COMPLEX INSTABILITY AROUND THE ROTATION AXIS OF TRIAXIAL SYSTEMS

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ABSTRACT. We examine the general instability at large amplitude of the radial periodic orbits along the rotation axis of bulges, spheroids and other rotating triaxial ellipsoidal systems.

1. INTRODUCTION

Complex instability of periodic orbits is a new phenomenon which may only appear in autonomous systems with more than 2 degrees of freedom. It is characterized by the fact that the four eigenvalues associated with the linearized transformation describing the motion close to the periodic orbit are complex and outside of the unit circle. In particular, it is shown that this phenomenon affects the z-axis orbits under the conditions mentioned below.

2. BIFURCATION ON THE Z-AXIS ORBIT FAMILY

Our systematic investigation of periodic orbits in various triaxial potentials led us to examine the stability of the z-axis orbit when the figure rotation and the shape change. In a first approach (Martinet & de Zeeuw, 1987), a quartic potential and a logarithmic potential were considered.

Here we use the 3D gravitational potential corresponding to the triaxial density law (Pfenniger & Udry, this Symposium) $\rho = \rho_c/(1+m^2)^{3/2}$, called $P_{3/2}$, as model of a E galaxy. We consider as well the potential of a previously used SB galaxy model (Pfenniger, 1984), which consists of a $n = 2$ Ferrer's bar imbedded in a Miyamoto disc.

Fig. 1 shows the different zones of stability (s), simple instability (u), double instability (du) and complex instability (cu) for the z-axis orbits in the model $P_{3/2}$ with the Schwarzschild (1979) axial ratios of 8:5:4 in an energy–rotation (H, Ω_p) diagram. *For not too slowly rotating figures, there exists a critical orbital amplitude above which we have the bifurcation $s \rightarrow cu$. This transition prevents the stable anomalous orbits which circle the long axis from joining the z-axis orbits.* We found that these features are *general* for rotating gravitational triaxial systems: completely analogous results are obtained in the SB galaxy, quartic and logarithmic potentials.

T. de Zeeuw (ed.), Structure and Dynamics of Elliptical Galaxies, 479–480.

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3. INFLUENCE OF A CONCENTRATED MASS IN THE CORE

A small Plummer sphere was added to the potentials considered above and its influence on our previous results was examined. We represent here the results obtained in the SB galaxy model. Completely similar results were obtained with the $P_{3/2}$ and the logarithmic potentials. The Plummer sphere mass M_p ranges between 0 and 0.0006, while $M_{bar} = 0.1$ and $M_{disc} = 0.9$ $(G = 1)$.

A (GM_p, H) diagram (Fig. 2) summarizes the destabilizing effect of the central mass. When $M_p > 6 \times 10^{-4}$ the z-orbit is practically fully *cu* from $z = 0$. *Therefore this perturbation plays a very important role in the orbital behaviour perpendicular to the equatorial plane.*

In order to illustrate the link between the instability of the z-axis orbits and the possible orbital diffusion of chaotic orbits, orbits starting close to the z-axis and along it and diffusing at larger distances were integrated in the SB galaxy model. The same Plummer sphere as above was put in the core, with an increasing mass. The results are that without perturbation the diffusion time in the spheroid is much longer than the Hubble time t_H. For small M_p $(M_p < 10^{-4})$, the stochastic orbits are still *confined* for a long time. However when $M_p > 10^{-3}$, the diffusion time becomes rapidly much shorter than t_H; then the central mass produces general strongly *cu* z-axis orbits.

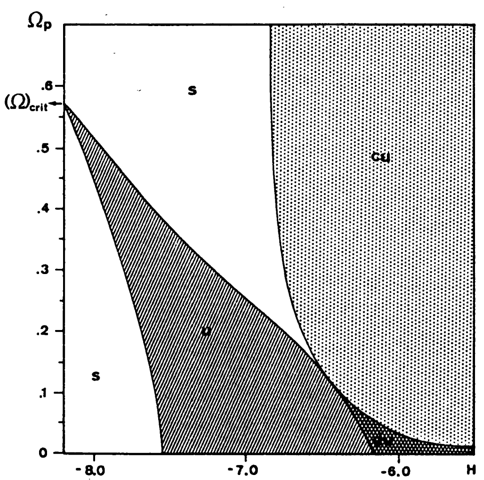

Fig. 1: Stability (H, Ω_p) diagram in the $P_{3/2}$ model

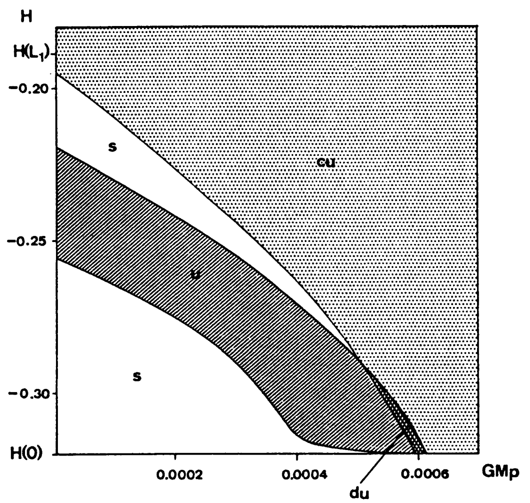

Fig. 2: Stability (M_p, H) diagram in the SB galaxy model

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