

CLASSIFICATION OF SPIRAL GALAXIES ON THE BASIS OF ABSOLUTE MAGNITUDE

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ABSTRACT

A sample of 164 Northern spiral galaxies is studied in context of their luminosity profile. The rotation curves and physical parameters of galaxies are available in literature, which are used in present study. It is well known that the galaxy rotation curve completely dominated by luminous matter. A physical parameter 'absolute magnitude' gives information about the luminosity of galaxy. In present study absolute magnitudes of galaxies are used as a tool to reveal the structure of galaxy.

Keywords: *Absolute magnitude, Galaxy rotation curve, luminous matter and spiral galaxy*

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INTRODUCTION

According to our present understanding in field of Astrophysics, galaxies are building blocks of our Universe. Many ways are followed to group the galaxies. These are biased on their structure, physical parameters and time of evolution. The first categorization was proposed by Edwin Hubble in 1935 called Hubble Morphological distribution of galaxies. In 1970s and 80s a hard working astronomer Vera Rubin published many papers individually and with astronomers of that time like M. Persic, P. Soluci. In these papers there is categorization is based on one of the physical parameters known absolute magnitude of galaxy. In the present paper author is following technique of Vera Rubin and collaborators as fundamental tool with some modification to categorize a sample of 164 Northern spiral galaxies. The galaxies of sample are further divided into eight groups on the basis of their absolute magnitude. Normalized rotational velocity (V/V_{opt}) and radial position (R/R_{opt}) of each galaxy in a group are merged together and average of (V/V_{opt} , R/R_{opt}) data point is taken to plot the rotation curve of the particular group of galaxies. Finally, Averaged co-added rotation curve is plotted by taking V/V_{opt} at y-axis and R/R_{opt} at x-axis. This analysis shows that the rotation curves of lowest absolute magnitude have higher rotational velocity and as absolute magnitude increases, the value of rotational velocity of test particles in galaxies decreases. For galaxy having absolute magnitude between any two groups, its rotation curve should lie between the rotation curves of these groups.

SAMPLE SELECTION

In present work, we are working with rotation curve data-base of northern sky spiral galaxies. The (V, R) data of rotation curves are reproduced using software “Get-Data” for the purpose of present work. The absolute-magnitude data of northern sky spiral galaxies are collected from an online database; Hypercat Lyon/Meudon Extragalactic. Maximum radius and maximum velocity of sampled galaxies are taken from CADC database curteau99.readme in 13th, 31st column respectively and tabulated in table 2 in column 2nd, 4th respectively. The sample includes 164

northern spiral galaxies, which belongs to different type of spiral galaxies and chosen on the basis of their $R_{\max} > R_{\text{opt}}$.

ANALYSIS ON THE BASIS OF ABSOLUTE MAGNITUDE

The sample includes 164 rotation curves of different galaxies. The galaxies of sample are further divided into eight groups on the basis of their absolute magnitude. The sample size with maximum and minimum absolute magnitude and average absolute magnitude of each group are tabulated in table 1. The rotational velocity and radial position data of each rotation curves are normalized by their optical velocity (V_{opt}) and optical radius (R_{opt}) respectively. Corresponding value of rotational velocity at optical radius (R_{opt}) is defined here as the optical velocity (V_{opt}). Normalized rotational velocity (V/V_{opt}) and radial position (R/R_{opt}) of each galaxy in a group are merged together and average of (V/V_{opt} , R/R_{opt}) data point is taken to plot the rotation curve of the particular group of galaxies. Finally, Averaged co-added rotation curve is plotted by taking V/V_{opt} at y-axis and R/R_{opt} at x-axis. This procedure is repeated for all the groups of sample. The plot V/V_{opt} vs R/R_{opt} of sample is shown.

Table 1: Distribution of absolute magnitude in sample

Group	Sample Size	Abs- M range		Average Abs m
1	6	-22.85	-22.3	-22.44
2	7	-22.05	-21.85	-21.92
3	32	-21.84	-21.36	-21.56
4	42	-21.34	-20.86	-21.11
5	39	-20.83	-20.36	-20.63
6	16	-20.33	-19.86	-20.11
7	18	-19.84	-19.37	-19.69
8	4	-19.19	-18.85	-18.97

Here, V/V_{opt} and R/R_{opt} is taken for each group, because all the galaxies in a group are not extended at same radius. Without taking V/V_{opt} and R/R_{opt} , it is not possible to average influence of each component (bulge, disc, spiral arm, bar and halo) on rotation curve of galaxy. The co-addition procedure averages over empirical properties of the galaxies like Hubble type, strength of budge, color, spiral design and presence or absence of bar. These graphs are plotted to show the variation in behavior of rotation curve of galaxy as absolute magnitude varies. It is clear from plot that the

galaxy of higher absolute magnitude shows rising rotation curve while galaxy of low absolute magnitude having a rising rotation curve up to a certain value ($R/R_{opt} = 0.3$) and then shows flat region. Co-added synthetic rotation curve between rotational velocity (V) and R/R_{opt} plotted for each group of galaxy. These averaged co-added synthetic rotation curves of each group are merged together to compare the difference between them. These plots show that as the absolute magnitude decreases, velocity increases, which confirm a well known previous finding; luminosity dictates the shape of the rotation curve (rotation dynamics of galaxy).

SAMPLE

In sample of 164 spiral galaxies are taken. The rotation curves of these galaxies are divided into 8 groups on the basis of absolute magnitudes of the galaxies. For each of the group, V vs R/R_{opt} and V/V_{opt} vs R/R_{opt} graphs are plotted. The averaged co-added V vs R/R_{opt} plots of each group are merged together in figure 1. V/V_{opt} vs R/R_{opt} graphs of each group are plotted separately in figure 2.

Table 2: Averaged value different physical parameters of each group

Group	vmax	vopt	rmaxkpc	Ropt	hkpc	2.2h	Abs m
1	279.0084	274.9667	28.973	24.064	7.52	16.544	-22.44
2	227.5786	226.05	20.78	18.066	5.64	12.42057	-21.92
3	203.3625	194.4282	20.176	15.743	4.91	10.82331	-21.56
4	198.675	195.3691	17.890	14.640	4.57	10.06552	-21.11
5	177.3731	173.6359	15.820	12.974	4.05	8.920154	-20.63
6	150.7063	146.6594	10.937	8.926	2.78	6.136625	-20.11
7	146.1084	139.9084	10.065	7.5751	2.36	5.207889	-19.69
8	126.9125	117.9375	6.262	4.624	1.44	3.179	-18.97

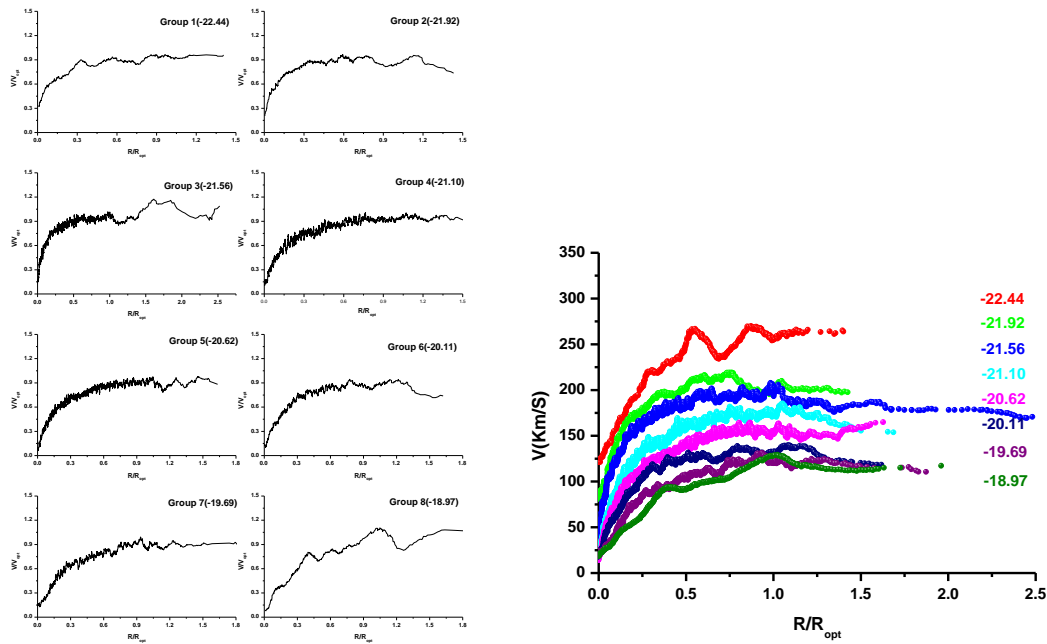


Figure 1: (a) RCs (V/V_{opt} vs R/R_{opt}) of each group of sample-A distributed according to absolute magnitude. (b) RC is plotted between Velocity and R/R_{opt} .

CONCLUSION

The galaxies of sample are classified into eight groups. It contains 164 galaxies having maximum radius greater than optical radius. A graph is plotted between averaged velocity verses normalized radius (R/R_{opt}) for each group. The plot between velocities verses R/R_{opt} of each group are merged together. It is clear from the above graph that the synthetic rotation curves of each class show plateau region which starts from 0.25times of normalized radius (R/R_{opt}). It indicate that in the inner part of galaxies, the mass distribution is nearly spherical and after that the mass distribution take a disk shape, plateau region of the galaxy shows nearly uniform mass distribution up to a certain extend. All synthetic rotation curves are extended upto at least 1.5times of normalized radius and some groups are extended up to twice of R/R_{opt} or more it. This analysis shows that the rotation curves of lowest absolute magnitude have higher rotational velocity and as absolute magnitude increases, the value of rotational velocity of test particles in galaxies decreases. For galaxy having absolute magnitude between any two groups, its rotation curve should lie between the rotation curves of these groups. In figure 2 synthetic rotation curves of each group are presented. It is clear from the graph that rotation curves of galaxy of low

absolute magnitude are flat and as absolute magnitude increases the rotation curves show rising attitude. It is well known that the value of rotational velocity is a measure of mass of galaxy; hence the large rotational velocity is signature of massive galaxy.

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