SECULAR EVOLUTION IN GALAXIES

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We have adapted the N-body code of Van Albada (1982) to study the secular evolution of a hot collisionless stellar component (E galaxy or galactic bulge) due to slow changes in another component of the same galaxy. Our equilibrium starting model is a non-rotating triaxial ellipsoid with axial ratios 1.3:1.4:2.0; the effects of the "other component" are then simulated by various simple means.

First, we consider the growth of a massive black hole or dense nucleus (represented by a point mass) at the centre of the galaxy, to a maximum mass $M_{p,max}$. We find an interesting large-scale structural effect: the system becomes rounder, out to radii more than 30 times the radius of influence GM_p/σ_o^2. This effect is greater for larger values of $M_{p,max}$; if $M_{p,max} = 10^{10}\ M_\odot = 0.05\ M_{gal}$, the observed change is one ellipticity subclass (E3.4 to E2.4). The observational statistic that radio galaxies appear rounder than normal E galaxies (Hummel 1980) may thus be evidence for massive black holes in active nuclei.

Secondly, we consider a torque applied slowly about the short axis, to mimic the effect on a galactic bulge of a rotating bar in the disc component. We find that, besides making the bulge rotate, the torque causes the system to assume a box or peanut shape in side view (see Fig. 1), like that observed in the bulges of the Milky Way (Hayakawa et al. 1981) and of some external galaxies (Kormendy and Illingworth 1982).

The key to both these effects may lie in the behaviour of individual stellar orbits under adiabatic changes (cf. Norman 1984): the first may be related to the loss of box-orbits, the second to the loss of long-axis tubes. Further work is in progress on these problems, as well as on the effect on a bulge component of the slow growth of a rigid disc potential.

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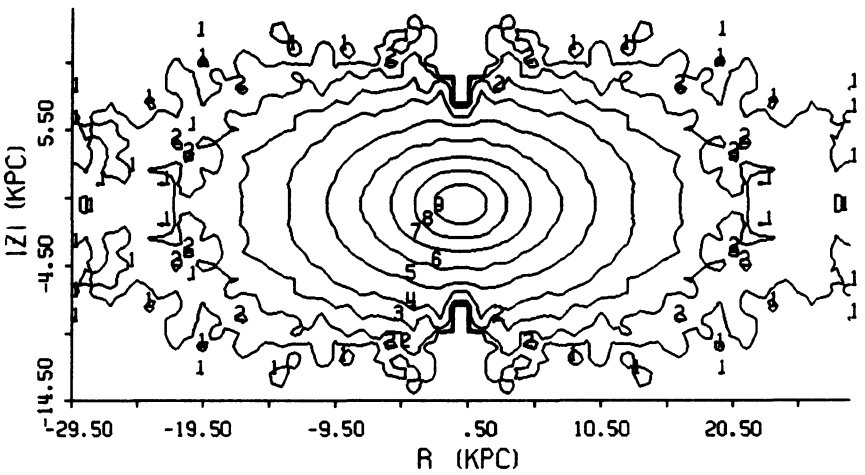

Fig. 1. Mean density in meridional (R, |z|) plane for torque model, after torque is switched off (averaged over 14 crossing times). Contour spacing is logarithmic (0.5 dex), in arbitrary units. Figure is reflected about R and |z| axes for clarity.

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