A BARRED GALAXY: THE INSIDE VIEWPOINT

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ABSTRACT: The observed gas distribution and kinematics in the central 4 kpc of our Galaxy show many aspects reminiscent of barred spirals. In this note I describe a collection of (l,v) maps obtained from a gas flow model of a barred spiral.

The central 4 kpc of our Galaxy shows a number of features that may be very similar to features commonly observed in barred spirals. The most striking of these are: a) the ring of HII regions around R = 4 kpc, similar to the inner ring in SB(r) or SAB(r) galaxies; b) the general lack of gas inside this ring down to R = 1 kpc; c) the inner molecular ring and nuclear disk, corresponding to a nuclear ring of HII regions; d) the large observed deviations from circular rotation. Where important details, such as the 3-kpc arm, should fit in is, however, not entirely clear.

The very different vantage point from which we observe our own Galaxy makes a more detailed comparison very difficult. Comparison with detailed model calculations of the gas flow appears to be a promising approach to the problem. Computations are now available that reproduce most of the observed features of SBbc-type galaxies (G.D. van Albada, 1984). The gas distribution and gas streamlines obtained for one such model are shown in Figure 1.

The model displayed was obtained for a bar with an axial ratio of 2.5:1 and a maximum ratio of tangential to radial forcing (Qtmax; Sanders and Tubbs, 1980) of 24%. A number of features stand out clearly in this model, namely 1) the straight, narrow regions of high gas density, presumably corresponding to the dust lanes in the bar and ending in a central region of enhanced gas density, and 2) crossing a region generally lacking in gas, two streams that show similarities to the "feathers" often observed in bars. Due to inadequacies in the current mass model, the central gas disk is rather too large and interferes with the formation of more realistic feathers. Yet we can already obtain some insight from this model into the way the various observed

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features could arise. The identifications of the nuclear disk and that of the empty region outside it are obvious. The 3-kpc arm is somewhat more problematic, but also of greater diagnostic value. If we identify it with a feather, the bar must make an angle of about 40° with the line of sight, with the near end at positive longitude. The lack of an exact counterpart at positive velocities is not surprising, in view of the asymmetries generally observed in galaxies, while several features can be found that would correspond to the +135 km/s arm.

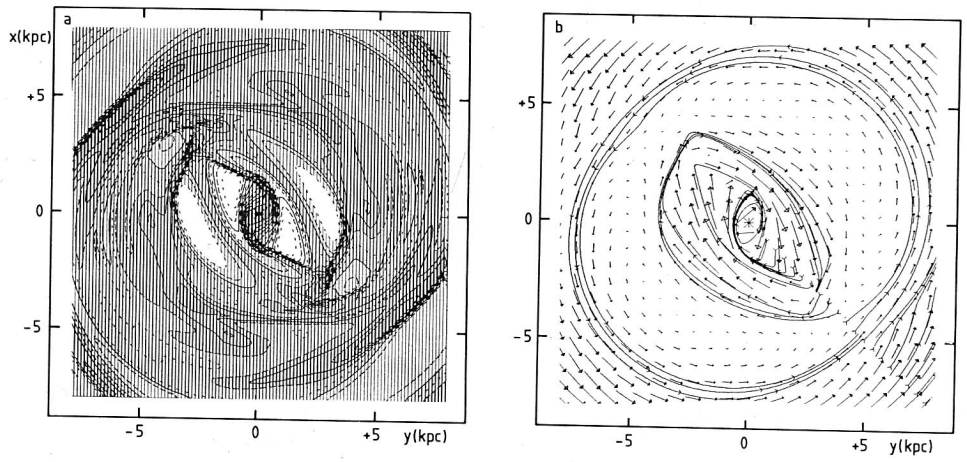

Figure 1. a: The central 8 kpc of the gas density distribution in a barred-galaxy model. b: The gas stream-lines in the rotating frame of the bar. The bar is at a position angle of +45° and has a semi-major axis of 5 kpc.

Using the computed gas distribution as input (and assuming that it represents one species, such as HI), it is possible to produce artificial observations. In Figure 2 we present (l,v) maps as they would be observed at a distance of 12 kpc (for scale purposes) from the centre, in the plane of the model in Figure 1. These (l,v) maps may be compared with the HI observations published by e.g. Burton (1970), or the CO observations published by e.g. Bania (1980). Many features similar to those observed in our Galaxy are indeed reproduced. The (l,v) map in Figure 2d especially appears to be a rather good model. However, in this case the feather corresponding to the 3-kpc arm would be at the far side of the nucleus. From Figure 2b, which corresponds most closely to the expected geometry, it is clear that a smaller, more rapidly rotating nuclear disk is required in order to obtain a more acceptable model.

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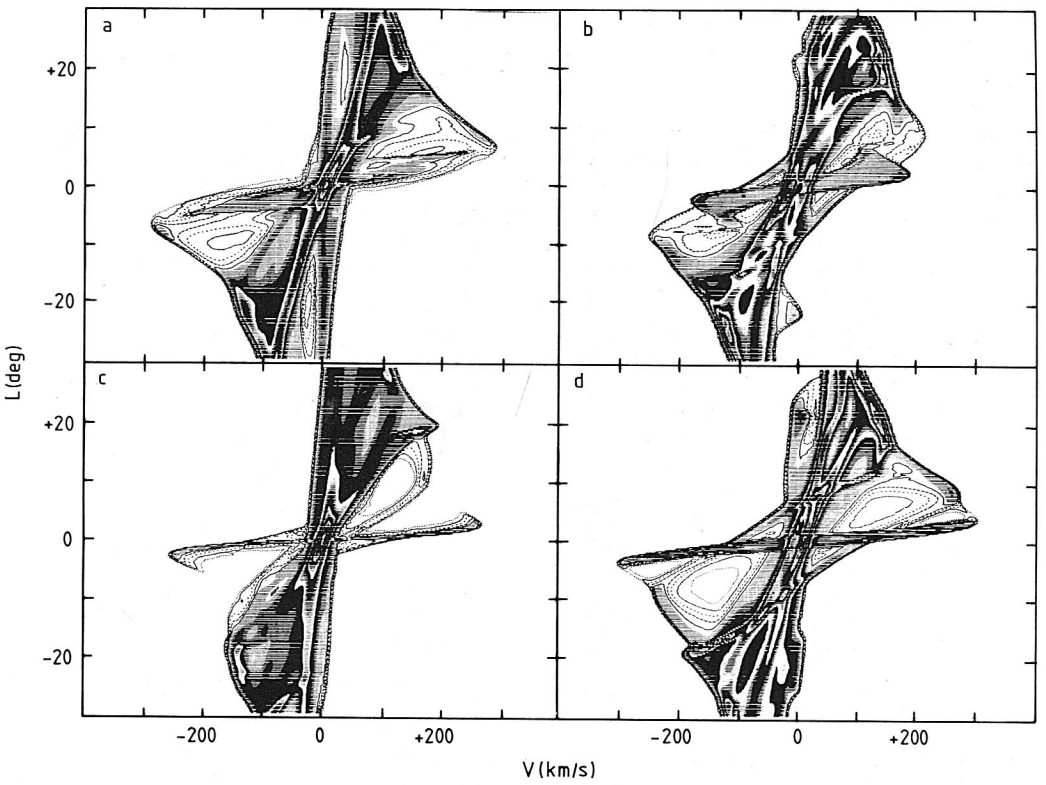

Figure 2. a: An (l,v) map such as would be observed along the bar from a distance of 12 kpc in the model galaxy of Figure 1.
b: Same as a, but 45° counter-clockwise relative to the bar.
c: Same as b, but perpendicular to the bar.
d: Same as b, but 135° counter-clockwise with respect to the bar.

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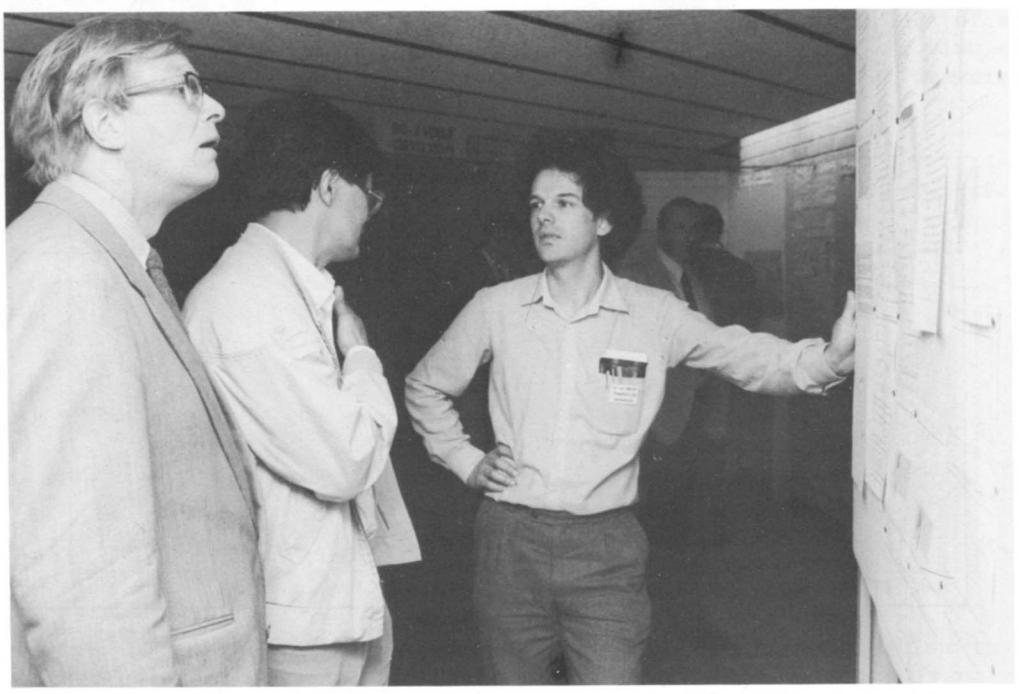

Van de Hulst (left) studies posters of G.D. van Albada (right) and Yuan. Background: Hodge CFD

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