PERTURBATION OF THE NON-RADIAL OSCILLATIONS OF A GASEOUS STAR BY AN AXIAL ROTATION, A TIDAL ACTION OR A MAGNETIC FIELD

P. SMEYERS

Astronomisch Instituut, Universiteit Leuven, Belgium

Abstract. The study of the linear and adiabatic oscillations of a gaseous star gives rise to an eigenvalue problem for the pulsation σ, if perturbations proportional to $e^{i\sigma t}$ are considered. In the presence of a rotation, a tidal action or a magnetic field, the equations are not separable in spherical coordinates. To get approximate expressions for the influence of these factors on the non-radial oscillations of a star, the author and his collaborators J. Denis and M. Goossens have used a perturbation method (Smeyers and Denis, 1971; Denis, 1972; Goossens, 1972; Denis, 1973). Their procedure corresponds to a generalization of the method proposed by Simon (1969) to study the second order rotational perturbation of the radial oscillations of a star.

Two types of perturbations are taken into account: volume perturbations due to the local variations of the equilibrium quantities and to the presence of a supplementary force in the equation of motion (Coriolis force, Lorentz force); surface perturbations related to the distortion of the equilibrium configuration and to the change of the condition at the surface in the presence of a magnetic field. The resulting expressions are accurate up to the second order in the angular velocity in the case of a rotational perturbation, to the third order in the ratio of the mean radius of the primary to the distance of the secondary in the case of a tidal perturbation, and to the second order in the magnetic field in the case of a perturbing magnetic field. These expressions can in principle be applied to any mode.

Numerical results have been obtained for a homogeneous model and for a polytropic model $n=3$. In particular, the splitting of the frequencies of the fundamental radial mode and of the f-mode belonging to $l=2$ and $m=0$ has been studied for the critical value of γ, in the case of a component of a synchronously rotating binary system.

References

Denis, J.: 1972, *Astron. Astrophys.* **20**, 151.
Denis, J.: 1973, Doctoral Thesis, Louvain, Belgium.
Goossens, M.: 1972, *Astrophys. Space Sci.* **16**, 386.
Simon, R.: 1969, *Astron. Astrophys.* **2**, 390.
Smeyers, P. and Denis, J.: 1971, *Astron. Astrophys.* **14**, 311.

DISCUSSION

Zahn: When you consider the rotational and tidal bulge, do you consider only the axis of the tidal

Ledoux et al. (eds.), Stellar Instability and Evolution, 197–198.

component, because the tidal bulge component is perpendicular to the axis of rotation and this has the same symmetry as the rotational case. So do you consider the axisymmetrical components only?

Smeyers: We take into account both the distortions caused by rotation and by tidal action. In the development of the tidal potential, we keep the Legendre polynomials $P_2(\cos\Theta)$, $P_3(\cos\Theta)$ and $P_4(\cos\Theta)$, Θ being the angle between the direction from the origin to the companion and the direction to the point considered.