Precision Asteroseismology
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The mean density and the surface gravity of the primary component of μ Eridani, an SPB variable in a single-lined spectroscopic and eclipsing system

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Abstract. Precision asteroseismology uses the observed effective temperature and luminosity or surface gravity in selecting evolutionary models for analysis. In the case of the primary component of μ Eri, an SPB variable, the surface gravity and luminosity can be derived from the parameters of the SB1 eclipsing system. We examine how the surface gravity and luminosity so derived help to select the evolutionary models suitable for asteroseismic analysis.

Keywords. stars: individual (μ Eri), stars: SB1, stars: eclipsing, stars: fundamental parameters

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μ Eri (B5 IV, $V = 4.00$ mag) is a single-lined spectroscopic binary and a detached eclipsing variable with an invisible secondary component. The primary component is a slowly pulsating B (SPB) star. Recently, Jerzykiewicz *et al.* (2013) derived the parameters of the system using *MOST* (Walker *et al.* 2003) time-series photometry and ground-based radial-velocity observations. In addition, from archival *UBV* and *uvby* indices these authors derived the primary's effective temperature, $T_{\rm eff} = 15\,670 \pm 470$ K. For an assumed mass, M, the parameters of the system, viz., the relative radius of the primary component, the inclination of the orbit, the semi-amplitude of the primary's radial-velocity variation and the eccentricity, suffice to compute the mean density, $\langle\rho\rangle$, and surface gravity, g. Then, the luminosity, L, can be computed from $\langle\rho\rangle$ and $T_{\rm eff}$. For $M = 5$, 5.5 and 6 $M_\odot$, the results of this exercise are given in Table 1. As can be seen from the table, $\langle\rho\rangle$ is virtually independent of M, while $\log g$ varies slowly with M.

Figure 1 illustrates how $\log g$ and $\log L$ so derived can help to select the evolutionary models suitable for asteroseismic analysis. In the figure, the positions of the primary component of μ Eri (circles with error bars) are compared with the 5.5 and 6.0 $M_\odot$ evolutionary tracks, computed assuming $X = 0.7$ and $Z = 0.015$, the Asplund *et al.* (2009) solar mixture, the OPAL opacities (Iglesias & Rogers 1996), the equatorial rotation velocity of 140 km s^{-1} on the ZAMS, and two values of the convective-core overshooting parameter, $\alpha_{\rm ov} = 0.0$ (left panels) and 0.2 (right panels). The figure shows that in the case of $\alpha_{\rm ov} = 0.0$ (left panels) the post-main-sequence models are more suitable for asteroseismic analysis of μ Eri than the main-sequence models, while the reverse is true for

Table 1. Fundamental parameters of the primary component of μ Eri, computed for three assumed values of mass. M and L are in solar units, $\langle\rho\rangle$ and g, in cgs units.

M	$\langle\rho\rangle$	$\log g$	$\log L$
5.0	0.0345±0.0032	3.597±0.027	3.273±0.058
5.5	0.0346±0.0032	3.612±0.027	3.299±0.058
6.0	0.0348±0.0032	3.625±0.027	3.323±0.058

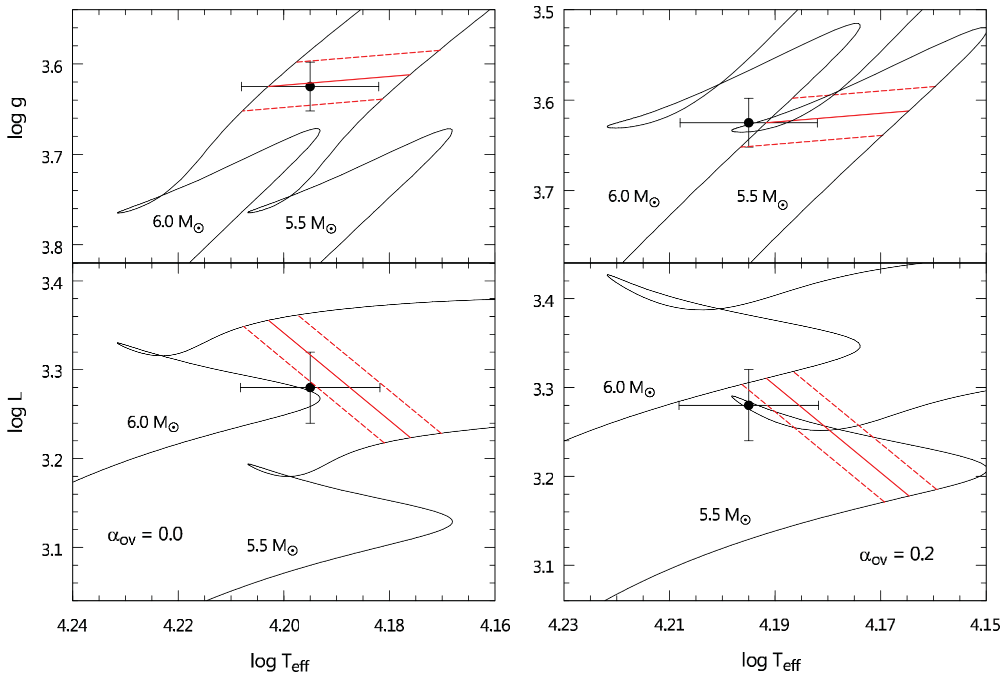

Figure 1. The positions of the primary component of μ Eri (circles with error bars) compared with the 5.5 and 6.0 $M_{\odot}$ evolutionary tracks, computed assuming $X = 0.7$ and $Z = 0.015$, the equatorial rotation velocity of 140 km s^{-1} on the ZAMS, and two values of the convective-core overshooting parameter, $\alpha_{\rm ov} = 0.0$ (left panels) and 0.2 (right panels). Also shown are lines connecting points on the evolutionary tracks for which μ Eri's $\log g$ is equal to the evolutionary tracks' $\log g$ (upper panels) or μ Eri's $\log L$ is equal to the evolutionary tracks' $\log L$ (lower panels). The dashed lines run at $\pm\sigma$.

$\alpha_{\rm ov} = 0.2$ (right panels). The former case would be an observational confirmation of the existence of pulsational instability in post-main-sequence massive-star models discovered recently by Daszyńska-Daszkiewicz *et al.* (2013).

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