

TWO NEW K-TYPE ECLIPSING BINARIES FROM THE ASAS DATABASE



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We present spectroscopic and photometric measurements and their modeling of two new eclipsing binaries with K-type components, ASAS_DEB_001 and ASAS_DEB_003, from the *All Sky Automated Survey* database. The radial velocities obtained with the 10-m Keck I/HIRES and combined with the light curves from the 1.0-m Elizabeth telescope (SAAO) allow us to determine the absolute physical parameters of both systems. In particular, the masses and radii are (in solar units): $M_1 = 0.846 \pm 0.003$, $M_2 = 0.840 \pm 0.003$, $R_1 = 0.994 \pm 0.011$ and $R_2 = 0.979 \pm 0.010$ for ASAS_DEB_001 and $M_1 = 0.714 \pm 0.006$, $M_2 = 0.694 \pm 0.006$, $R_1 = 0.705 \pm 0.007$ and $R_2 = 0.701 \pm 0.003$ for ASAS_DEB_003.

INTRODUCTION:

The ASAS_DEB_001 and ASAS_DEB_003 are the first two low-mass and fully characterized detached eclipsing binaries from our ongoing spectroscopic survey of the eclipsing binaries from the ASAS database. Due to a well known discrepancy between the models and observations of the mass-radius relation for the lower Main Sequence, such low mass pairs are especially useful. In particular, few systems of this kind have absolute values of the physical parameters known with the accuracy better than 3%.

The two new objects were found in a sample of detached binaries selected from the *All Sky Automated Survey* (ASAS; Pojmański 2002) catalog, which we have been following spectroscopically. The input list for our spectroscopic survey was created based on two basic criteria: V-I and the shape of the light-curve. ASAS_DEB_001 and 003 are the first two systems with masses below $1 M_\odot$ confirmed by the follow-up spectroscopy carried out on the Keck I/HIRES. The subsequent V and I band precision photometry (as compared to the ASAS photometry) with the 1.0-m Elizabeth telescope (SAAO) allowed us to determine the absolute fundamental parameters with an excellent accuracy. The modeling was carried out with the Wilson-Devinney (Wilson & Devinney, 1971) and JKTEBOP (Southworth et al. 2004) codes.

RESULTS:

Figures 1 and 2 show the results of the modeling of photometric and RV data. For both systems the radial velocities and brightness measurements in V and I bands are plotted together with the best-fit solutions. The absolute values of physical parameters and their uncertainties are shown in Table 1.

As can be seen, both of the binaries show some brightness fluctuations outside of the eclipses. In the case of ASAS_DEB_001 it is most likely due to the slightly elliptical shapes of the components. Their large radii suggest that the system is old and is going out of the Main Sequence (see Figure 3). This could be one the oldest system with low-mass components known to date.

The ASAS_DEB_003's components are both heavily spotted stars. Our solution results in two large dark spots with the temperature factors close to 1 which may suggest that the large areas are probably uniformly covered by groups of small spots. Spot parameters are collected in Table 2. There is also a 3rd light included in the solution which mostly affects the uncertainties of the primary star parameters. It is probably a companion which we deduce to be an M1-M2 star (from the V-I color).

AGES:

Both systems seem to be old. The activity level is relatively low (weak or no H α emission, even despite the spots on ASAS_DEB_003) and the spatial velocities do not put them into one of the known young moving groups. In Figure 3 we plot both binaries in a mass-radius plane together with two Yonsei-Yale (Y^2 ; Yi et al. 2001) isochrones. The position of both systems favors high metallicity and age around 9 Gyr. Nevertheless, other parameters like V-I or M_{bol} suggest that ASAS_DEB_001 has the metallicity around the solar level or lower and ASAS_DEB_003 is more metal-rich than the Sun but is younger than 9 Gyr (probably ~ 5 Gyr). For these two systems the metallicity determination from the spectra is difficult because of a large rotational broadening (components are tidally locked). The lack of accurate evolutionary models is an another impediment.

The investigation is ongoing and it's results will be presented in a forthcoming paper.

CONCLUSIONS:

We present two interesting K-type detached eclipsing binaries and their accurate parameters. These are the first from our ongoing spectroscopic survey of the ASAS eclipsing binaries. Their characteristics make them useful for testing models of stellar structure and evolution.

Table 1.: Parameters of ASAS_DEB_001 and ASAS_DEB_003 systems.

Parameter	ASAS_DEB_001		ASAS_DEB_003	
	Value	\pm	Value	\pm
P [d]	1.62220952	0.00000046	1.52848715	0.00000040
T_0 [JD-2450000]	1871.1698	0.0006	1869.2016	0.0007
a [AU]	6.918	0.061	6.260	0.009
i [deg]	83.023	0.049	88.927	0.093
e	0.0061	0.0011	0.0	(fixed)
Ω [deg]	90.08	0.07	---	---
γ [km/s]	51.62	0.07	32.13	0.08
K_1 [km/s]	106.65	0.13	102.14	0.13
K_2 [km/s]	107.44	0.14	105.01	0.17
q	0.9927	0.0018	0.9727	0.0036
M_1 [M_\odot]	0.846	0.003	0.714	0.06
M_2 [M_\odot]	0.840	0.003	0.694	0.06
R_1 [R_\odot]	0.994	0.011	0.705	+0.007 / -0.003
R_2 [R_\odot]	0.979	0.010	0.701	0.003
$\log(g_1)$	4.371	0.010	4.59	0.02
$\log(g_2)$	4.381	0.009	4.61	0.01
$(V-I)_1$ [mag]	1.078	0.035	1.299	+0.020 / -0.014
$(V-I)_2$ [mag]	1.231	0.055	1.411	+0.025 / -0.013
$M_{bol,1}$ [mag]	5.59	0.05	6.66	0.20
$M_{bol,2}$ [mag]	5.94	0.04	6.89	0.20

Table 2.: Parameters of dark spots on ASAS_DEB_003's components.

Parameter	on primary		on secondary	
	Value	\pm	Value	\pm
Longitude [rad]	1.73	1.05	3.99	0.70
Latitude [rad]	2.93	0.07	2.75	0.08
Ang. radius [rad]	1.93	0.05	1.20	0.07
T_{spot} / T_{star}	0.958	0.002	0.954	0.006

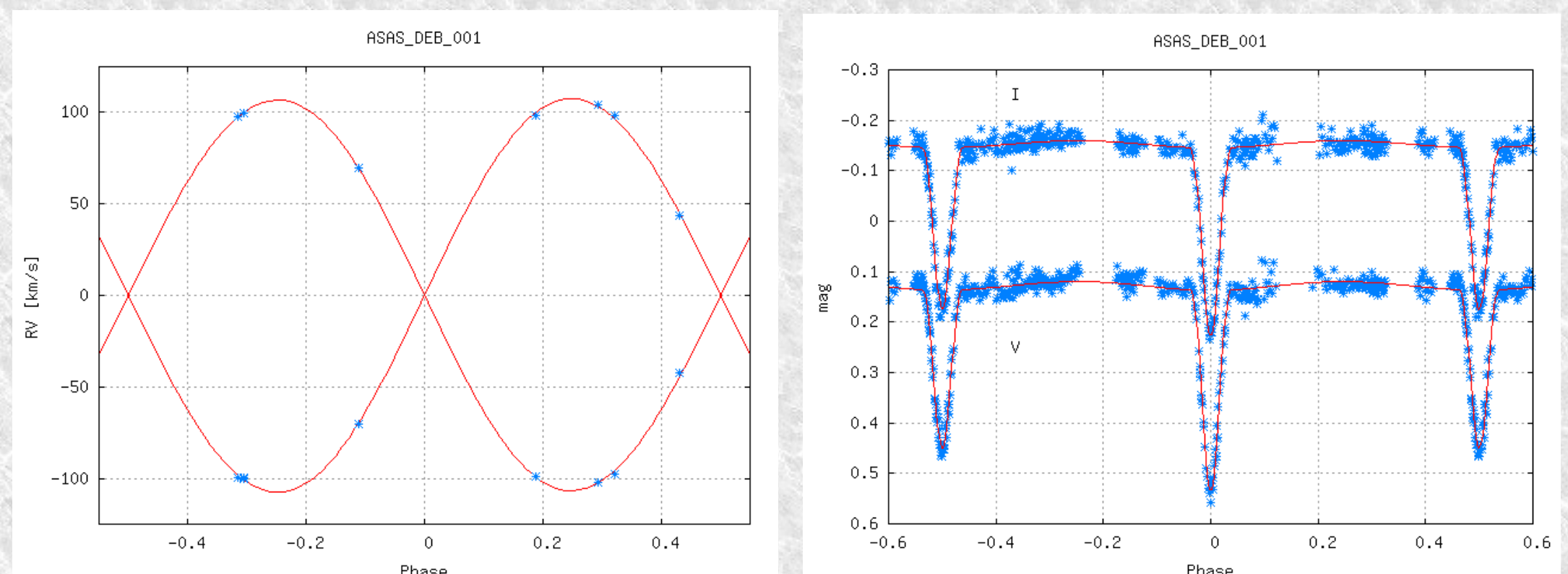


Figure 1.: Radial velocities and light-curves of ASAS_DEB_001 and the best fitting model.

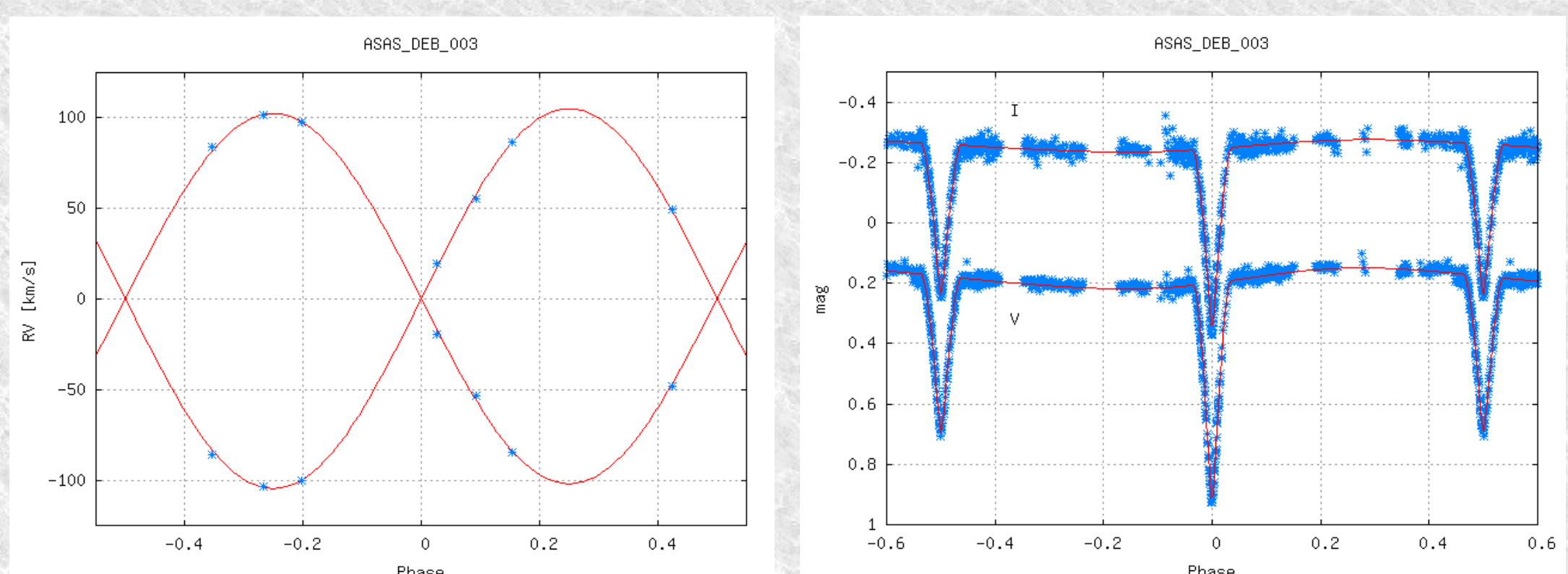


Figure 2.: The same as Fig. 1. but for ASAS_DEB_003.

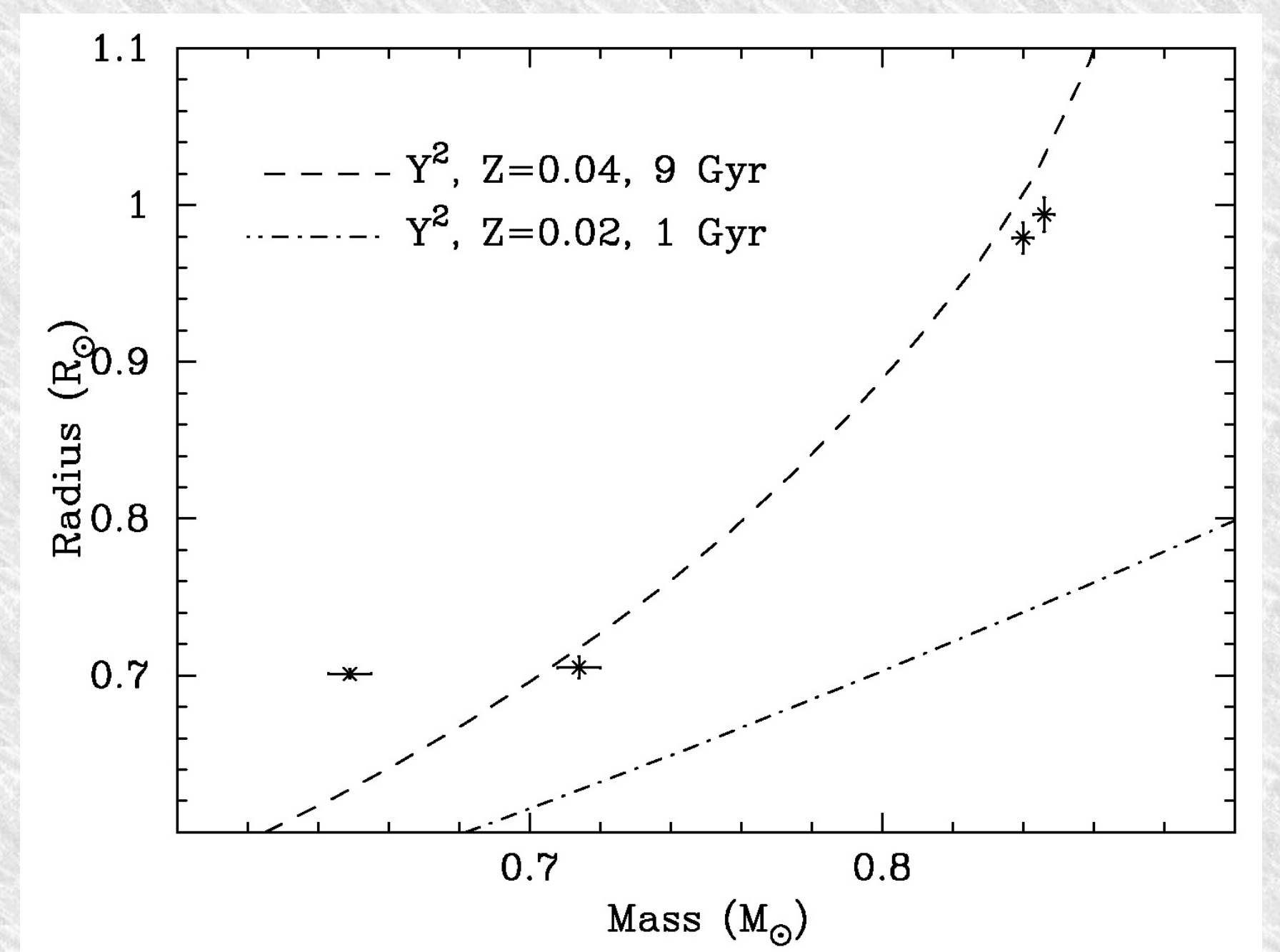


Figure 3.: ASAS_DEB_001 (higher values) and ASAS_DEB_003 on a mass-radius plane, together with two isochrones of given parameters.

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