RECENT TAURUS RESULTS ON Hα VELOCITIES IN M83

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SUMMARY:

Preliminary Hα observations with the TAURUS imaging spectrometer confirm a pattern of systematic radial motions in a section of spiral arm in M83. The velocity gradients are not consistent with those predicted for the neutral gas.

Non-circular motions have also been discovered in the central regions of the galaxy.

1. INTRODUCTION:

For some time now the existence of large-scale patterns of non-circular motions in the interstellar gas near spiral arms has been accepted as evidence for the presence of underlying density waves in the mass distribution of the disk. The well-known example of the distribution and motions of HI in M81 as observed by Rots (1975) and analysed by Visser (1980a, b) has remained unique in its clarity for many years.

The kinematics of the ionized gas may be different from that of the neutral gas (see for example Bash and Visser, 1981), and these differences may be of great interest for the study of the mechanisms and time scales for the formation of massive stars out of the interstellar HI in spiral arms. With this general motivation we have examined a section of spiral arm near the minor axis of M83 using an Hα data cube which was available more by accident than by design. We have also studied the velocity field in the central regions of the galaxy with the hope of finding kinematic evidence for a bar of about 1 arc-minute size which has been reported as being present there (Comte, 1981).

E. Athanassoula (ed.), Internal Kinematics and Dynamics of Galaxies, 147–150.

2. OBSERVATIONS AND DATA REDUCTION:

The observations were made with the TAURUS imaging spectrometer (Taylor and Atherton, 1980; Atherton et al., 1982) during one of the first test runs at the Anglo-Australian Observatory in the spring of 1980. M83 had been selected as an interesting candidate for a number of reasons, and an approximately one hour exposure on the 3.9-meter telescope produced a data cube of 180 × 180 pixels at 91 spacings of the Fabry-Pérot interferometer. Unfortunately, the pre-filter defining the overall passband of the system was not optimally centered on the systemic velocity of M83, and the Hα emission from the southwestern side of the galaxy was very weak. Partially for this reason the data have not been photometrically calibrated. The transformation from Fabry-Pérot spacing to velocity was carried out using the STARLINK computer at the Royal Greenwich Observatory; subsequent spatial smoothing and velocity profile analysis of selected regions of the galaxy have been done with the Groningen Image Processing System (GIPSY). The final spatial resolution was 3 arcseconds for the spiral arm region, and 6 arcseconds (Gaussian FWHM) for the central areas of the galaxy. The velocity resolution is 35 km s^{-1} (Lorentzian FWHM).

3. RESULTS:

In the accompanying figure we show a contour map of the Hα emission in the northeastern side of M83; as remarked earlier, the southwestern side is virtually absent and the map is not photometrically calibrated. Isovelocity loci are drawn over the contours in several places. The broken curve indicates the position of a prominent dust lane.

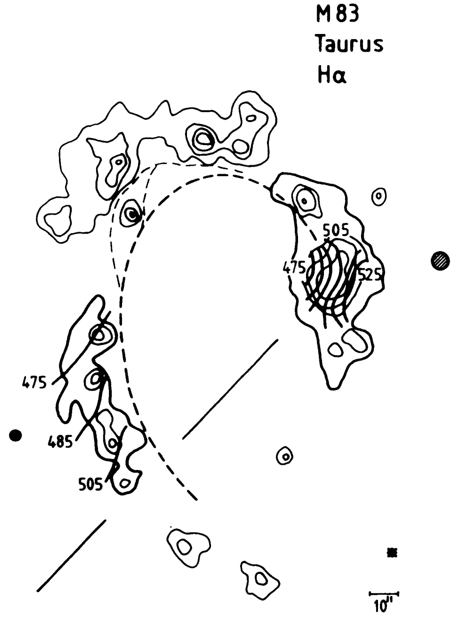
a) The Eastern Spiral Arm:

A region of this spiral arm near the minor axis has been chosen for study, since any radial streaming velocities should be greatest there. If we assume that the spiral arms are trailing, then the SE-side in the figure is the far side of M83. Since the dust lane is on the inside of the arm, we expect corotation to be located at some larger radial distance. The models of neutral gas flow (e.g. Visser, 1980b) under these conditions predict that just outside the shock (dust lane), the gas radial velocity $V_r < 0$ indicating infall, and furthermore $\delta V_r/\delta r > 0$ as we encounter streamlines which are further downstream from the shock.

If we accept the minor axis position angle ϕ of 135° (indicated by the straight line segments in the figure) and a systemic velocity V_s of 505 km s^{-1} (e.g. Comte, 1981) we encounter the first contradiction, viz. the radial velocity of the ionized gas is greater than the systemic velocity in the region where the minor axis crosses this arm. This would indicate outflow, were it not for the uncertainties in the two parameters ϕ and V_s. However, quite independent of the exact choice of these parameters, we see from the figure that $\delta V_r/\delta r < 0$ since a velocity gradient of approximately -10 km s^{-1} in a radial increment of +20 arcseconds is clearly present across the spiral arm. The isovelocity contours have a slope opposite to that predicted by the neutral gas flow models.

The observational results in the SE spiral arms (and elsewhere in M83) are consistent with the earlier photographic Fabry-Pérot study carried out by Comte (1981). Similar photographic observations have been recently made by De Vaucouleurs, Pence and Davoust (1982); their results do not appear to show the flow velocities described above, although their sensitivity and spatial averaging methods make a direct comparison difficult.

Because the photographic techniques result in a spatially undersampled velocity field it could be that peculiar velocities of the HII regions compared to the surrounding diffuse emission may account for some of this discrepancy, depending upon the regions which were sampled. The possibility that these peculiar velocities exist was first pointed out in a comparison of the HI and HII velocities in M101 by Viallefond,



Distribution and radial motion of the Hα emission in the eastern arm of M83. The contours are Hα intensity in linear equal increments after subtraction of the continuum emission, but not photometrically calibrated. The angular resolution is shown by the two hatched circles, one to the right of the nucleus (giving the resolution of 6" for the central regions), and the other to the left of the eastern spiral arm (3"). Isovelocity loci in these two regions are also shown, as is the dust lane (broken line). The symbol directly above the 10" horizontal bar is a star.

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Allen, and Goss (1982, see for example NGC 5447). Since TAURUS can obtain reliable Hα velocities for both the HII regions and the diffuse gas, we can now make a comparison for the ionized gas alone. We find that there is indeed considerable small-scale structure in the observed velocities, or order 10 km s^{-1}. However, these velocities appear insufficient to explain the discrepancy between the map of De Vaucouleurs, Pence and Davoust on the one hand, and that of Comte (1981) and the present results.

b) The Central Regions:

The velocity contours in the central areas of the galaxy show a strong gradient and a general S-shaped morphology which is reminiscent of the kinematic effects associated with the presence of a bar in other galaxies, for instance NGC 5383 (Peterson et al., 1978; Sancisi et al., 1979; Sanders and Tubbs, 1980). This result was not available in previous Fabry-Pérot work on M83 owing to saturation effects on the photographic plates.

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