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Coordinated Multi-site Photometry of Southern Rapidly Oscillating Ap Stars

I: The 1992 Campaign on HD 84041 - a call for collaborators.

Asteroseismology is a powerful tool which allows the interior structure and dynamics of stars to be examined in a way analogous to studying the seismology of the Earth. The rapidly oscillating Ap (roAp) stars, being main sequence stars, are excellent subjects for asteroseismological studies. These stars are the only main sequence stars, other than the sun, for which there is indisputable evidence of high-overtone p-mode acoustic oscillations. The peak-to-peak Johnson B oscillation amplitudes are all less than 16 mmag and the oscillation periods range from 4-16 min. Recent reviews are given by Kurtz (1990) and Matthews (1991).

In May of 1990, we started the *Cape Rapidly Oscillating Ap Star Survey*, a systematic study of the roAp phenomenon in the southern hemisphere. The survey has already led to the discovery of 8 new roAp stars (Martinez *et al.* 1990a,b,c,d, 1991a,b,c). This compares favourably with the 14 discovered in the previous 12 years by all roAp star observers. At present, we have only limited frequency analyses of these stars and much further observational work is required. The study of these stars is observationally intense; we need as many collaborators as we can get.

The oscillations in the roAp stars are usually studied using high-speed photometry through a Johnson B filter. The basic goal of such time-series photometry is to extract from the light curve of the star the component frequencies of the oscillations. A coherent oscillation gives rise to a peak in the Fourier transform whose height is proportional to the amplitude of the oscillation. The width (resolution) of such a peak goes roughly as the inverse of the length of the light curve. It is possible to improve the resolution by combining data from successive nights, but then the day-time gaps in the data give rise to ambiguous peaks, or *aliases*, in the amplitude spectrum. Aliasing arises because of cycle count ambiguities when the data are interrupted periodically, as is the case when observations are acquired over several nights from a single site. Since the alias peaks confuse the analysis, the only way to reduce the aliasing problem is to minimize the day-time interruptions in the light curve, hence the need for contemporaneous multi-site observations.

Another reason for acquiring contemporaneous multi-site observations of roAp stars is that the oscillation spectra are not stable in many roAp stars. There is evidence of transient oscillation modes with growth/decay times of the order a day. There is also a possibility of phase-jitter in at least one well-studied roAp star. If we are to follow the temporal behaviour of a changing amplitude spectrum, continuous monitoring of the star is required.

We are planning several multi-site campaigns on the new roAp stars and the purpose of this Bulletin is to call for collaborators to join one or more of these campaigns. In the past, such campaigns have resulted in significant advances in our understanding of these pulsating stars. An example is the 1986 campaign on HR1217 (Kurtz *et al.* 1989).

It is important to appreciate that the detection and study of roAp star pulsations demands the most precise ground-based high-speed photometric measurements possible. Although most roAp stars are so bright that photon statistics are not the major source of noise, the amplitudes of oscillation are very low - less than 1 mmag in many cases. In order to produce useable roAp photometry, it is imperative that observers overcome some common sources of error such as the use of small apertures, careless guiding, sensitivity variations across the aperture, dirty filter or photocathode surfaces, fogged Fabry lenses, damp photomultiplier tube bases, vignetting, spurious periodicities introduced by telescope drive oscillations, erratic excursions of the star in the aperture in a telescope that is too finely balanced, misalignments in the photometer, electronic malfunctions such as drifting or fluctuating HT supply, inadequately shielded photomultiplier tubes, cold boxes that do not regulate the temperature well enough and inaccurate time in the dome.

Readers desiring an example of the kind of photometry required should consult the references listed below. Briefly, we require the noise in the amplitude spectrum above 0.6 mHz to be $\leq$ 0.4 mmag for a two-hour run at low airmasses on a 1-m telescope. If the noise for frequencies higher than 1.0 mHz is above 0.5 mmag, we regard the night to be marginally photometric and often reject such data from further analysis. Since the scintillation noise scales inversely to the mirror diameter, smaller telescopes will produce data with higher scintillation noise. However, such data will still be highly useful. We routinely obtain data of sufficient quality with our single-channel University of Cape Town photometer attached to the 0.75-m or 1.0-m telescope at the Sutherland site of the South African Astronomical Observatory.

All of the new roAp stars are south of $\delta = -17^{\circ}$, so prospective collaborators should preferably have access to good photometric sites in the southern hemisphere.

Proposed campaign on HD 84041 in February 1992

Our first campaign will focus on the roAp star HD 84041 which pulsates with a 14.62-min period and an amplitude as high as 3 mmag on some nights (Martinez & Kurtz, 1991b). The pulsation amplitude is modulated on a night-to-night basis and perhaps on even shorter time-scales. One of the aims of the campaign is to study this amplitude modulation in detail.

The campaign will be centered on a core two-week period from 11 Feb to 24 Feb 1992. Collaborators should ideally obtain telescope time during this core period, but several consecutive nights' worth of observations acquired within a 30-day time-span on either side of the core period will still be extremely valuable. We have successfully studied this star with an 0.5-m telescope, but observations using 0.75-m or 1.0-m telescopes are preferable because of the lower scintillation noise.

We envisage making heavy use of electronic mail networks to expedite the transfer and analysis of the data. In this way, we also hope to keep contributors informed of the progress of the campaign even while it is in progress. This should allow us a capacity, albeit limited, to identify and remedy problems arising in the observations. Interested readers are urged to contact us as soon as possible to facilitate the coordination of observing efforts and so that reliable E-mail links can be established. The early establishment of such links will be necessary to develop and test software to cope with the various participants' inevitably different data recording formats.

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