THE δ SCUTI STAR QS GEMINORUM

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QS Geminorum ($\alpha_{2000} = 06^h46^m28^s\!.6$, $\delta_{2000} = +20°50'37''\!.1$, HIP 32459, HD 263446, GSC 01342-00231) was found to be a variable star by the HIPPARCOS satellite. The Variability Annex of the HIPPARCOS Catalogue (ESA 1997) reports QS Gem to have a period of 0.134613 d with H_p magnitudes ranging between 8.874 to 8.973. The spectral type is listed as A3 and the star is classified as a δ Scuti.

As part of our ongoing δ Scuti star program, and as part of our Phscs 329 Observational Astronomy class, we selected stars from the Variability Annex of the HIPPARCOS Catalogue that showed δ Scuti type characteristics. During winter semester of both 1999 and 2000, QS Gem was observed by groups of Phscs 329 students. Observations were made with the 0.4-m David Derrick Telescope of the Orson Pratt Observatory at Brigham Young University (Hereafter DDT). Data were obtained with a Pictor 416XT CCD mounted at the newtonian focus of the telescope. This gave a plate scale of 0.93 arcsec/pixel. Observations were made through a standard Johnson V filter modeled after Bessell (1990). A total of nine nights of data were obtained between 23 February 1999 and 12 April 2000. The CCD field for the DDT is shown in Fig. 1 with QS Gem and the comparison stars labeled.

All frames were reduced using standard IRAF functions. Apparent magnitudes were determined using comparison stars 4 and 5 as shown in Fig. 1. Star 4 is identified as HD 263542 (GSC 01342-01109, $V = 9.72$) and star 5 is identified as HD 48995 (GSC 01342-00517, $V = 8.61$). From this we found an average magnitude for QS Gem of $V = 8.85$. The two other comparison stars labeled in Fig. 1 were considered too faint to use in the final analysis. However, star 3 (GSC 01342-01261) was found to be an eclipsing variable and is detailed in a separate paper (Carroll & Hintz, 2000).
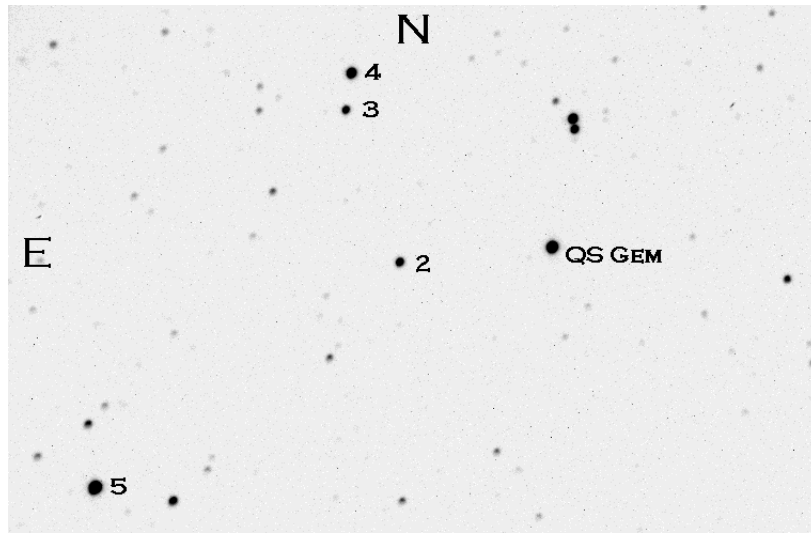
From the light curves, ten times of maximum light were determined. These times are given in Table 1. Using linear regression techniques we determined an ephemeris for QS Gem as given in Eq. 1. The period determined is similar to the value found by HIPPARCOS although significantly shorter.

$$\mathrm{HJD}_{\mathrm{max}} = 2451222.8693 + 0.131955(\pm 0.000002) \times E. \tag{1}$$

In Fig. 2 we show a light curve for QS Gem from HJD 2451444 and in Fig. 3 we show a light curve from HJD 2451626. Clearly the amplitude of QS Gem is not constant. The amplitude varies from 0.08 to 0.20. Due to this variable amplitude we chose to examine the data with the frequency search program Period98. From this analysis only f_1 and $2f_1$

were found to be reliable frequencies as shown in Table 2. The value for f_1 is in excellent agreement with the period found by linear regression. A larger data set is called for to find the true frequency spectra.

QS Gem appears to be a normal low-amplitude δ Scuti variable with a complex light curve. Since this star is relatively bright with a moderate amplitude it would be an ideal star for an international campaign or for one of the small variability satellites currently under development.

Figure 1. CCD field of QS Gem with comparison stars labeled. The field of view is $8' \times 12'$.
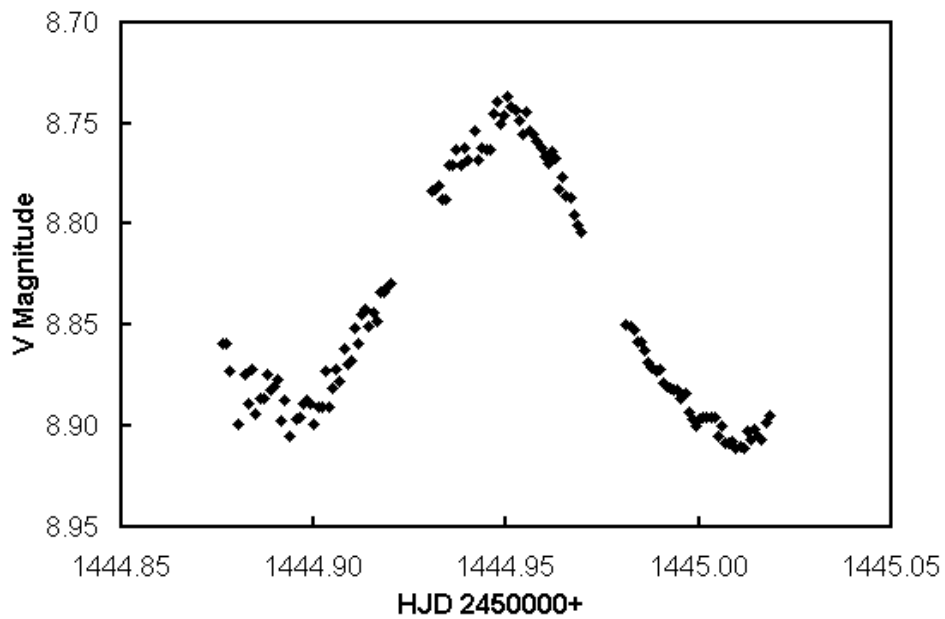
Figure 2. Light Curve of QS Geminorum from HJD 2451444
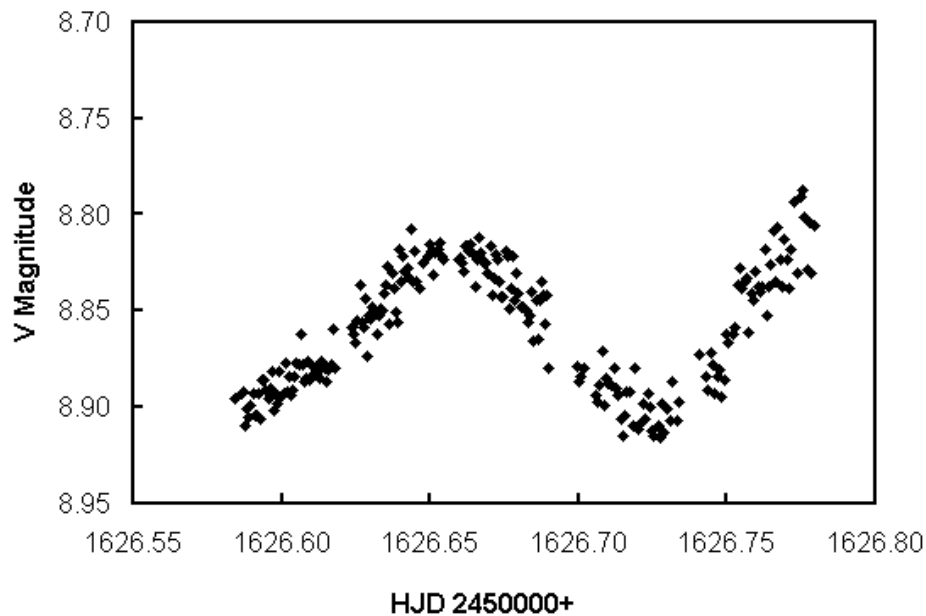
Figure 3. Light Curve of QS Geminorum from HJD 2451626

Table 1: New Times of Maximum Light for QS Geminorum

HJD 2451000.0+	Cycle	$O - C$
222.8692	0	−0.0001
444.9492	1683	−0.0004
463.9563	1827	0.0052
489.8115	2023	−0.0028
489.9398	2024	−0.0064
496.8071	2076	−0.0008
597.7505	2841	−0.0030
626.6504	3060	−0.0012
632.5904	3105	0.0008
632.7199	3106	-0.0016

Table 2: Frequencies Present in Light Curve of QS Geminorum

	Frequency (cycle/day)	Amplitude	Phase
f_1	7.5782	0.054	0.614
$2f_1$	15.1564	0.004	0.445

References:

Bessell, M. S. 1990, *PASP*, **102**, 1181
Carroll, D. D., Hintz, E. G., 2000, *IBVS*, No. 4928
ESA, 1997, The HIPPARCOS Catalogue, ESA, SP-1200