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GSC 2118-00297: A NEW DOUBLE-MODE δ SCUTI VARIABLE

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The star GSC 2118-00297 (= ROTSE1 J182943.22+280955.2; $\alpha_{2000} = 18^{\rm h}29^{\rm m}43^{\rm s}$; $\delta_{2000} = +28^\circ09\farcm9$) was announced by the ROTSE1 (Robotic Optical Transient Search Experiment 1) survey (Akerlof et al., 2000) to be a δ Scuti variable with a period of $0\fd170407$ in the approximate magnitude range 12.6-12.9.

The star was observed at Beersel Hills Observatory on six nights between August and October 2001. A total of 760 data points were obtained during 15.4 hours of photometry. The instrument used was a 0.40-m telescope, equipped with a ST7E CCD camera. No filter was used. The exposure times varied between 50 and 90 seconds. The images were reduced with the aperture photometry procedure of the Mira AP software package[†].

The brightness of the variable was measured with respect to GSC 2118-00221, having a colour ($\Delta(B-V)= 0.19$) closest to the variable, from among neighbouring stars. GSC 2118-00299 ($\Delta(B-V)= 0.56$) and GSC 2118-00292 ($\Delta(B-V)= 0.26$) served as check stars. The instrumental values of $\Delta(B-V)$ were determined from images in B and V light, using a filterset following Bessel's specifications. The nightly standard deviation of the differences in unfiltered magnitudes between the comparison and the first check star averaged $0\fm012$, and $0\fm023$ for the second check star. The check stars respectively have an instrumental magnitude of -0.90 and 0.64 with respect to the comparison star.

Using the Fourier analysis program Period98 (Sperl, 1998), the dominant frequency in the observations turned out to be 6.86961 c/d (see the Fourier periodogram in fig. 1), a one-day alias of the period given by Akerlof et. al. (2000). The peak to peak amplitude of this frequency is $0\fm30$. Frequencies below 3 c/d in the power spectrum were not considered as the density of observations at these frequencies is too low (the longest observing run being 4.2 hours on a total observation interval of 59 days).

After prewhitening for the fundamental frequency and its first harmonic (13.73923 c/d with an amplitude of $0\fm06$), a second frequency of 8.96848 c/d was found (see fig. 2), making this star a new double-mode δ Scuti star. The ratio of the first overtone to the fundamental period is 0.766, on the low end of the narrow observed range for this ratio in other double-mode δ Scuti stars (Petersen and Christensen-Dalsgaard, 1996). The amplitude of the second frequency is $0\fm03$, one tenth of the amplitude of the fundamental frequency, but well above the error bar on individual observations. These will be on the order of $0\fm012$ as GSC 2118-00297 is of similar brightness as the first check star.

[†] The Mira AP software is produced by Axiom Research Inc.

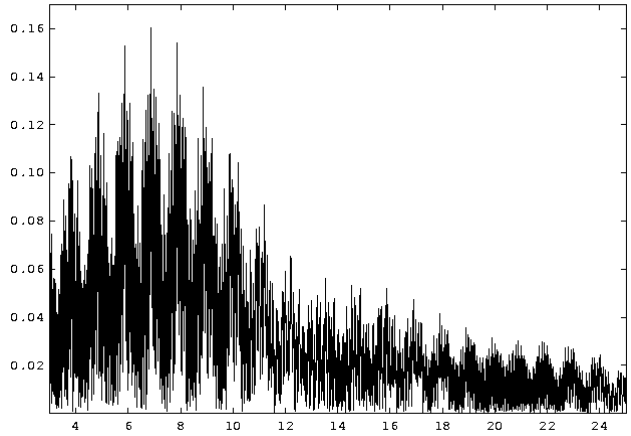

Figure 1. Fourier periodogram for GSC 2118-00297.

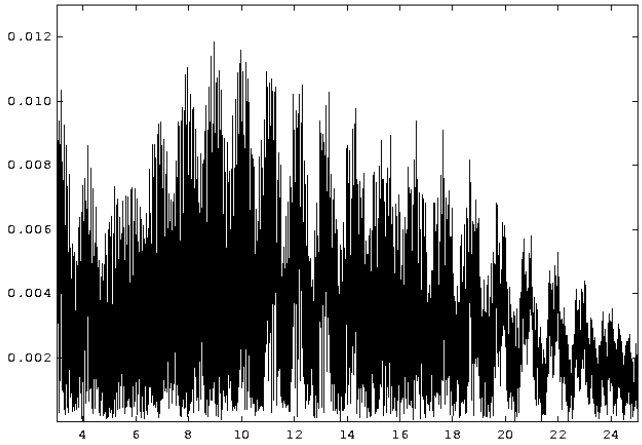

Figure 2. Fourier periodogram for GSC 2118-00297 after prewhitening for the fundamental period.

The following times of maxima have been determined (O-C values are listed with respect to the ephemeris derived below):

JD Hel.	E	O-C [d]	Observer
2451241.575	-6217	0.000	ROTSE1
2452146.518	0	0.001	PVC
2452175.334	198	-0.003	PVC
2452205.324	404	0.002	PVC

The first maximum in the list is obtained from a phase diagram of the ROTSE1 data (available through http://www.umich.edu/~rotse). From these maxima, the following ephemeris was derived:

$$\begin{aligned} \text{Max.} = \text{HJD } 2452146.516 + 0\overset{\text{d}}{.}1455591 \times E. \\ \pm 0.003 \pm 0.0000014 \end{aligned}$$

Fig. 3 shows the phased light curve from our data, folded with the fundamental period, and Fig. 4 the phase diagram of the first overtone (after prewhitening for the fundamental period and its first harmonic).

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Petersen, J.O, and Christensen-Dalsgaard, J., 1996, *A&A*, **312**, 463

Sperl, M., 1998, Manual for Period98 (V1.0.4). A period search-program for Windows and Unix, (http://dsn.astro.univie.ac.at/~period98)

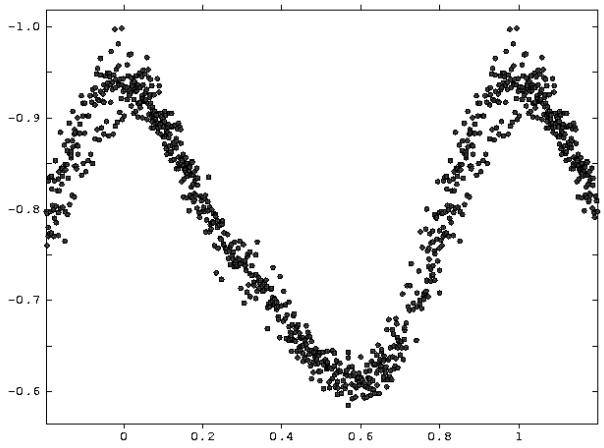

Figure 3. Phase diagram for the fundamental period of GSC 2118-00297.

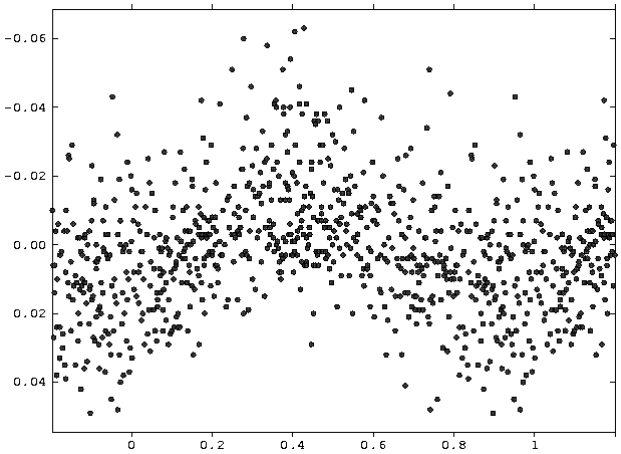

Figure 4. Phase diagram for the secondary period of GSC 2118-00297.