SELF–CONSISTENT ELLIPTICAL DISKS

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ABSTRACT. Self-consistent solutions for the perfect elliptic disk have been obtained. Velocity field, dispersion maps and the distribution function in action space have been derived.

Self consistent solutions for perfect elliptic disks (de Zeeuw 1985) have been constructed by means of Schwarzschild's (1979) method. A grid was chosen in elliptic coordinates (λ, μ) with $N_\lambda = 32$ cells in λ and $N_\mu = 8$ cells in μ, so that a complete set of orbits consists of $N_\mu * N_\lambda = 256$ box orbits and $N_\lambda * (N_\lambda + 1)/2 = 528$ tube orbits.

By optimizing the streaming in the disk, two distinct solutions for each model were calculated: a solution with minimum streaming, which *does* however need some tube orbits, and a solution with maximum streaming. This means that such models have non–unique self–consistent solutions.

In the maximum streaming solution, the density along the minor axis outside the focal point is contributed by the thinnest tube orbits only (de Zeeuw, Hunter & Schwarzschild 1987). This makes it possible to calculate the *direct* numerical solution with N_λ tube orbits and $N_\lambda * (N_\mu - 1)$ box orbits (the complete set of box orbits minus the marginal orbits) without linear programming, by solving N_λ simple equations, followed by solving a $N_\lambda * (N_\mu - 1)$ squared triangular matrix equation (cf. Schwarzschild 1986). It has been verified that in the limit $b/a \to 1$, this solution becomes the well known Kuzmin disk with thin tubes only.

Distribution functions in action space have been derived. The maximum streaming solutions (Figure 1) have smooth distribution functions in action space, apart from an allowed discontinuity at the closed loop orbits. In a real system this might plausibly arise through dissipational formation. The minimum angular momentum solutions are all discontinuous over the marginal (unstable) orbits, which indicates that these solutions are probably unphysical.

Associating stars with all orbits and gas with the closed elliptic orbits, mean streaming and velocity dispersion fields for the stars and gas have been derived. Velocity fields for the stars and gas are projected onto the sky and are shown as such hypothetical systems would be observed. There is a significant difference in the kinematics of the stars and gas. This may have some relevance to hot ovally distorted disks with little or no figure pattern speed or to gas in a principal plane of a triaxial elliptical galaxy.

T. de Zeeuw (ed.), Structure and Dynamics of Elliptical Galaxies, 491–492.

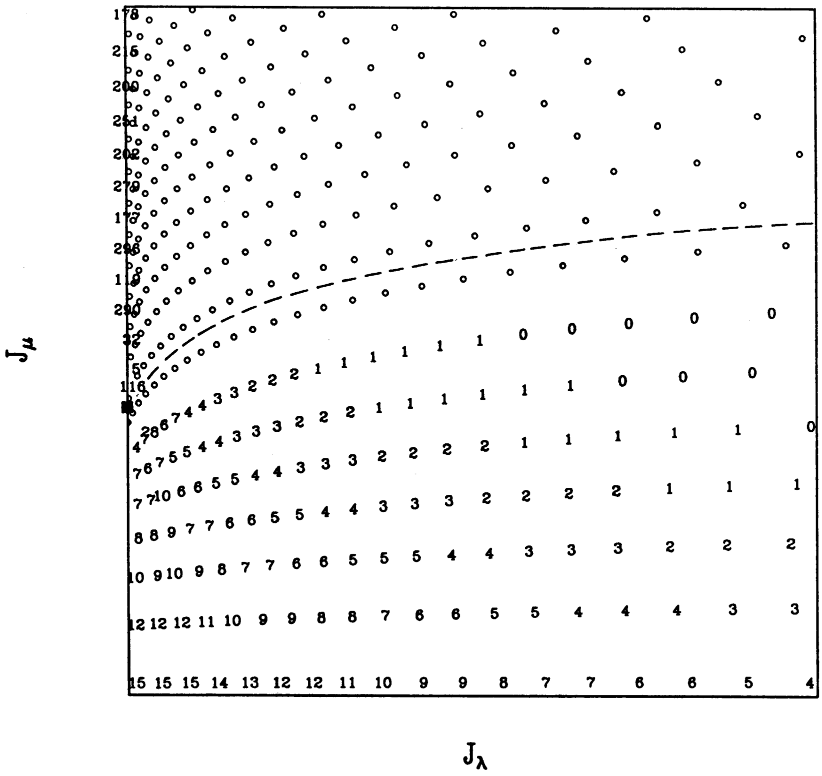

Figure 1. Distribution function in action space for the maximum angular momentum solution for an elliptic disk with $b/a = 0.7$. The dashed line represents the marginal orbits, separating the loop orbits (above) from the box orbits (below), the filled square represents the focal short axial orbit. The open circles are orbits with zero weight from the linear program, the numbers represent the actual value of the distribution function as found by the linear program.

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