SCALE-FREE MODELS OF ELLIPTICAL GALAXIES

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In this note I will report the general character of all scale-free solutions of the collisionless Boltzmann and Poisson equations for a specific shape. In this case, the density falls as r^{-2} along any radial ray, the potential is logarithmic with oblate spheroidal level surfaces, and the flattening corresponds to an E5 or E6 density distribution (see Richstone 1980, hereafter Paper I). Schwarzschild's (1979) method was used. Toomre (1982) has recently discussed the properties of scale free models of this sort with distribution functions dependent on only the two classical isolating integrals. The method used here automatically incorporates the third integral.

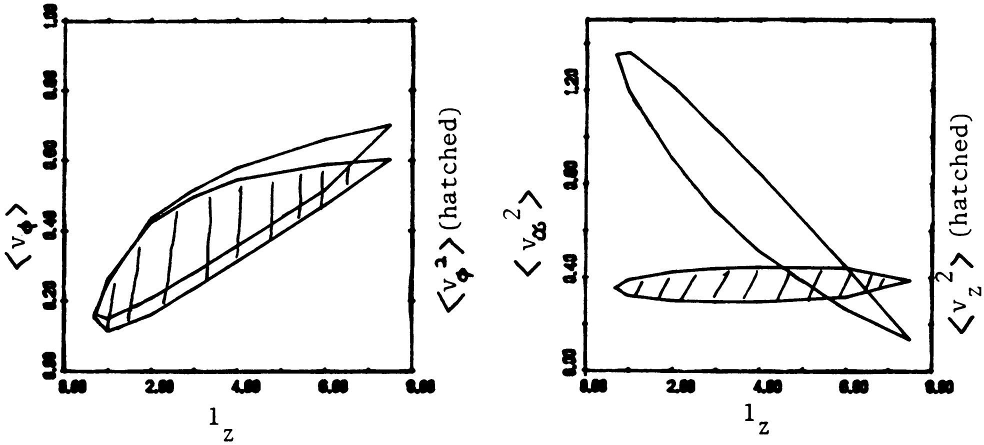
The linear programming techniques used here in determining the orbit occupation numbers have certain noteworthy features. First, the models produced are "basic" (have the minimum possible number of orbits to produce a solution and lie on the very edge of the solution set. This may mean that they are astrophysically implausible because they are almost impossible. Second, the solution set is convex, hence, a number of basic solutions delineate the complete solution set, and any solution can be constructed via a weighted mean of basic solutions. Completeness of the solution set is achieved only if the orbits surveyed have complete or representative coverage of phase space (Richstone 1981).

With the above remarks in mind we display overleaf the projection of the complete solution set on to planes defined by the total z axis angular momentum ℓ_z and the non-trivial first and second moments of the velocity distribution. All orbits are assumed circulating in the same sense. All moments are computed on a thin spherical shell any distance from the center. The cross-hatched region on each plot corresponds to the ordinate label on the right hand side of the plot. The moment subscripts correspond to the usual cylindrical coordinates. The dispersion tensor is approximately aligned with the cylindrical coordinates.

These plots indicate that the choice of total ℓ_z approximately

E. Athanassoula (ed.), Internal Kinematics and Dynamics of Galaxies, 289–290.

determines the other global dynamical parameters, but that there is additional freedom. The velocity ellipsoid is always approximately aligned with the principal coordinate axes. At low ℓ_z the third integral plays an important role in flattening the models. The models do locally satisfy a tensor virial theorem, but as pressure stresses are very important Binney's (1981) estimate of an anisotropy parameter as a function of v/σ doesn't work for them.



Like their predecessor in Paper I, the low ℓ_z models described here exhibit a tendency toward increasing observed first and second velocity moments with distance from the equator. This effect may not be present in non basic low ℓ_z models, and is not a common feature of high ℓ_z models. Nonetheless, variation of $\langle v_{obs} \rangle$ and $\langle v_{obs}^2 \rangle$ with latitude may be a valuable clue to the importance of the third integral in galaxian structure.

REFERENCES

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