GAS FLOW MODELS FOR BARRED SPIRALS

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ABSTRACT

This paper is a progress report on a research project studying the gas flow in barred spirals. The parametrization of the potential and the gasdynamics code being used are described in section 1, some preliminary conclusions and a sample result are presented in section 2.

1. PARAMETRIZATION OF THE POTENTIAL; THE GASDYNAMICS CODE

The gas flow is computed in a series of potentials derived from a three component model of a barred spiral galaxy. The model is somewhat ad hoc, designed for computational simplicity as much as to give a reasonable description of the type of potential actually expected. The components are:

1) A prolate inhomogeneous spheroidal bar with

$$\rho_{BAR} = \rho_{0,BAR} \cdot \left[1 - x^2/a^2 - (y^2 + z^2)/b^2\right] \quad (1.1)$$

The free parameters for the bar are the axial ratio a/b and the quadrupole moment, while a = 5 kpc is fixed.

2) A Hubble density law bulge. The free parameter in this case is the sum of the central densities of the bar and the bulge, while the core radius of the bulge is derived from the constraint that the sum of the masses of the bar and the bulge within 10 kpc is fixed.

3) A n=1 Toomre-Kuzmin disk leading to an essentially flat rotation curve outside 10 kpc. This disk has no adjustable parameters. A fourth adjustable parameter is the corotation radius, or more precisely the radius of the Lagrangian point at the end of the bar.

The gasdynamics code is based on the FS2 code in Van Albada, Van Leer, and Roberts (1982), which is a second order accurate upwide centered method. It has been adapted for two-dimensional computations by using time-splitting, also to second order accuracy. In extensive tests

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it was found that the properties of the particular code used can strongly affect the derived gasflow, thus at the very least affecting the quantitative results of a parameter study. The code effects for the FS2 code are much smaller than for previously used codes (assuming a perfect gas), but still non-neglibible. They were further reduced by using a finer grid than usual.

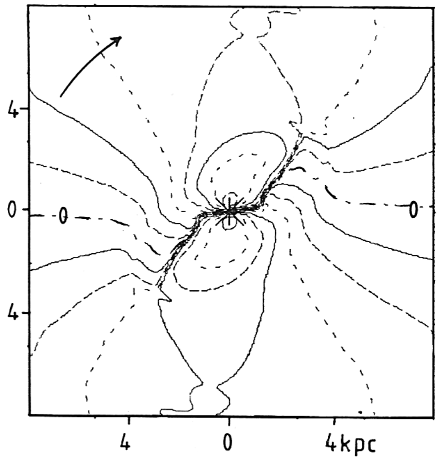

Fig. 1.
Model velocity field obtained for a bar with a/b = 3.0, corotation at 6 kpc, ρ_{CEN} = 30 $M_\odot$ pc^{-3} and QT_{max} = 33%. The bar is at 45° with the horizontal axis; the galaxy rotates clockwise. Shown are 50 km s^{-1} contours of the velocity in the x-direction.

2. RESULTS

The parameter space allowed by the four free parameters in the model is quite large; thus far the emphasis has been on finding that part of the parameter space where models similar to the classical SBb galaxies like NGC 1300 are obtained. This implies that we are looking for long, straight shocks, more or less parallel to the axis of the bar and offset to the leading edge. In fact it has proved to be quite easy to produce such models for strong bars (QT_{max} > 40%, as defined in Sanders and Tubbs, 1980), as long as the central mass density is sufficiently high (over 18 $M_\odot$ pc^{-3}). However, N-body models of bars so far have not resulted in QT_{max} exceeding about 30% for more than a dynamical time scale (Sanders, private communation). Therefore, the present research is primarily directed at finding models with weak bars. Some of such models have already produced quite satisfactory results, the velocity field shown in Fig. 1 is an example of a model with QT_{max} = 33%.

REFERENCES

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