KINEMATIC MODELLING OF NGC 3379

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Giant elliptical galaxies are now known to be supported by anisotropic pressure rather than by rotation (cf. Binney, 1981). This anisotropy can be derived from observable quantities for spherical systems as was shown by Binney and Mamon (1982) in their study of M87. We investigate here the velocity anisotropy of the E1 galaxy NGC 3379, a giant elliptical whose surface brightness constitutes an excellent illustration of the $r^{1/4}$ law.

For a spherical system, the kinematics are described by the equation of stellar hydrodynamics:

$$df/dr + 2\beta f/r = -(M/L)F. \qquad (1)$$

Here, $f=\ell\sigma_r^2$ is the stellar 'pressure', $\beta=1-\sigma_\theta^2/\sigma_r^2$ is the anisotropy and $F=G\ell L(r)/r^2$; where σ_r and σ_θ are two principal components of the velocity ellipsoid, ℓ is the space-luminosity density, and $L(r)$ is the integrated luminosity. The radial velocity dispersion can then be projected to obtain the line-of-sight velocity dispersion σ_v:

$$\int_R^{R_t} \frac{fr\,dr}{(r^2-R^2)}{}^{1}/{}_{2} - R^2 \int_R^{R_t} \frac{\beta f\,dr}{r(r^2-R2)}{}^{1}/{}_{2} = \frac{1}{2}\,\sigma_v{}^2(R)\Sigma(R). \qquad (2)$$

The knowledge of $\Sigma(R)$ provides us with ℓ and hence with F. In our first scheme, we choose $\beta(r)$ and a constant M/L, compute σ_r from equation (1), and project onto the line-of-sight with equation (2) to obtain $\sigma_v(R)$. In the second scheme, we start directly with the observable quantities $\Sigma(R)$ and $\sigma_v(R)$ to derive $\beta(r)$ and a constant M/L following the solution to the system of equations (1) and (2) for f and β from Binney and Mamon (1982).

We adopt for NGC 3379 the 2-component model of de Vaucouleurs and Capaccioli (1979) for $\Sigma_B(R)$ (an $r^{1/4}$ law with a gaussian core superposed), and truncate it at 1201". We begin with scheme #2 and fit three model profiles through the velocity data of Sargent et al. (1978) and of Davies (1981), and a fourth model (D) through the unpublished data of Davies, Illingworth and McElroy (1982; Illingworth, private communication). Fig. 1 shows $\beta(r)$ as computed from the $\sigma_v(R)$ models plotted in Fig. 2. Models A, B, and C all exhibit positive anisotropy, while model D is isotropic

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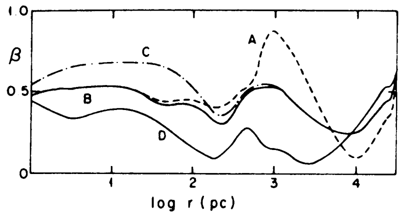

Figure 1. Anisotropy profiles for NGC 3379 (1"=38.8 pc).

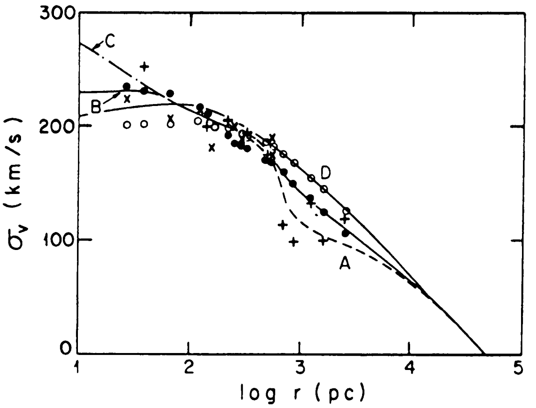

Figure 2. Line-of-sight velocity dispersion for NGC 3379. Crosses and plus signs are measurements by Sargent et al. (1978) and Davies (1981) respectively. The curves labeled A, B and C are three model fits to these data, while the D curve is a fit to the measurements of Davies et al. (1982; not shown in the figure). The open and filled circles are the seeing and slit convolved profiles from $\beta=0$, M/L=11 and $\beta=0.5$, M/L=8.5, respectively.

in the main body of the galaxy.

These results are better understood when we compute the velocity dispersion profiles from constant β and M/L, using the first scheme. Since the innermost measurements are affected by atmospheric seeing and by averaging over the slit, we convolve our results in two dimensions with a gaussian PSF of $\sigma^{*}=1''$ and the appropriate slits (Fig. 2). The anisotropic model ($\beta=0.5$,M/L=8.5) clearly fits better the older two sets of data, whereas the isotropic model (M/L = 11) presents an adequate fit to the more recent data.

In summary, the strong scatter (±25%) in the velocity dispersion measurements beyond 15" in NGC 3379 prevents one from distinguishing between isotropic and anisotropic models. This puts the mass-to-light ratio in the interval (8.5,11). However, M/L may not be constant, and isotropic models with M/L increasing in the core can be made to fit the data. The answers to all of these questions must therefore await higher quality spectra in the inner arcsec and beyond 15" for NGC 3379.

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