THE STABILIZING EFFECTS OF HALOES AND SPIRAL STRUCTURE

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The equilibrium and the stability of homogeneous gaseous and uniformly rotating MacLaurin spheroids imbedded in a rigid, homogeneous and spherical stellar halo are considered. Such systems may be useful as crude models of disk-halo galaxies. Explicitly, we have determined the modes of oscillations stemming from the fundamental radial mode of the homogeneous compressible sphere and its non radial "f" (or Kelvin) modes belonging to the second (ℓ=2) and third (ℓ=3) spherical harmonics, together with the first "pressure" and gravity modes p_1 and g_1 belonging to the first spherical harmonics (ℓ=1). It has been assumed that the oscillations are adiabatic with a ratio of specific heats γ=5/3, and several sequences of spheroids corresponding to various values of the halo mass have been examined.

Two interesting results emerge from this study. We first find that the halo does not always exert a stabilizing effect on dynamical instability. Indeed, the gravity mode g_1 becomes stable for a value of the meridional excentricity e of the spheroid greater in the presence of the halo than without it, and this value increases with the ratio q of the halo mass to the spheroid mass (fig. 1).

On the other hand, the dynamical instabilities exhibited by the "two-arms" mode (i.e. corresponding to the spheroidal harmonics ℓ=2 with the exp(i2ϕ) azimuthal dependence) and the "three-arms" mode (ℓ=3 and exp(i3ϕ)) are successively suppressed when the ratio q reaches rather low values: $q > q_2 \simeq 1.2$ for ℓ=2, and $q > q_3 \simeq 2.1$ for ℓ=3. This agrees with previous expectations (fig. 2). However, it is worth noting that when $q > q^* \simeq 0.2$, those instabilities reverse order: for $q > q^* \simeq 0.2$, the ℓ=3 instability occurs first and even more, for $q_2 < q < q_3$, only this instability manifests itself. This suggests that the occurrence of three-armed spiral structures might be due to the presence of a halo of high enough mass.

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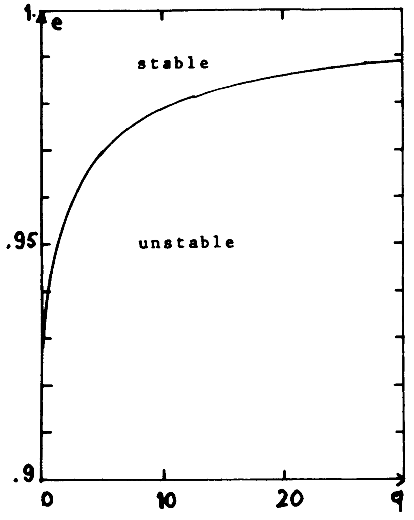

Fig. 1. Spheroid excentricity e at dynamical stability as a function of the ratio q of the halo mass to the spheroid mass, for the gravity mode g_1 with $\ell=1$.

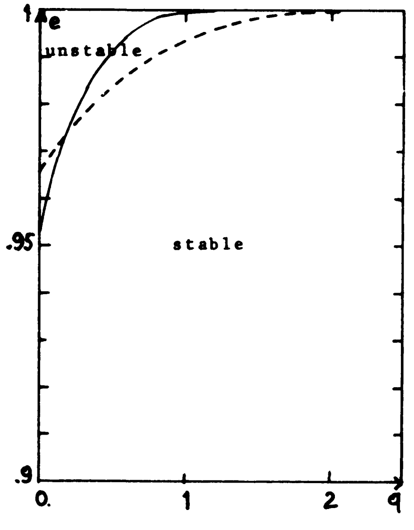

Fig. 2. Spheroid excentricity at dynamical instability as a function of q. The full and dashed lines correspond to the Kelvin modes $\ell=2$ and $\ell=3$, respectively.

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