New Light Curves and Spectra of the close PG1159 Binary System SDSS J212531.92−010745.9

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Abstract. Methods to measure masses of PG 1159 stars in order to test evolutionary scenarios are currently based on spectroscopic masses or asteroseismological mass determinations. SDSS J212531.92−010745.9, a recently discovered PG 1159 star in a close binary system, may finally allow the first dynamical mass determination, and has so far been analysed on the basis of one SDSS spectrum and photometric monitoring. In order to be able to phase radial velocity measurements of the system SDSS J212531.92−010745.9, we have followed up the photometric monitoring of this system. New white light time series of the brightness variation of SDSS J212531.92−010745.9 with the Tübingen 80 cm and Göttingen 50 cm telescopes extend the monitoring into a second season (2006). We give the improved ephemeris for the orbital motion of the system, based on a sine fit which now results in a period of 6.95573(5) h. In 2007, we have obtained a series of phase-resolved medium-resolution spectra with the TWIN spectrograph at the 3.5 m telescope at Calar Alto, which will allow us to derive the radial velocity curves for both components of the system, and to perform spectral analyses of the irradiating and irradiated components at different phases. We briefly describe the newly obtained spectra. The light curve and radial velocities combined will allow us to carry out a mass determination.

The difficulties in measuring masses for PG 1159 stars, using spectroscopic and asteroseismic methods, are discussed in Werner et al. (these proceedings), and references therein. Their conclusion is that current errors in mass determinations are typically larger than 15%, resulting in even larger uncertainties for the progenitor masses.

While the role of binary stellar evolution is highly relevant in the discussion of the possible progenitors for many types of hydrogen-deficient stars, binarity does not seem to be a particularly common occurrence among PG 1159 stars (and is not needed to explain their origin). In fact, SDSS J212531.92−010745.9 (discovered by Nagel et al. [2006]) remains the only securely confirmed PG 1159 star with a close companion.

The significance of this system however derives less from its contribution to binary statistics, and much more from the fact that it contains the first PG 1159 star for which a dynamical mass determination will be possible (Schuh & Nagel [2007]). This will add an important third method of mass determination to the spectroscopic and asteroseismic approaches.

The light curve of SDSS J212531.92−010745.9 shows a 6.96 h variation that Nagel et al. [2006] interpret as the orbital period of the system, with the peri-
odic brightening caused by a reflection effect. Based on white light photometric measurements obtained at the Tübingen 80 cm and Göttingen 50 cm telescopes, spanning two observing seasons, Schuh et al. (2007) report the improved ephemeris for the times of maximum light to be

$$\text{HJD} = 2454055.2134(4) + 0.289822(2) \cdot E.$$  

The associated new amplitude determination, obtained from a sine fit, results in 0.299(33) relative intensity change. The phased light curve variation profile, with its shape deviating from strictly sinusoidal, reinforces the interpretation of the variation as a reflection effect.

Spectroscopic observations of SDSS J212531.92−010745.9 were obtained on 2007/08/20 and 08/21 at the 3.5 m telescope at Calar Alto, equipped with the TWIN spectrograph and gratings T08 for the blue and T04 for the red channel. At an exposure time of 1800 s, a total of 13 usable spectra were obtained within two nights, resulting in a good phase coverage. A first look at the spectra clearly confirms that the photometric variation indeed corresponds to the orbital period, as the same period is seen in the preliminary radial velocity curves. Furthermore, the strength of the hydrogen emission lines, evident in the snapshot provided by the SDSS spectrum, and attributed to the irradiated side of the companion (Nagel et al. 2006), varies with phase as expected.

We will be confronted with two problems when interpreting the value of the dynamic mass in a broader context and comparing it with results for spectroscopic and asteroseismic masses: The spectroscopic parameters for SDSS J212531.92−010745.9, in particular log $g$, will still suffer from the same uncertainties (due to uncertainties in the line broadening theory) as those of other PG 1159 stars; and furthermore, since no pulsations have so far been detected in this object, a cross-calibration of asteroseismic mass determinations will not be immediately possible.

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