ATTACKING THE PROBLEM OF A SELFCONSISTENT BAR

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One way of approaching the problem of a selfconsistent bar, is to examine the orbits of the stars which make up the bar. Given that there are 10^{10} such stars and therefore 10^{10} such orbits, one has to devise a way of studying and classifying them. Once one knows the most important types of orbits which appear in a system and when they appear, can proceed in constructing a selfconsistent bar.

The most important families of periodic orbits which appear in a system are:
The x_1 family: When the potential is axially symmetric, this family represents the circular orbits of various energies. If we add some bar perturbation to the potential the x_1 family consists of distorted orbits elongated along the bar.
The x_2, x_3 families: They are 2:1 resonant orbits which appear between the two inner Lindblad resonances. They are elongated perpendicularly to the bar and the x_2 are stable while the x_3 are unstable. The way these families vary according to the strength of the bar is shown in figure 1 where we plot the radius of the orbit perpendicularly to the bar versus the value of the Jacobi constant (assuming that we have a rotating coordinate system).(Papayannopoulos & Petrou 1982).

The study of the periodic orbits is very important because the majority of the non-periodic orbits in a galaxy are trapped around the stable periodic ones. So, one periodic orbit is like a representative of a large group of orbits.

The trapped orbits have, apart from the Jacobi constant, which is an exact integral of the motion, other approximate constants too. The orbits which have only the Jacobi constant as integral of the motion are called ergodic and they fill up all the available space in the (x,y) coordinates specified by their zero velocity curves. There are two mechanisms which lead to ergodicity: 1)Many high order resonant families of the form n:1 appear close to corotation. When n is even they are separated from the x_1 family by a gap while when n is odd they bifurcate from it. As the areas of importance of each resonance overlap the

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approximate integrals dissolve. (Resonance interaction). This mechanism appears in intermediate bars inside corotation (figure 2a).
2)An odd bifurcation of the x_1 family followed by a cascade of infinite bifurcations. This is the Feigenbaum effect and has been found in the case of strong bars immediately after the 3:1 resonant family bifurcates from x_1 inside corotation and in intermediate bars immediately after the 1:1 family bifurcates from x_1 beyond corotation(fig.2b)(Contopoulos 1982).

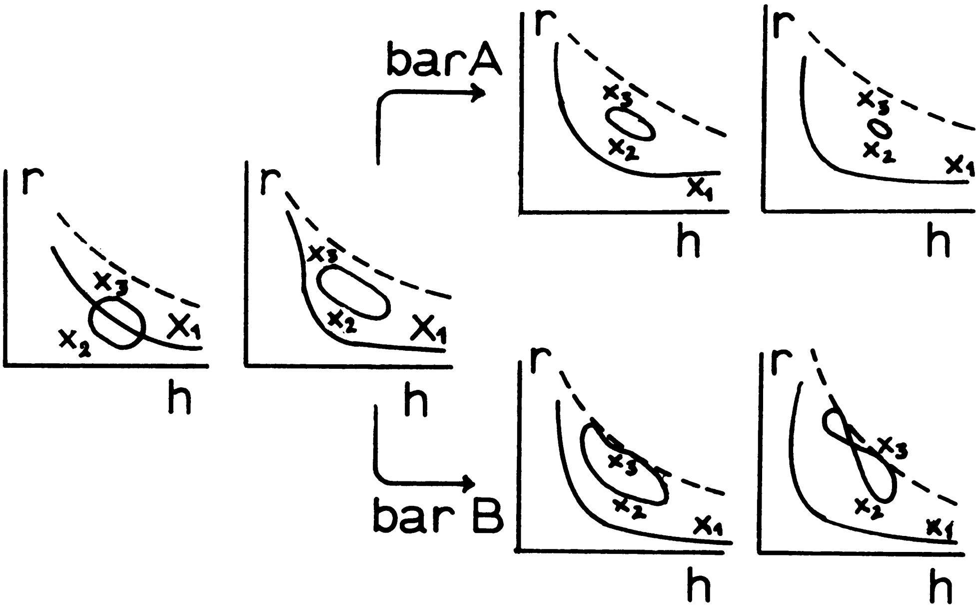

Fig.1:Evolution of the x_2,x_3 families as the bar becomes stronger from left to right. The first diagram is without a bar. Bar A:a cos2ϑ bar. Bar B:An inhomogenious prolate spheroid. The dashed line is the zero velocity curve.

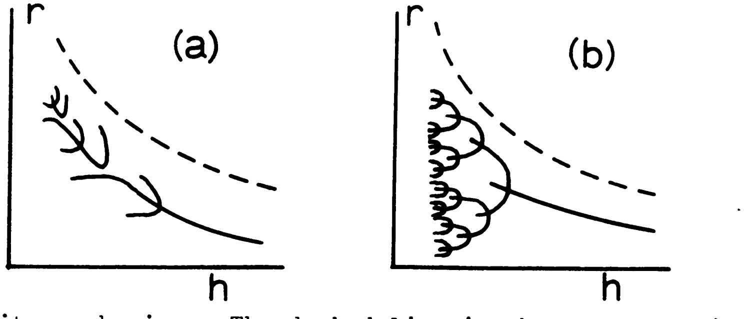

Fig.2:Ergodicity mechanisms. The dashed line is the zero velocity curve.

References

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