THE INTERACTION OF ACCRETION FLUX WITH STELLAR PULSATION

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We consider the usual hypothesis that the short period coherent oscillations seen in cataclysmic variables are attributable to g-modes in a slowly rotating star, for details see Papaloizou and Pringle (1977). We show that this hypothesis is untenable for three main reasons: (i) the observed periods are too short for reasonable white dwarf models, (ii) the observed variability of the oscillations is too rapid and (iii) the expected rotation of the white dwarf, due to accretion, invalidates the slow rotation assumption on which standard g-mode theory is based. We investigate the low frequency spectrum of a rotating pulsating star, taking the effects of rotation fully into account. In this case there are two sets of low frequency modes, the g-modes, and modes similar to Rossby waves in the Earth's atmosphere and oceans, which we designate r-modes. Typical periods for such modes are 1/m times the rotation period of the white dwarfs outer layers (m is the azimuthal wave number). We conclude that non-radial oscillations of white dwarfs can account for the properties of the oscillations seen in dwarf novae.

References

Papaloizou, J.C. and Pringle, J.E., 1977, Mon. Not R. Astr. Soc., in press.

DISCUSSION of paper by PAPALOIZOU and PRINGLE:

KIPPENHAHN: Since the vibrational stability of white dwarfs has been mentioned several times now, I would like to report on some unpublished results obtained by Lauterborn about 10 years ago. He investigated cooling white dwarfs where their evolutionary track crosses the Cepheid strip extrapolated across the main sequence into the white dwarf region. The models were vibrationally stable. They had a thin, hydrogen-rich envelope and a hydrogen burning shell at the bottom. It was never possible to get the ε-mechanism working since, whenever the shell was burning there had to be sufficient hydrogen on top of it, and there was too much damping in that hydrogen envelope. If the hydrogen envelope contained less mass, there was no burning shell. For these reasons, Lauterborn never got vibrational instability due to nuclear burning, but he found that in the (extrapolated) cepheid strip there was a well-pronounced excitation due to the κ-mechanism. The excitation was not enough to overcome the damping in these models, but they were almost unstable.

DZIEMBOWSKI: About a year ago I published a paper where I showed that the κ-mechanism indeed works in white dwarfs lying in the extension of the Cepheid instability strip.

PAPALOIZOU: Yes, I know of this work. It may be relevant to single stars. But I don't think these calculations are likely to be relevant to the white dwarfs in dwarf novae.

DZIEMBOWSKI: The problem which seems to me very difficult to interpret in terms of oscillation, is the presence of only one period in the rapid variability of the dwarf novae. For this reason I think models relating periodicity with rotation are more plausible.

PAPALOIZOU: I agree. The interaction of a thin disk with a nonrotating star is likely to produce many modes of high e. This would most likely produce noise rather than a discrete period. Accordingly, we think that the discrete period is most likely to be about $2\Pi/m\ \Omega$, i.e., produced by rotation.

VOGT: How can we observe pulsations of a white dwarf which is imbedded in an optically thick disk?

PAPALOIZOU: But it is not. In general the thickness of the disk is only a few percent of the white dwarf's radius. Accordingly the star should be visible.

KRAFT: How stable in fact are the fast modes - scales of several months or years? Does one observe similar periodicites at different times in the same star?

WARNER: Observations made during different outbursts of a given dwarf nova show similar periodicites at the same points of the outburst light curve. There is in general a clear relationship between period and apparent magnitude for each star.