A HIGH RESOLUTION HI SURVEY OF M31

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1. INTRODUCTION

The first results of a new high resolution 21-cm HI line survey of M31 made with the Westerbork Synthesis Radio Telescope are presented. Five areas were mapped, covering the galaxy except for the extreme northern and southern parts, at a resolution of $\Delta\alpha \times \Delta\delta \times \Delta V = 24'' \times 36'' \times 8.2$ km s^{-1}. The spatial resolution corresponds to 80 x 120 pc at the distance of M31. This is of the same order as the resolution at the distance of the center or our own galaxy given by a 25-m dish. Consequently the M31 survey is comparable to surveys of the Milky Way galaxy in wealth of detail as well as in amount of data ($\sim$ 1 Gigabyte).

2. RESULTS

The presence of local galactic foreground HI in the observations and calibrations was accounted for during the data reduction. The continuum background was removed by subtracting a separate 21-cm broadband continuum survey from the line survey (Walterbos, Brinks, and Shane, in preparation). The interferometer spacings of 0-m and 18-m were Fourier filtered from the survey of M31 made by Cram, Roberts, and Whitehurst (1980) using the 100-m Effelsberg telescope. Finally, the five survey areas were combined to give in total 147 channel maps each covering M31 at 4.1 km s^{-1} velocity intervals. Figure 1 shows the total HI surface density map at full resolution. The noise varies across the map and increases rapidly at the extreme northern and southern ends. The HI emission is concentrated in a ring at about 10 kpc. This main ring coincides with the ring of radio continuum radiation, of HII-regions, OB-associations, etc. The HI is also strongly correlated with dust. Due to its unfavourable inclination, no firm statements can as yet be made about the spiral structure of M31, although it is possible to trace over several kpc arm segments.

Figure 2 shows isovelocity contours based on the *mean* velocities superimposed on the total surface density map. Because of the presence of two or more velocity components in the line of sight, this mean velocity map should be interpreted cautiously. This map shows simply the HI-intensity

E. Athanassoula (ed.), Internal Kinematics and Dynamics of Galaxies, 23–26.

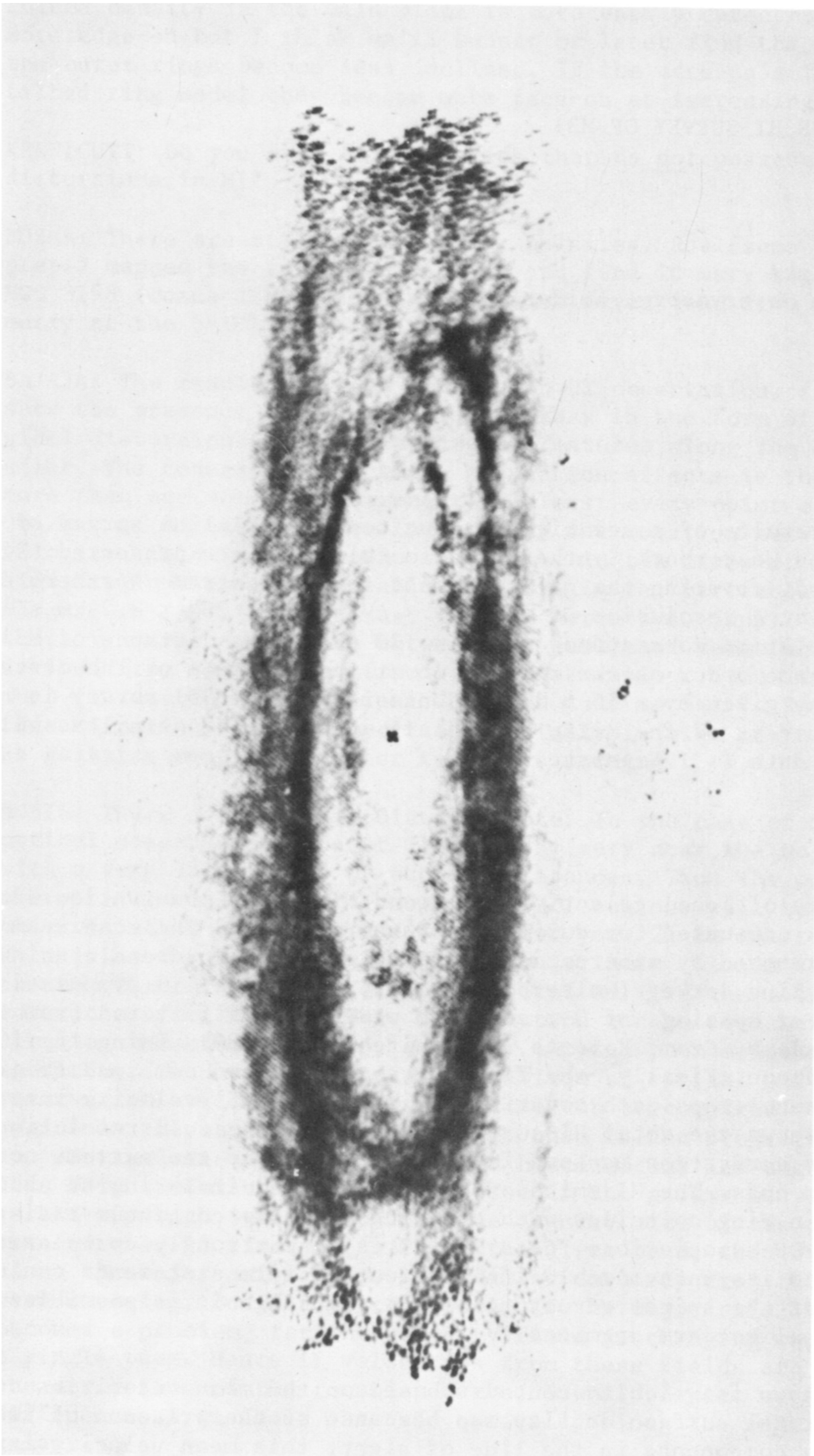

Figure 1: Total HI surface density map at full resolution. The cross indicates the nucleus. North is to the left.

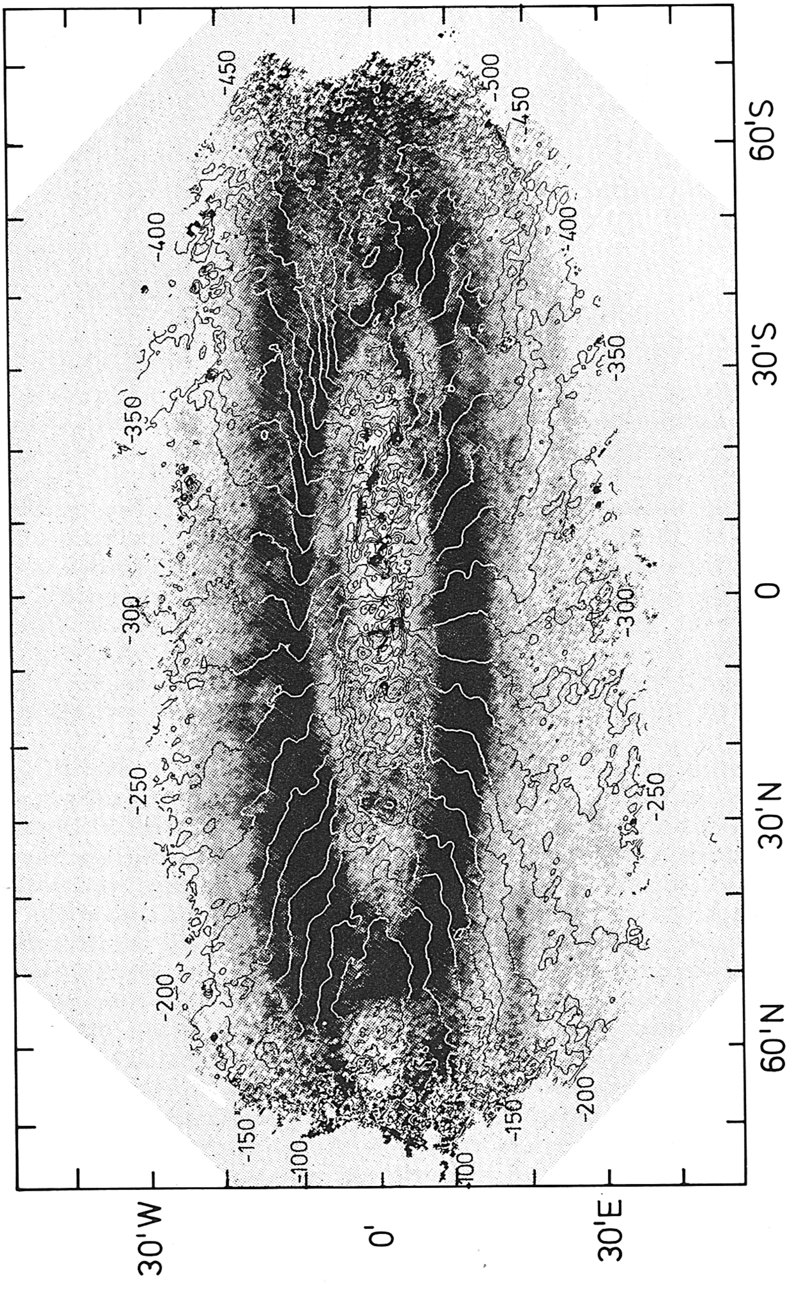

Figure 2: Total HI surface density map at full resolution with the mean velocity field, obtained after smoothing the data to twice the beam, superimposed. Iso-velocity contours are drawn at 25 km s^{-1} intervals.

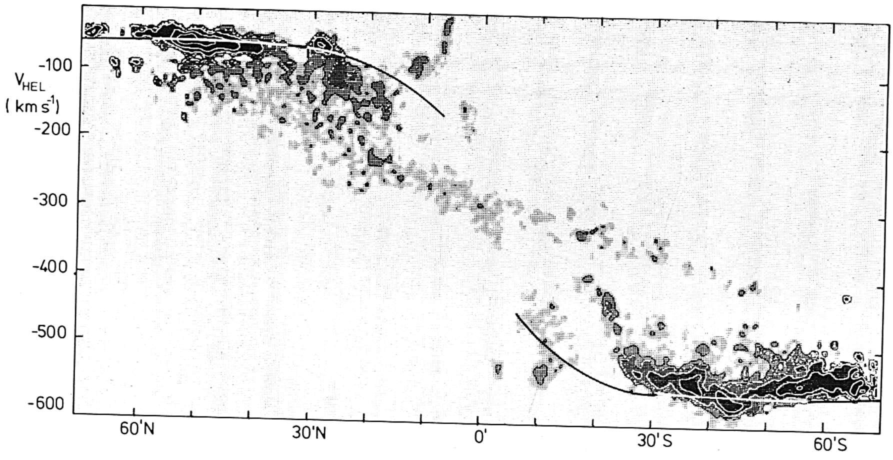

Figure 3: Position-velocity map along the major axis. Contour levels are 2.5, 5, 10 and 25 K. The thick line is based on the mean rotation curve used by Bajaja and Shane (1982).

weighted mean velocity at each position of M31, after smoothing to twice the original beamsize. The isovelocity contours show the signature of a differentially rotating disk, although there are marked deviations from pure circular rotation. Indications of streaming motion in the gas are present on both the near and the far, i.e. South East, side of the galaxy. The strong deviations on the North-West side, corresponding to the dust arm at a distance of 5 kpc from the nucleus, agree with the findings of Bajaja and Shane (1982) based on previous, rather incomplete, observations of the central area.

Figure 3 shows a position velocity map made along the major axis of M31. The map gives a first order approximation of the rotation curve. The thick line is a rotation curve based on previous HI data. The map shows that the kinematics of M31 is far from simple. At least three subsystems can be recognized in this and similar plots. In addition to the differentially rotating disk, which follows roughly the drawn line, there is a second component present across the whole galaxy. This component shows up as an almost straight line running diagonally across the map. It is attributed to warping of the outer part of M31 into the line of sight. The third subsystem is restricted to the central 4-5 kpc, where velocities as high as 200 km s^{-1} with respect to systemic velocity are found. This inner part of M31 is discussed in a separate contribution in this volume.

REFERENCES

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Walterbos, R.A.M., Brinks, E., Shane, W.W.: in preparation