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METHODOLOGICAL ASPECTS IN THE FREQUENCY ANALYSIS OF MULTIPERIODIC δ SCUTI STARS

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DATA COLLECTION

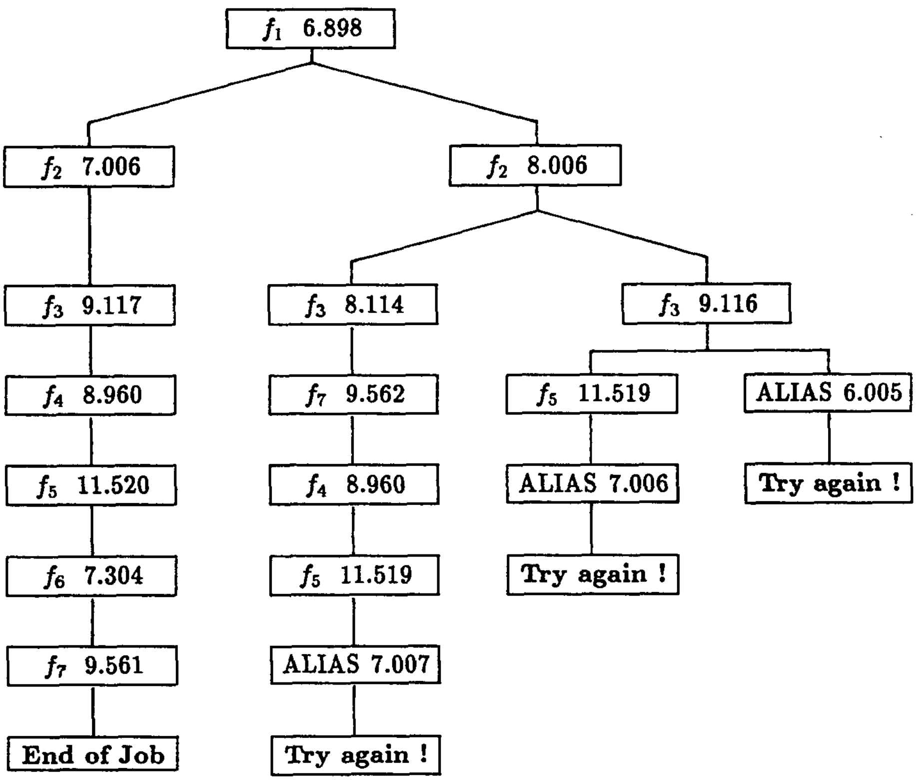
At Merate Observatory the study of δ Sct stars began in the sixties and spectroscopic and photometric campaigns were continuously undertaken in order to clarify the controversial points. As an obvious extension of the research, the observation of δ Sct stars was proposed for telescope–time allocation at European Southern Observatory, in order to take advantage of the ESO facilities and of the considerably better sky of La Silla. We put in our observing programme δ Sct stars showing cycle–to–cycle variations and, possibly, an amplitude larger than 0.05 mag in order to have a better signal–to–noise ratio; they are listed in the table. It is important to notice that we always tried to collect a number of measurements as large as possible (from 1988 we collected more than 1000 measurements per star), because it is a well–established fact that periodicities with

Star	Site	Observing period	Survey [hours]	Reference
HD 37819	Merate	Jan. 1986	32	A&A 1987, **181**, 273
HR 1225	ESO	Nov. 1987	38	A&A 1989, **220**, 144
o^1 Eri	ESO	Nov. 1987	38	A&A 1989, **220**, 144
HR 547	ESO	Nov. 1987	22	A&A 1989, **220**, 144
HD 16439	Merate	Dec. 1988–Jan. 1989	54	A&A 1990, **230**, 91
HD 101158	ESO	Apr. 1989	62	A&A 1991, **245**, 136
V974 Oph	ESO	Apr. 1989	64	work in progress
X Cae	ESO	Nov. 1989	54	A&A 1992, **255**, 153
44 Tau	Merate	Dec. 1989–Feb. 1990	117	A&A 1992, **256**, 113
BD+2°1867	ESO	Jan.–Feb. 1991	100	work in progress
BD+2°1867	Merate	Jan.–Feb. 1991	43	work in progress
HD 224639	ESO	Sep.–Oct. 1991	120	work in progress
HD 18878	Merate	Nov. 1991–Jan. 1992	150	work in progress

an amplitude of a few thousandths of magnitude can be present in δ Sct stars. Moreover, when several modes are excited, an adequate frequency resolution becomes necessary and, therefore, a sufficient time baseline is requested (Poretti and Mantegazza 1992). A poor data sampling also gives an apparent good fitting for several solutions, all leaving a small residual rms, and there is no possibility to choose among them: different authors can pick up different solutions, generating the conflicting interpretations often found in δ Sct star literature.

THE FREQUENCY ANALYSIS METHOD

In the frequency analysis we used the simultaneous least–squares fitting procedure proposed by Vaníček (1971), which does not require any prewhitening since the amplitudes and phases of the known constituents (i.e. the frequencies already identified) are recalculated for each new trial frequency. Moreover, before searching for new frequency the values of the known frequencies can be refined by means of a non–linear sine wave least–squares fitting routine; for example, the program PERDET (Breger 1989) or the program MTRAP (Carpino et al. 1987). In spite of all these precautions, we generally performed some parallel analysis, considering not only the highest peak but also its aliases. Indeed, when dealing with a rich power spectrum a particular care must be taken in the iden-



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tification of the true frequency because the aliases at ±1 c/d can be as strong as the true peak, especially if the datasest is collected in a single–site campaign.

These parallel analyses can supply additional confirmations on the goodness of the choices. Let us discuss the application of this procedure to the 2434 V measurements collected on 44 Tau. This star was considered a double–mode radial pulsator (Wizinowich and Percy 1979) until Poretti et al. (1992) showed that seven frequencies were necessary to fit its light curve in a satisfactory way (f_1=6.898 c/d, f_2=7.006 c/d, f_3=9.117 c/d, f_4=8.960 c/d, f_5=11.520 c/d, f_6=7.304 c/d, f_7=9.561 c/d). The second power spectrum (i.e. that obtained by considering f_1 as a known constituent) suggested as possible values both 7.006 c/d and 8.006 c/d. When choosing the former, the analysis revealed the above reported seven frequencies, without any doubt on the identifications of each of these terms (but in any case we performed additional tests to verify them). On the other hand, if we consider for f_2 the value of 8.006 c/d we obtain a more complicated third power spectrum, where the two frequencies 8.114 c/d and 9.116 c/d are both possible. Again, when continuing with the value f_3=9.116 c/d we quickly meet the frequency 6.005 c/d, i.e. an alias of the adopted value for f_2. If we continue with the value f_3=8.114 c/d we find the f_7, f_4, f_5 terms and finally we meet 7.007 c/d, i.e. another alias of the adopted value for f_2. All this process is better evidenced in the figure. Therefore, we suggest that the absence of aliases of previously identified frequencies in the successive power spectra indicates that the right choices were done.

FINAL CONSIDERATIONS

The variability of the mode amplitudes is one of the most recent results in the study of δ Sct stars. This phenomenon gives a strict constraint to the observer: indeed, it is necessary to obtain a good solution for each observing season in order to compare their results and establish the amount of the mode amplitude variability. For these reasons we consider necessary: a) the collection of large datasets, well sampled in time and covering a time baseline as long as possible; b) a careful frequency analysis of these measurements, as described in the previous section; c) a careful comparison between all the competitive solutions and between the behaviours of their residuals.

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