Spectroscopically and Spatially Resolving the Components of Close Binary Stars
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Fundamental parameters and stellar evolution

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Abstract. Some discrepancies have been pointed by various authors (Popper 1997, Torres & Ribas 2002) in the past few years between stellar evolution model predictions in the 0.7 - 1.1 $M_\odot$ mass range and results obtained from binary stars with the most accurately known properties. The study of the eclipsing binary UV Psc, with relative accuracy of mass better than 1% for both components, suggests that fixing the mixing length parameter $\alpha_{\rm MLT}$ to its solar value (1.6), a standard hypothesis assumed in the most of stellar evolutionary models, is not correct. This parameter seems to decrease with stellar mass. To confirm this possible trend, we intend to use new data from an international programme of spectroscopic and photometric observations of detached eclipsing binaries, mainly with solar-type components.

1. The observational programme of eclipsing binaries

The initial programme, started in 1997 at the Haute-Provence Observatory with the CORAVEL instrument, includes about fifty detached eclipsing binaries, mainly systems newly discovered by Hipparcos. Amongst them, some thirty systems have been observed spectroscopically since 1999 with the ELODIE instrument. From the sample of 29 new double-lined Hipparcos eclipsing binaries, some 18 stars have a component with a mass between 1.1 and 0.7 solar masses.

2. First determinations of masses and radii

Table 2 presents preliminary results on masses and radii obtained for three binaries: BW Boo (HIP 71487), HP Dra (HIP 92835), V2154 Cyg (HIP 105584) (see Table 1), observed photometrically and spectroscopically. Two of these binaries have components with a mass less than 1.1 $M_\odot$. The relative precision of the masses and radii reaches the expected level of a few percent.

Table 1. Newly discovered double-lined detached systems from the Hipparcos catalogue with at least one component of a subsolar mass.

Name	HIP	Epoch +240000.	Rem	Period	Sp type	B−V	V_J
WZ Ari	14610	52493.5125	x	30.145	G5V+	0.701	8.21
EM Cet	15728	48510.883	?	13.271	F8	0.575	9.69
DI Cam	20896	48501.040		4.1659	F8	0.465	7.76
CF Lyn	37748	48500.5000		1.38540	F8	0.532	9.54
CN Lyn	39250	52309.5748	x	1.9555035	F5	0.413	9.01
FK Leo	54711	48501.		1.73720	F5III	0.466	8.50
HR UMa	56330	51980.4635	x	1.474126	F8	0.425	8.70
FK Dra	61006	48501.6300	x	2.00072	K0	0.805	9.24
IO UMa	64636	48500.280		5.5200	A3	0.241	8.18
BW Boo	71487	50595.1953	x	3.332930	F0V	0.128	7.13
EM Boo	72426	48501.1117	?	2.44630	G5	0.506	9.02
V335 Ser		51677.4051	x	3.4498968	F		7.50
V948 Her	85057	48501.1070		1.27519	F2	0.393	8.93
HP Dra	92835	51041.4812	x	10.7615305	G5	0.600	7.96
V2080 Cyg	95611	51053.7050	x	4.93355	F5	0.508	7.38
IO Aqr	102041	48502.3278	?	2.36816	G0	0.512	8.82
V2154 Cyg	105584	51435.3250	x	2.630664	F0	0.441	7.78

Rem: ? – The epochs and Hipparcos periods are wrong, but not yet available from the present observational data, x – our own determination of epochs and periods.

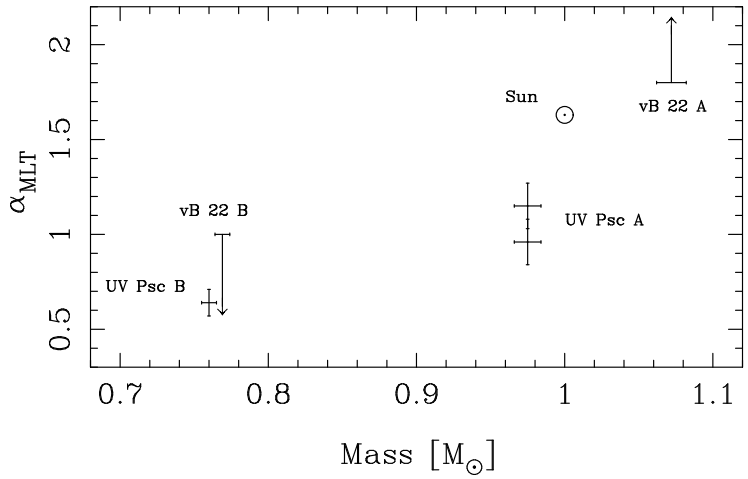

Figure 1. Values of α_{MLT} for both UV Psc A and B in a α_{MLT} vs. mass diagram. The value of α_{MLT} for the A component depends slightly on the derived T_{eff}, while α_{MLT} for B is independent of the T_{eff} scale. The Sun is shown for comparison, as well as estimates (shown as upper and lower limits) derived from CESAM models with the same input physics for both components of the Hyades binary vB 22 (Lebreton, Fernandes, & Lejeune 2001).

Table 2. Masses and radii with their uncertainties for three detached eclipsing binaries.

Name	HIP		Mass [$M_\odot$]	σ_M	R [$R_\odot$]	σ_R
BW Boo	71487	1	1.874	± 0.022	1.676	± 0.015
		2	1.043	± 0.009	1.182	± 0.012
HP Dra	92835	1	1.168	± 0.013	1.259	± 0.013
		2	1.121	± 0.011	1.251	± 0.013
V2154 Cyg	105584	1	1.276	± 0.009	1.541	± 0.013
		2	0.763	± 0.005	0.778	± 0.008

3. Fundamental parameters and stellar evolution

Lastennet et al. (2003) calculated a grid of CESAM models (Morel 1997) for each of the components of the UV Psc binary studied by Popper (1997). Thanks to the high precision of masses and radii for the components, they derived a possible variation of the mixing-length convection parameter (α_{MLT}) which was usually assumed to be constant and equal to the solar value for all types of stars.

Moreover, as seen on Figure 1, it clearly appears that α_{MLT} is different for the two components of UV Psc. Adding the constraints obtained by Lebreton et al. (2001) for the components of the binary vB 22, Figure 1 suggests that the parameter $\alpha_{\rm MLT}$ could be a function of stellar mass. At any rate, the solar value does not seem to be universal. The discordant ages of the components (a very strong difference with previous models) disappears with new values of $\alpha_{\rm MLT}$. This result must of course be confirmed with further data on other systems in this mass range. Our new spectroscopic and photometric observations of eclipsing binaries could allow us to obtain a possible statistical relation between $\alpha_{\rm MLT}$ and stellar (subsolar) mass.

References

Lastennet, E., Fernandes, J., Valls-Gabaud, D., & Oblak, E. 2003, A&A, 409, 611
Lebreton, Y., Fernandes, J., & Lejeune, T. 2001, A&A, 374, 540
Morel, P. 1997, A&AS, 124, 597
Popper, D. M. 1997, AJ, 114, 1195
Torres, G., & Ribas, I. 2002, ApJ, 567, 1140