GLOBAL DYNAMICS IN ELLIPTICAL GALAXIES

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In order to study global dynamics in non–integrable triaxial systems, we take advantage of a new tool, the "Mean Exponential Growth factor of Nearby Orbits" (MEGNO), that proves to be efficient to investigate both regular and stochastic components of phase space. The MEGNO is not only useful to locate stable and unstable orbits, but also provides a measure of hyperbolicity in chaotic domains that coincides with that given by the Lyapunov Characteristic Number (LCN). Previously this technique has been applied to simple models (Cincotta et al., 2000), with the exception of extrasolar planetary systems (Goździewski et al., 2001). Here we will apply it to a more realistic system, a perturbed 3D Stäkel potential, to illustrate some of its important properties.

A detailed description of the MEGNO method may be found in a serie of papers (Cincotta & Simó 2000; Cincotta, Giordano & Simó 2002). The MEGNO indicator is defined as:

$$Y(t) \equiv \frac{2}{t} \int_0^t \frac{\dot{\delta}(s)}{\delta(s)}\, s\, ds \qquad (1)$$

δ being the norm of the solution of the variational equations corresponding to a given orbit and $\dot{\delta}$ its time derivative.

Space telescope observations show that early-type galaxies essentially never have constant-density cores; the stellar surface brightness always continues to rise down to the smallest observable radius.

On the other hand, it is known that the addition of a central mass concentration to an integrable triaxial potential can have profound effects on at least one family of orbits, the boxes, which fill a region that includes the center. Nuclear black holes or density cusps subject stars on box orbits to deflection that can destroy the stationary triaxial configurations, introducing chaotic dynamics in the system. Many of the last investigations suggest that triaxial galaxies with strong central mass concentrations would evolve in the direction of axisymmetry, at least near their centers.

To investigate this aspect and motivated by the observations, here we construct models of triaxial galaxies, taking an analytically simple integrable potential and adding to it a mass models with density cusps to obtain, in this way, a more realistic representation. Therefore, our models have a mass density:

$$\rho(m) = \frac{\rho_0}{(1+m^2)^2} + \epsilon \rho_{pert}(m) \qquad (2)$$

where $m^2 = x^2/a^2 + y^2/b^2 + z^2/c^2$, with $a \geq b \geq c$. The first term corresponds to the Stäckel model and the second to the perturbed model, already studied by Merritt D. and Fridman T. (1996), and Wachlin F. and Ferraz-Mello S. (1998),

$$\rho_{pert} \approx m^{-\gamma}(1+m)^{-(4-\gamma)}. \qquad (3)$$

The parameter γ determines the slope of the central density cusp.

A detailed study of the global dynamics of this system has been carried out using MEGNO. It has proved to be also efficient in these more realistic models, showing that its convergence is faster than the LCN one, and requiring shorter times to separate the stochastic motion from the regular one.

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