Barred Galaxies
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A Search for Symmetries in the Star Formation Patterns of Spiral Disks: Barred Galaxies

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Abstract. The Hα brightness distribution of a face-on galaxy is a classical representation of the massive star formation rate per unit surface area. Here, we present a test for the degree of symmetry in this distribution, aimed at deciding whether this parameter shows a significant difference between barred and non-barred galaxies. The test consists in deriving the cross-correlation function of the Hα brightness as a function of curvilinear distance along pairs of opposed arms. In order to use the test, we first apply a geometrical unfolding technique. Here we explain this technique, and present the initial results of applying the test to NGC 157 and NGC 6764.

1. Introduction

The existence of star formation patterns along arms of some spiral galaxies has recently been confirmed (e.g. Knapen et al. 1992). Such patterns may be caused by spiral density waves.

The global form of the spiral arms of grand-design spiral galaxies is usually bi-symmetric both in optical continuum and in radio, but studying the distribution of the star formation (through Hα) along the arms we find that whereas in some galaxies this is symmetric in both arms (e.g. M51; Knapen et al. 1992), it is not, nor it is even anti-symmetric, in others (e.g. M100; Knapen et al. 1995).

Such symmetries in Hα have been studied in a preliminary way in a small number of grand-design spiral galaxies (Knapen 1992), leading to a possible correlation between the *absence* of symmetry in Hα along the arms and the *presence* of a bar in the galaxy. If confirmed, this would imply that the star formation along the arms is modulated in different ways in barred and non-barred spirals.

Here we present a newly developed test to measure the degree of symmetry in the Hα distribution, which we plan to apply to a sample of barred and non-barred galaxies. We also present preliminary results for two barred galaxies: NGC 157 and NGC 6764. We used the Hα continuum-subtracted images described in detail by Rozas, Beckman & Knapen (1995).

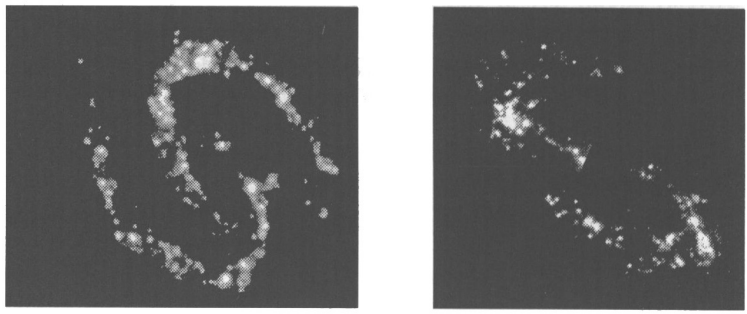

Figure 1. Arm-only images of NGC 157 (left) and NGC 6764 (right). The arm shape has been defined comparing the continuum and Hα images of the galaxies.

2. Procedure

- First, we interactively eliminate all inter-arm regions from the galaxy images, thus producing an image with only the spiral arms (Figure 1).
- We correct the curvature of the arms, and sum the Hα emission perpendicular to the length direction of the arm. This gives a one-dimensional Hα profile *along* the arm (Figure 2a, b).
- Finally, we determine the linear correlation between the distribution of Hα emission along the two arms, and the cross-correlation between the reconstructed arm-only images. The values of these correlations would be unity in the case of perfect correlation, and zero in the case of perfect anti-correlation (Figure 2c).

3. Conclusions

- From the preliminary study of the two galaxies presented here, we see that the symmetry in Hα is enhanced near the ends of the bar, where two regions of strong star formation are located (near D = 100 pix in NGC 157, D = 150 pix in NGC 6764). But apart from these points, symmetry is mostly absent.
- We plan to use this method in the near future to analyze a sample of barred and non-barred galaxies to be able to answer the question whether in barred galaxies the symmetry in Hα along the spiral arms is less developed then in non-barred galaxies.
- Specifically, we can conclude the lack of symmetry in NGC 157, where most of the Hα peaks along one arm do not show a counterpart along the other arm.

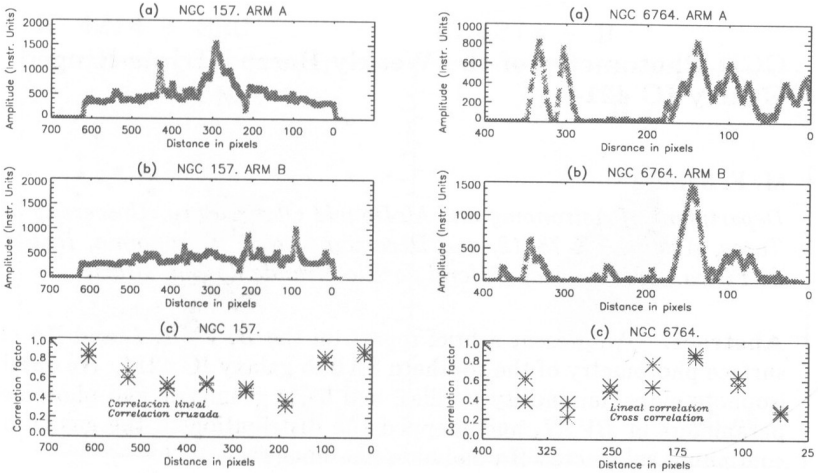

Figure 2. Hα luminosity profiles along the two main arms of NGC 6764 and NGC 157, showing Hα flux (instr. units) as a function of distance along the arms (pixels). The panels (c) show the values of the linear correlation between these two luminosity profiles (dotted asterisks), and the cross-correlation between the two images of the arms (solid asterisks) for distinct positions along the arms. Note that the centers of the galaxies are plotted on the right-hand sides.

- NGC 6764 shows higher correlation coefficients, but the symmetry indicated by this may be at least partly caused by the presence of a foreground star with residual Hα emission (near D = 300 pix in arm A).

References

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