5 Gyr, respectively. Hot subdwarf stars are hot, compact helium core burning stars with a very thin hydrogen envelope. Their temperature ranges from 20 000 to 80 000 K, with a typical mass of 0.47 M$\odot$ and surface gravity $\log(g/\mathrm{cm\,s^{-2}})$ of 5.0 to 5.8, resulting in radii of 0.1 to 0.3 R$\odot$. The formation of hot subdwarf stars can occur through various channels, including binary systems and white dwarf mergers.

Our work has confirmed three pulsating subdwarf B (sdB) stars, KIC 2569576 (B3), KIC 2438324 (B4), and KIC 2437937 (B5), in NGC 6791, while none in NGC 6819. As compared to previous reports, we extended the data coverage for the analysis of these stars, discovered additional pulsation frequencies and features in their amplitude spectra. Analysis of spectroscopic observations revealed that four stars (B3, B4, B5 and B6) have atmospheric parameters consistent with gravity mode dominated sdBs. Additionally, hints of radial velocity variability in B3, B5, and B6 suggest they may be part of binary systems. We present the outcomes of asteroseismic modeling, by means of MESA and GYRE models, of B3 and B4 along with two field pulsating sdB stars, KIC 2991403, and KIC 11159657. The modeling accounted for a pulsation mode assignment and spectroscopic parameters (T_{eff} and $\log g$). For B3 and B4, we tried using two cluster parameters (total age and metallicity) with limited success. In the case of B4, a spectroscopically constrained approach resulted in a unique solution. We derived unique solutions except for the hydrogen envelope mass and progenitor mass (B3 and KIC 2991403), and for convective core and progenitor masses (KIC 11179657). Our fits, assessed by relative pulsation period differences ($\Delta P/P$), were consistent within 1%, except for KIC 11179657. Our results should be encouraging for further asteroseismic modeling of sdB stars.

While searching for pulsating hot subdwarfs we identified variable stars in both clusters. In NGC 6791, we found 278 variable stars, including 119 previously unknown. We calculated cluster membership probabilities for the variable stars using *Gaia* astrometry and we found 129 to be cluster members, which also provided an insight into their evolutionary status. For eclipsing binary systems, we determined eclipse mid-times and identified three systems with significant orbital period variability. Spectroscopic analysis delivered stellar parameters for 111 objects and revealed inconsistencies in the metallicity among cluster members, suggesting the presence of multiple stellar populations. By fitting MIST isochrones, we estimated the metallicity range to be $0.26-0.28$ and age of 8.91 Gyr, as well as its average distance of 4134 pc. The latter agrees with the estimate derived by means of *Gaia* EDR3 astrometry. In NGC 6819, we found 385 variable stars, including 270 previously unknown. We derived 128 variable stars to be cluster members. For eclipsing binary stars, we determined eclipse mid-times and we found five objects with significant orbital period variability. Using MIST isochrones, we estimated the age of 2.54 Gyr and metallicity of -0.03 – +0.01. The distance of 2300 pc agrees with the one derived by means of *Gaia* DR3 astrometry.