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Kinematics of the Circumnuclear Region of M 100

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Abstract.

Circumnuclear regions of barred galaxies can host ring-like regions of enhanced star formation, thought to be related to the position of one or more Inner Lindblad resonance(s). Here we present kinematic observations and modelling of one such region, namely in the barred galaxy M100. The observations and modelling agree qualitatively and quantitatively, and support the idea that the circumnuclear structure forms an integral part of the dynamical structure of this galaxy.

1. Introduction

Most galaxies are barred (e.g. Knapen 1999) and many barred galaxies have rings, which can be classified into three broad categories: nuclear, inner and outer rings (see Buta & Combes 1996; Buta 2000 for reviews). We concentrate on nuclear rings, which appear on scales of less than or of order one kpc in the circumnuclear regions (CNRs) of many barred galaxies (see reviews by Knapen 1999; Shlosman 1999). In particular, we present kinematic data of the core of the barred galaxy M100 as obtained through Hα Fabry-Pérot imaging, in comparison with our previous modelling (Knapen 1995a,b).

2. Observations and Results

We used the TAURUS II instrument in Fabry-Pérot (FP) mode on the 4.2m William Herschel Telescope on La Palma to make two-dimensional kinematic observations in the Hα line of the CNR of M100. The $\sim$ 0.″7 seeing was well sampled with 0.″28 pixels. Wavelength and phase calibration were done by observing a calibration lamp before and after each science exposure, and we corrected the raw data set using the TAUCAL software package to produce a cube containing a series of spatial maps at increasing wavelength, thus velocity.

After determining which channels of the data set were free of Hα line emission, we used those channels to determine and subtract the continuum emission. The results of a moment analysis are shown in Fig. 1, namely the moment zero (Hα total intensity) and moment one maps (velocity field). The total intensity Hα map is comparable in quality to the narrow-band Hα image published by Knapen et al. (1995a), with an estimated spatial resolution of 0.″6 – 0.″7. This image shows clearly that the star formation within the CNR is organised into

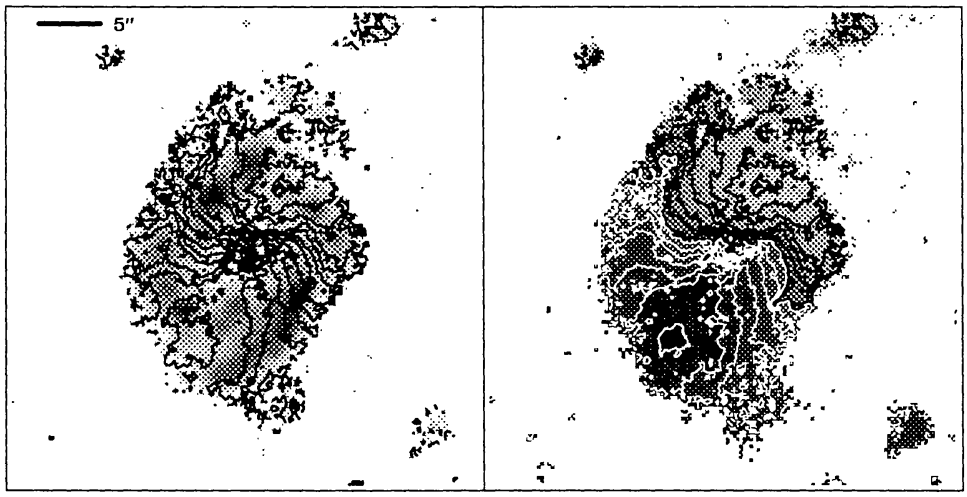

Figure 1. Hα FP moment maps of the central region of M100: the velocity field is shown in contours and overlaid on the total intensity Hα image (left, *a.*), and on the velocity field itself (right, *b.*). Contours are separated by 15 $\mathrm{km\,s^{-1}}$, from 1480 $\mathrm{km\,s^{-1}}$ to 1675 $\mathrm{km\,s^{-1}}$. Black contours in right panel are low velocities, the first white contour is at 1585 $\mathrm{km\,s^{-1}}$. N is up, E to the left.

spiral arm fragments (Knapen et al. 1995a,b). The velocity field shows strong deviations from circular motion, and by relating the positions where these deviations take place to the total intensity map, it is clear that they are due to streaming motions in the spiral arms, and to a lesser extent, to gas streaming along the inner part of the bar (see Knapen et al. 2000 for more details). This confirms kinematically that the spiral armlets are density wave spiral arms, and that the elongation in the NIR isophotes as reported before (Knapen et al. 1995a,b) is in fact due to a bar.

We used our velocity field to further study the circular and non-circular motions by fitting a rotation curve to the data, producing a 2-dimensional model velocity field from it, and subtracting that model from the observed velocity field (Fig. 2). The result (Fig. 2c) confirms that the strongest deviations from circular motion are found in the areas where the spiral arms and inner bar are located.

3. Comparison with modelling and conclusions

To make a detailed kinematic comparison with the new Hα FP data, we produced a velocity field from our dynamical model of the CNR of M100 (Knapen et al. 1995b), which was made before detailed kinematic data was available. The result of that comparison is shown in Fig. 3. The qualitative and quantitative agreement between the model and Hα velocity fields, as shown in the Figure, is in excellent agreement with, and further confirms, our interpretation of the CNR in terms of a resonance region driven by one bar, dissected by the ring-like region which houses the star-forming spiral armlets.

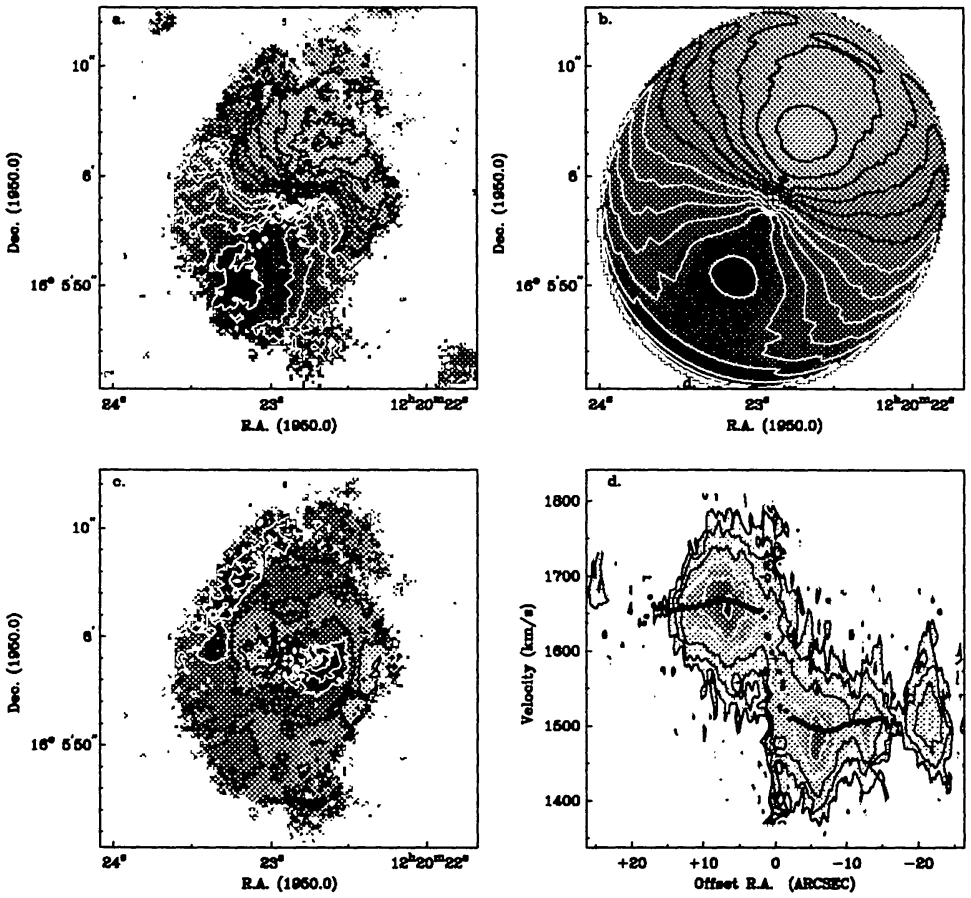

Figure 2. *a.* (upper left) Hα velocity field of the circumnuclear region of M100 at full (better than 1″) resolution. Contour levels are as in Fig. 1b. Grayscales indicate roughly the same range in velocities. *b.* (upper right) Model velocity field as determined from the rotation curve (see text). Contour and gray levels as in Fig. 2a. *c.* (lower left) Residual velocity map, obtained by subtracting the model (Fig. 11b) from the velocity field (Fig. 2a). Contours are at $-28, -20, -12$ and -4 km s^{-1}(black) and 4, 12, 20 and 28 km s^{-1} (white), with grayscales indicating a similar range and higher values coded darker. *d.* (lower right) Position-velocity diagram along the major axis ($\phi = 153°$) of the Hα FP data set. Contour levels are at approximately -2σ (dashed), 2, 4, 8 (black), 16, 32, and 64σ (white). Overlaid (white dots) is the rotation curve for the whole disc at the same resolution. The cross marks the kinematic centre.

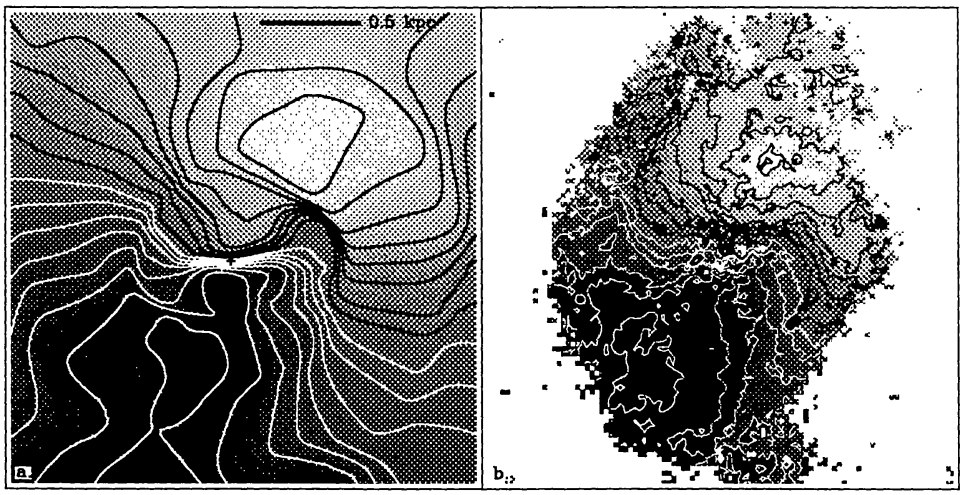

Figure 3. Left panel (*a.*): Gas velocity field as derived from the numerical model of Knapen et al. (1995b). Contour separation is $15\,\mathrm{km\,s^{-1}}$, and the scale is indicated in the top right hand corner. N is up, E to the right. The position angle of the major axis is as in M100. Resolution is comparable to our Hα data. Right panel (*b.*): For comparison, Hα velocity field of Fig. 1 at the same scale and orientation, and with the same contour separation. From Knapen et al. (2000).

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