

Insights into the Pulsational Behaviour of δ Sct Stars

L. Mantegazza

Università di Pavia, Dipartimento di Fisica Nucleare e Teorica, Via Bassi 6, 27100 Pavia, Italy

E. Poretti

Osservatorio di Brera, Via E. Bianchi 46, 22055 Merate, Italy

1. Introduction

Extensive photometric monitoring of bright δ Scuti stars, made in the last years, allowed us to get reliable frequency determinations also in very complicated cases. Table 1 gives a full description of our photometric targets. Recently, we realized that combining photometry with simultaneous high resolution spectroscopy, in order to study line profile variations, offers the possibility to perform a much more reliable mode identification. Hence, the photometric runs of FG Vir, X Cae, HD 2724 were paired with spectroscopic ones obtained at the Coudé Auxiliary Telescope (ESO, La Silla, Chile). The stellar spectra are centred at 4508 Å and they cover a range of 37.6 Å; the resolving power is about 50000-60000 and the linear dispersion is 2.4 Å/mm.

2. New results

X Caeli – Already observed in the *V* colour in 1989, *X Caeli* was reobserved both photometrically and spectroscopically in 1992. The frequency analysis of the new photometric data confirmed the presence of a dominant mode (7.39 c/d, amplitude 37 mmag), two modes with intermediate amplitudes (6.04 c/d, amplitude 7 mmag, and 7.46 c/d, amplitude 5 mmag), many other modes with smaller amplitude, the first Fourier harmonic of the three strongest modes and their nonlinear coupling terms. The amplitude ratios and phase shifts between *V* and *B - V* curves suggest that the three strongest modes are nonradial with $\ell=1$ or $\ell=2$.

The availability of light, colour and radial velocity curves allowed us to perform a preliminary application of the Baade-Wesselink method to the dominant mode. There is an acceptable solution for $\ell=2$ only, from which we also obtain a mean stellar radius of $R = 5.0 \pm 0.4 R_{\odot}$, $f = 18.9 \pm 1.5$ (ratio of flux to radius variation), $\psi = 100.5^{\circ} \pm 3.5^{\circ}$ (phase difference between the radius and the flux variations), $\epsilon = 0.0052 \pm 0.0004$ (the projected radial semi-amplitude), $A = 2.48 \pm 0.26$ (the gradient of the surface brightness-colour relationship).

In the stellar spectra obtained in 1992, a narrow absorption core is visible at the bottom of the spectral lines. This feature is stable with respect to the stellar reference frame; 9 additional spectra taken in November 1994 confirm

its stability over an interval of years. Therefore, we could be in presence of a circumstellar shell.

HD 16439 – This star was observed at Merate Observatory in 1988-89. Two frequencies at 17.1266 c/d and 10.1273 c/d were clearly identified; no additional peak was visible. *HD 16439* was re-observed at Merate Observatory in December 1994 and January 1995. The presence of the main frequency at 17.13 c/d was confirmed, while the difference in height between the 10.13 c/d peak and its alias at 11.13 c/d is reduced. Moreover, a new peak at 10.48 c/d, not observed in the 1988-89 dataset, is clearly identified in the frequency analysis. Since the two datasets were obtained in the same conditions (site, length of the observations, number of data, ...), the evidence for a change in the frequency content between 1989 and 1994 seems well established. Moreover, the similar height of the peaks at 10.13 and 11.13 c/d makes one suspect that other undetectable terms are present in this spectral region.

Table 1. Summary of the photometric observations carried out by the Merate group

Star	Site	Year	N	Survey [hours]	Reference
HD 37819	Merate	1986	462	32	A&A 1987, 181, 273
HR 1225	ESO	1987	705	38	A&A 1989, 220, 144
α^1 Eri	ESO	1987	710	38	A&A 1989, 220, 144
HR 547	ESO	1987	462	22	A&A 1989, 220, 144
HD 16439	Merate	1988-89	1020	54	A&A 1990, 230, 91
HD 16439	Merate	1994-95			work in progress
HD 101158	ESO	1989	1234	62	A&A 1991, 245, 136
X Cae	ESO	1989	1013	54	A&A 1992, 255, 153
X Cae	ESO	1992	1634	100	work in progress
44 Tau	Merate	1989-90	2434	117	A&A 1992, 256, 113
HD 66853	ESO	1991	1390	100	A&A 1994, 281, 66
HD 66853	Merate	1991	642	43	A&A 1994, 281, 66
HD 224639	ESO	1991	2567	120	A&A 1995, in press
HD 224639	ESO	1994			work in progress
HD 18878	Merate	1991-92	2915	150	A&A 1993, 274, 811
HD 19279	Merate	1991-92	2679	150	A&A 1993, 274, 811
β Cas	Merate	1986 and 1992	925	30	A&AS 1994, 108, 55
FG Vir	ESO	1992	792	53	A&A 1994, 287, 95
HD 2724	ESO	1993			work in progress
AZ CMi	Merate	1994			work in progress