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DISCOVERY OF RAPID OSCILLATIONS IN THE Ap STAR HD 42659

In May of 1990 we began the *Cape Rapidly Oscillating Ap (roAp) Star Survey* (Martinez *et al.* 1991), a systematic search for new roAp stars in the Southern sky. In this paper we report the tenth new roAp star to emerge from the Cape Survey. The cool Ap SrCrEu star HD 42659 was monitored photometrically for 5.15 hr on the night 22/23 November 1992 (JD 2448949). The data were acquired using the University of Cape Town Photometer attached to the 0.75-m telescope of the South African Astronomical Observatory (SAAO) at Sutherland. The data comprised continuous 10-s integrations through a Johnson B filter with occasional interruptions for sky background measurements. Inspection of the real-time data display at the telescope indicated the presence of rapid oscillations with a 10-minute period and a Johnson B amplitude of 0.5 mmag. The data were corrected for coincidence-counting losses, sky background and extinction. The resulting instrumental magnitudes were not placed on the standard system. A Fourier transform of the light curve shows a peak at ν = 1.7 mHz corresponding to the signal tentatively identified at the telescope.

HD 42659 has V = 6.768 so the dominant source of noise in these observations is scintillation rather than photon statistics. Because of the extremely low amplitude of these oscillations, we elected to confirm their reality on the larger SAAO 1.0-m telescope using the same photometer as was used in the discovery observations. This is an example of a case where a larger telescope was used not to increase the number of photons counted, but instead to *decrease* the scintillation noise. HD 42659 was observed again on nights JD2448965, 8966, 8967, 8968 and 8969. The 10-min oscillation was evident in the Fourier transform only on the first two nights. On nights 8967 - 8969 there were indications of the 10-min oscillations in the less noisy portions of the light curves, but there were no unambiguous peaks at ν = 1.7 mHz in the Fourier transforms of these light curves.

To obtain further confirming observations at lower noise we switched to using the St Andrews Photometer, which has an autoguider, on the SAAO 1.0-m telescope. The continuous pointing corrections performed by the autoguider minimize the effect of light variations caused by tracking errors in the telescope. This allows us to use smaller apertures when conditions permit and produces more precise photometry than manual guiding. Observations of HD 42659 using this instrumental configuration were acquired on nights JD2449000-9002, 9004 and 9005. The 1.7 mHz signal appears on all these nights.

In Figure 1 we show the amplitude spectra acquired on three good nights. The peak of interest here is the arrowed peak at ν = 1.72 mHz. The other peaks at low frequency are produced by sky transparency variations. Normally we remove such sky transparency variations so that the variance of the data is dominated by the stellar signal standing out against a background of white noise. Here we intentionally include all the low frequency noise to show that we have a convincing detection even in the presence of sky transparency variations.

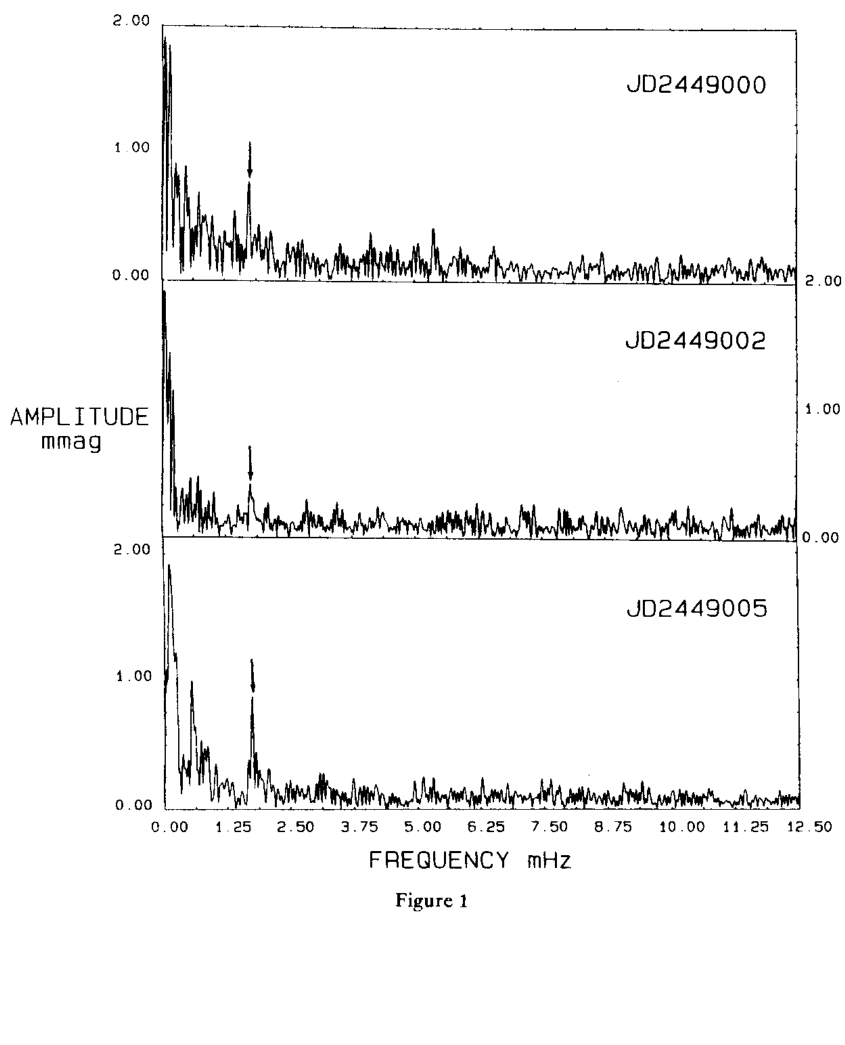

Figure 1

Figure 2 shows the *B* light curve acquired on night JD2449005.

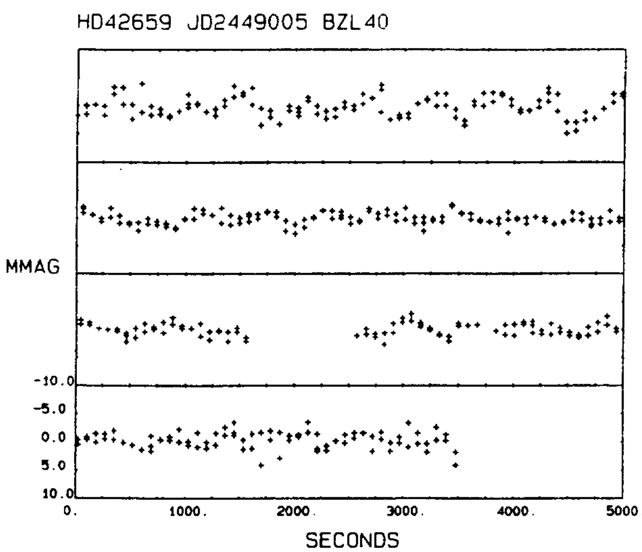

Figure 2

The reality of rapid oscillations in HD 42659 is well established. There is evidence for amplitude modulation of the oscillations since on some nights no signal is seen. However, because the oscillations are at the limit of detectability of the equipment, this star will be very difficult to work on

PETER MARTINEZ, D.W. KURTZ & R. ASHLEY
Department of Astronomy
University of Cape Town
Rondebosch 7700
South Africa
PETER@UCTVAX.UCT.AC.ZA

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