FOURIER ANALYSIS OF SPIRAL TRACERS. A PROGRESS REPORT.

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Fourier analysis of the observed distribution of spiral tracers (e.g. HII regions) can yield a wealth of information about the spiral structure of a given galaxy. A description of the method has been given by Kalnajs (1975) and, in brief, involves decomposing the observed distribution into components with given angular periodicity m. Component m = 0 corresponds to the axisymmetric part, m = 1 to either a one-armed spiral or an asymmetry, m = 2 to a spiral or a bar, etc. Each component is then analysed into a superposition of logarithmic spirals. This does not imply that the observed spirals are assumed to be logarithmic, but rather that logarithmic spirals are convenient building blocks.

We have set out to apply this method to a sufficiently large number of galaxies to permit a statistical treatment. The database for this type of study has been successfully accumulated by various astronomers over many years. There are approximately 50 galaxies with sufficiently complete catalogues of HII regions to permit a Fourier analysis (see Hodge 1982 for a compilation of the existing literature). To this already long list should be added the available information on other spiral tracers. For instance Iye (this volume) has applied it to V-band plates.

There are many interesting applications of this study. Norman (this volume) has noted its relevance for theoretical models. Correlations of various properties of the spiral arms like angular periodicity, pitch angle or maximum amplitude with Hubble type and luminosity class could help towards a more quantitative classification of galaxies. Correlations with observational parameters that influence the dynamics of the galaxy (e.g. the form of the rotation curve) could provide constraints for theoretical studies. The influence of observational constraints (Kormendy and Norman 1979) and of the environment (Elmegreen and Elmegreen 1982) can be made more quantitative. Finally it would be interesting to compare the spiral structures of various tracers in the same galaxy.

We have made only a very small first step in this long-term project. We have tested our method on four galaxies (Considère and Athanassoula 1982). The first two,M51 and M33, were chosen to test the method.

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Indeed in M51 we found the well-known two-armed spiral in addition to the observed N-S asymmetry. The inner 15' of M33 revealed a clear m = 2 component of which the southern arm shows both better fit and better continuity than the northern one. Thus these results gave us confidence in the method but, at the same time, brought forth the problem of choosing the orientation parameters (see Considère and Athanassoula 1982 and Bosma, this volume for a discussion). However, there could be no particular merit to the method if it only found already obvious results. Thus the two other galaxies chosen, NGC 2997 and M31, were more controversial. In NGC 2997 we found both an m = 2 component and a, somewhat weaker, m = 3. Note that m = 3 is a favoured periodicity when the percentage of halo mass is large (Toomre 1981). For M31 we too found the one-armed leading spiral first proposed by Kalnajs (1975). In addition we delineated a faint two-armed leading pattern for 45' < r < 60' and a faint two-armed trailing one for r > 65'. In all four galaxies we found that few components can very well represent the observed distribution. The sum of these components defines an area of some 15-35 % of the galaxy surface (within a radius defined by the outermost region) which contains 75-90 % of the observed HII regions.

The analysis of several more galaxies is underway.

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