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The evolved slowly pulsating B star 18 Peg

A testbed for upper main sequence stellar evolution

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Abstract. The predicted width of the upper main sequence in stellar evolution models depends on the empirical calibration of the convective overshooting parameter. Despite decades of discussions, its precise value is still unknown and further observational constraints are required to gauge it. Irrgang et al. ([1]) showed that the B3 III giant 18 Peg is one of the most evolved members of the class of slowly pulsating B (SPB) stars and, thus, bears tremendous potential to derive a tight lower limit for the width of the upper main sequence. In addition, 18 Peg turns out to be part of a single-lined spectroscopic binary system with an eccentric, more than 6-year orbit. The orbital solution, in combination with the absence of additional signatures of the secondary component in the spectroscopic data and the spectral energy distribution, lead to the conclusion that all the observations of 18 Peg are fully compatible with the assumption that the secondary component is either a main-sequence star with a mass of 1-4 $M_\odot$ or a neutron star.

1 18 Peg as an asteroseismic target in a binary

To exploit the full potential of 18 Peg (RA(2000) = 22:00:07.93; DEC(2000) = +06:43:02.78; V = 6 mag; $v \sin i = 15(3)\,\mathrm{km s^{-1}}$; [2]) as benchmark object for stellar evolution theory, additional observations are required. In 2016, 18 Peg is approaching periastron (see Fig. 1) and is hence in the orbital phase were the orbital velocity is changing fast. We therefore organized a follow-up campaign with the HERMES spectrograph attached to the 1.2m Mercator telescope (Roque de Los Muchachos Observatory, La Palma, Canary Islands; [3]) to gather high-quality, high-resolution spectra appropriate for the fine-tuning of the orbit and for a detailed study of the main pulsation mode (see gray area on Fig. 1). The new orbit found after inclusion of the new spectroscopic data (open diamonds in Fig. 1) is drawn with a solid curve in Figure 1 and the corresponding orbital parameters are given in the right column of Table 1. Given that only few of the revised values of the orbital parameters agree within the 1 σ errors with those published by Irrgang et al. ([1]), more data is needed to fine-tune the orbit.

So far, only one pulsation mode with a period of ~1.4 days has been detected for 18 Peg, which is insufficient to derive an accurate asteroseismic position in the Hertzsprung-Russell diagram. 18 Peg is (1) being observed in the Strömgren u- and y-band with the 0.75m T6 APT at Fairborn Observatory

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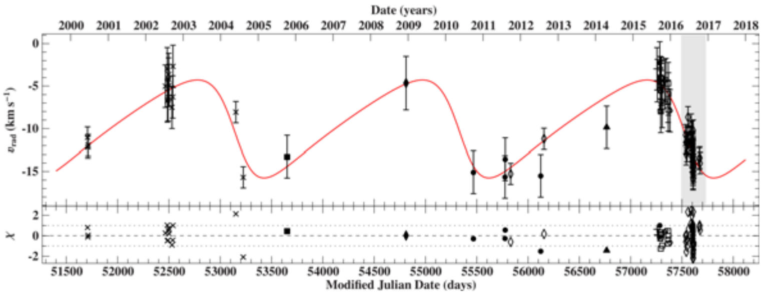

Figure 1. Radial velocity curve of 18 Peg. The radial velocities were derived from spectra taken with multiple instruments represented by different symbols. The HERMES spectra (open diamonds) in the grey zone were not available yet at the time of publication of Irrgang et al. ([1]).

Table 1. Comparison of the orbit published by Irrgang et al. ([1], left) to the one found after inclusion of HERMES spectra obtained up to November 8, 2016 (right). The orbital and derived parameters are given in the top and bottom part, respectively. Incompatible values are given in italics.

Parameter	Published	This work
Period P (in days)	*2245^{+25}_{-30}*	*2191±14*
Epoch of periastron $T_{\rm periastron}$ (in MJD)	*57730^{+40}_{-60}*	*57550^{+60}_{-70}*
Eccentricity e	*$0.60^{+0.07}_{-0.08}$*	*0.33±0.06*
Longitude of periastron ω (in deg)	123^{+12}_{-7}	103±14
Velocity semiamplitude K_1 (in km s^{-1})	*$7.74^{+1.9}_{-1.1}$*	*5.7±0.5*
Systemic velocity γ (in km s^{-1})	-9.9 ± 0.4	-9.6 ± 0.4
Mass function $f(M)$ (in $M_\odot$)	$0.054^{+0.035}_{-0.017}$	$0.036^{+0.011}_{-0.009}$
Projected semimajor axis a_1 sin(i) (in AU)	$1.27^{+0.23}_{-0.15}$	$1.09^{+0.10}_{-0.09}$
Projected periastron distance $r_{\rm p}$ sin(i) (in $R_\odot$)	*108^{+21}_{-17}*	*156±23*

(Arizona, USA; kindly offered by G. Handler), (2) has been accepted as a target for the BRITE-constellation and (3) will (probably) be observed for 27 days with the space mission TESS (to be launched in March 2018) to gather complementary time-series of accurate photometry with a sufficiently long time-base to be able to study the expected low amplitude modes that are unobserved so far.

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