Can Cluster Environment Modify the Dynamical Evolution of Spiral Galaxies ?

P. Amram[1], C. Balkowski[2], V. Cayatte[2], M. Marcelin[1], W. T. Sullivan III[3]

[1] Observatoire de Marseille, France
[2] Observatoire de Paris-Meudon, France
[3] Dept. of Astronomy, Universtiy of Washington, USA

N93-26880

Over the past decade many effects of the cluster environment on member galaxies have been established. These effects are manifest in the amount and distribution of gas in cluster spirals, the luminosity and light distributions within galaxies, and the segregation of morphological types. All these effects could indicate a specific dynamical evolution for galaxies in clusters.

Nevertheless, a more direct evidence, such as a different mass distribution for spiral galaxies in clusters and in the field, is not yet clearly established. Indeed, Rubin, Whitmore and Ford (1988) and Whitmore, Forbes and Rubin (1988) (hereafter collectively referred to as RWF) presented evidence that inner cluster spirals have falling rotation curves, unlike those of outer cluster spirals or the great majority of field spirals. If falling rotation curves exist in centers of clusters, as argued by RWF, it would suggest that dark matter halos were absent from cluster spirals, either because the halos had become stripped by interactions with other galaxies or with an intracluster medium, or because the halos had never formed in the first place. Even if they didn't disagree with RWF, Distefano et al (1990) pointed out that the behaviour of the slope of the rotation curves of spiral galaxies (in Virgo) is not so clear. Amram et al. (1992) using a different sample of spiral galaxies in clusters found only 10% of declining rotation curves (2 declining vs 17 flat or rising) in opposition to RWF who find about 40% of declining rotation curves in their sample (6 declining vs 10 flat or rising), we will hereafter briefly discuss the Amram et al. (1992) data paper and compare it to the results of RWF.

We have measured the rotation curves for a sample of 21 spiral galaxies in 5 nearby clusters. These rotation curves have been constructed from detailed two-dimensional maps of each galaxy's velocity field as traced by emission from the Hα line. This complete mapping, combined with the sensitivity of our CFHT 3.60 m.+ Perot-Fabry + CCD observations, allows the construction of high-quality rotation curves. Details concerning the acquisition and reduction procedures of the data are given in Amram et al. (1992). We will now present and discuss our preliminary analysis and compare them with RWF's results.

Following RWF, we characterize the slope of a rotation curve with reference to fiducial points defined relative to the optical radius R_{25}. The "outer gradient" (OG) is the change in rotation velocity between 0.4 and 0.8 R_{25}, normalized to the maximun measured velocity and expressed as a percentage. RWF presented evidence for falling rotation curves in the central regions of clusters, as well as for a marked correlation between OG and r_{cl}, the projected distance of each galaxy from its cluster center. In the figure we present the same plot for our sample; it can been seen that the correlation is not significative. This holds for our sample whether or not we confine ourselves to our 12 galaxies of hightest quality (black dots), or include 9 other galaxies that are questionable (crosses and plus).

The reasons for this discrepancy with RWF probably arise in three distinct arguments : 1) the samples are different, 2) the technics are different and 3) the criteria of selection are different :

1) The RWF's sample contains much more galaxies who are closer to the centers of the clusters. In particular, 2 galaxies located in DC 1842-63 cluster having strong negative value of OG (-26% and -18%) tend to strength the RWF's correlation between r_{cl} and OG. In an other hand, among the 6 galaxies in common, for 2 galaxies (NGC 6045 and UGC 4329) very close from the cluster center, the values of OG disagree. So the other reason for the discrepancy could be the observational technics.

2) Our rotation curves are based on the entire velocity field, as opposed to RWF's data from a 1 arcsec-wide slit along the major axis, for which the emission in the rest of the disk is

PRECEDING PAGE BLANK NOT FILMED

ignored (the local non-circular movement are not distinguable from the circular ones and furthermore not taken into account in the rotation curve) and for which gaps in line-emitting gas along the major axis could cause problems. As a consequence of the 2-dimensional field, the deprojection parameters (inclination, position of the dynamical major axis,...) are derived from the dynamics itself. Moreover, the Perot-Fabry + CCD technics is more sensitive than a traditional spectrograph + image tube and photographic plate; for example, this allowed us to measure rotation velocities typically 15 to 30 % father out from the nucleus than RWF and the shape of the rotation curve is computed with much more velocity points.

3) In our plot we have eliminated doubfull galaxies (highly inclined galaxies, galaxies with companion or peculiar, extrapolated rotation curves, ...) and RWF didn't.

We have found no biases in our sample in luminosity, morphological type, size or HI content that might affect our main result of no significant environmental effect. WFR also found that M/L rose much more weakly for galaxies in the inner regions of clusters. They presented this as further strong evidence in favor of a lack of dark halos around inner galaxies. The surface brightness photometry of 10 of our galaxies is being reduced. We have also in preparation a new data paper containing 15 more rotation curves in 2 other clusters which will increase the confidence we have in our result.

REFERENCES

Amram, P., Le Coarer, E., Marcelin, M., Balkowski, C., Sullivan, W.T., III and Cayatte, V. 1992, Astron. Astrophys. Suppl. Ser 1992, 94, 175

Distefano, A., Rampazzo, R., Chincarini, G. and de Souza, R. 1990, Astron. Astrophys. Suppl., 86, 7

Rubin, V.C., Whitmore, B.C. and Ford, W.K.,JR. 1988, Ap. J., 333, 522

Whitmore, B.C., Forbes, D.A. and Rubin, V.C. 1988, Ap. J., 333, 542

Figure. *Outer gradient OG for each galaxy versus its projected radius from its cluster center. Three samples are distinguished : sample 1 (the best quality data) with filled circles and a last-square linear fit (solid line), sample 2 (inclination > 65°) represented by a "x" and sample 3 (questionable due to the presence of companion galaxies, evidence for non-circular motions, or rotation data requiring extrapolation) represented by a "+". The dash-dot-dash line shows the fit published by RWF.*