Having eliminated a number of possibilities for individual stars, I conclude that these stars are either exhibiting non-radial g-modes, or we are confronted with a completely new physical mechanism for producing light variations in stars. We present preliminary results of ongoing observations of some of these stars.


Krisicjans, K. 1993, Comments on Astrophys. 17, no. 4, in press.


84.03
Nonlinear Dynamical Analysis of Stellar Variability

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Earlier attempts in characterising the irregularities in stellar pulsations as arising from chaotic dynamics have been inconclusive due mainly to the short data lengths and high noise levels. Pulsating white dwarfs have been recognized to be suitable candidates for the study of dynamical behavior because of their short pulsation time scales, allowing a typical observation to cover a significant number of periods. A major reason of the inconclusive result of the earlier studies is the short data length due to the finite observation time of 3-4 hours with a single telescope. With pulsation periods of 3-32 min, a typical observation covers about forty periods, which may not be adequate to yield its complex behavior. However, the Whole Earth Telescope has produced more than 256 hrs of nearly continuous time-series photometry data on the pulsating pre-white dwarf star (DOV) PG 1159-035, consisting of more than 50,000 data points. A singular spectrum analysis of the time series light curve data yields two dominant eigenvalues close to each other. The rest of the eigenvalues however does not define a single noise floor but many of them, although with small values, are above an average noise floor. This suggests that the dynamics of PG 1159-035 is governed by two sets of variables: the two dominant ones and some others which are not strongly coupled to these two but may be strongly coupled among themselves. The potentially low dimensional dynamical behavior is further studied by computing the correlation dimension and the reconstruction of phase space.

84.04
Nonradial Pulsation Mode-Typing of 53 Per from the Far-UV

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Voyager 2 (FUV) spectroscopic observations during January 1991 have been obtained and compared with coterminous optical photometric observations by Huang et al. (1994, ApJ, in press). The ephemeris derived from the optical light curve shows a two-mode solution with frequencies of 0.462 and 0.233 day$^{-1}$. These frequencies are also in good agreement with frequencies derived for 53 Per in the late 1970's and mid-1980's. The FUV results show excellent agreement with the FUV light (11800 Å) and color (11800 Å - 18550 Å) curves. The UV/visual amplitude implied is 4.6±1.

On the assumption that the optical and UV periods arise from nonradial pulsation (NRP) modes, we compare our UV amplitudes with those obtained by linear NRP theory. To make this comparison we have computed wavelength-dependent, limb-darkening integrals from metal line blanketed model atmospheres and used them to evaluate the sources of light variations. We find that the effects of temperature on these modes should be dominant, a prediction verified by the new UV data. We also derive a modal identification i = 2 for the principal mode.

84.05
Nightly Variations of Non-Radial Oscillations in the Delta Scuti Star v UMa

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We observed the rapidly rotating Delta Scuti star v UMa with the Advanced Fiber Optic Echelle (AFOE) spectrometer at the Mt. Hopkins 1.5-m telescope on 5 successive nights in April 1993. Spectra covering a total of 730 Å were obtained at a 5-min cadence over about 4 hours on each night. The rotationally-broadened profiles of unblended strong lines clearly show previously-seen "bumps" propagating from the blue side to the red side of the lines. We isolated moving features for each individual spectrum by subtracting the spectrum from the mean spectrum for that night, normalizing to the latter. We then calculated the cross-correlation function between each difference spectrum and a standard template spectrum, which was a very high signal-to-noise spectrum of a slowly-rotating star (Procyon) of similar spectral type, obtained with the same instrument. The cross-correlation combines the information from all the bumps moving across all spectral lines (including rotationally-blended lines) into a single function of displacement from line center, thereby significantly increasing the signal-to-noise ratio of the moving features. Analysis of the time-series of cross-correlation functions yields the rate of propagation of features and their separation in velocity, which may be interpreted in terms of effective azimuthal wavenumber and oscillation frequency. Modes are identified by remapping the cross-correlation functions in terms of longitude and performing two-dimensional Fourier transforms. For each night a different modal pattern was found, usually with several modes. The modes have effective azimuthal order m ranging from about 2 up to about 12, and frequencies between 120 and 170 µHz (i.e., 2.5 to 1.6 hours), with frequency gradually increasing with increasing m. The relative amplitude of the different modes changes substantially from night to night, suggesting either that the coherence time of the modes is not longer than about a day, or that beats are being observed between modes of similar wavelength and frequency.

84.06
BV Photometry of RR Lyrae Variables in the Globular Cluster NGC 5466

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We present BV CCD photometry for fourteen RR Lyrae variables in the globular cluster NGC 5466. New ephemerides are computed and V, B, and B-V light curves are given. This work was supported in part by a UNC Charlotte summer research grant to TMC.

84.07
Pulsations and Dust Formation in R Coronae Borealis Stars

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The observed correlation between pulsational phase in RCB stars and the timing of their declines shows empirically that the stellar pulsations and dust formation are intimately connected. However, the nature of this relationship and the process of dust formation itself are not understood at all. We have shown that it is likely that dust is forming in close proximity (< 2 R$_\odot$) to the RCB star photosphere, based on time scales for acceleration of the dust, eclipse of the chromospheric region, and dispersal of the dust. The temperature at which amorphous carbon forms can be as high as 4000 K, and can occur in conditions far removed from thermodynamic equilibrium, as long as a mechanism exists to contain carbon atoms within a given volume. A likely form of carbon condensate is fullerene such as C$_{60}$. Shocks in the stellar atmosphere due to the pulsations may provide such a mechanism for containing the carbon. We will present a large amount of recently obtained observational data which document molecular, kinematic and geometrical variations related to RCB pulsations. These data include 7 years of spectroscopy and polarimetry of R Coronae Borealis, and high dispersion UV and visible spectroscopy of RY Sagittarii covering a complete pulsation cycle of that star. This work was carried out with the support of NASA grants NAGW-2538 and NAGS-87.

84.08
A Dramatic Change in the Polarization of V Hyrae

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The unusual carbon star, V Hyrae, is a semiregular variable with a period of 530 days superimposed on a longer, large amplitude period of 6500 days. It has been observed to have bipolar CO outflow (Kahane et al., 1989), and is believed to be an early precursor of a bipolar planetary nebula (Taigi et al.,...