THE DYNAMICS OF EMISSION-LINE GALAXIES FROM NEW FABRY-PEROT OBSERVATIONS

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Abstract Intense star formation (SF) and starbursts (SBs) manifest themselves in emission-line spectra. Although merging and interactions are widely accepted as a trigger for SBs, it is still unclear to what extent these factors play a role and what other aspects are important. Measuring the internal motions in galaxies can, in combination with other diagnostics, contribute to our understanding of SB triggers. Here, we present recent observations of a complete sample of emission-line galaxies, using the Hα emission line to determine the internal dynamics of the targets. Masses are estimated, assuming Keplerian motions.

1. Introduction

Studying the dynamics of galaxies has a long history and has put forth many important results, including the evidence for dark matter. However, spatially resolved information about radial velocities on objects of small angular size is scarce. However, compact objects comprise interesting targets, e.g., Blue Compact Galaxies (BCGs) and dwarf galaxies. The former have received great attention due to their young and intense starburst (see Kunth & Östlin [2000] for a review), and the understanding of the latter is important for the larger context of galaxy formation. Östlin et al. (1999, 2001) have conducted a study of luminous BCGs, using the Fabry-Perot interferometer CIGALE (see Amram et al. [1991] for a description) to obtain radial velocities of the ISM from the Hα emission line. In many cases, they found complex velocity fields, which is in concordance with other findings, namely that merging may play a role in the triggering of a starburst, even though it may not be the only prerequisite. In order to put the results onto a broader basis, we selected a volume-limited sample and obtained Hα velocity fields, using an improved version of the CIGALE instrument. In Section 2, we present the sample and our observations, Section

3 shows some preliminary results and Section 4 discusses them and outlines the work to be done in the near future.

2. Sample Selection and Observations

In 2000, the initial sample of Östlin et al. (1999) was extended to nearly 20 BCGs of different subtypes (Östlin et al. 2005, in prep.). Nevertheless, the selection criteria (usually UV excess, strong emission lines) for archetypal BCGs were not quantitative and although the sample contained objects with lower luminosities, it was still dominated by luminous objects (median of $M_B = -18$). Therefore, fainter Blue Compact Dwarfs (BCDs) needed more attention and a well-defined sample had to be set up.

20 galaxies have been selected from the 5th list of the University of Michigan (UM) survey, including all objects up to a radial velocity of $v = 2500$ km s^{-1}. No other selection criteria were applied and the cut-off in v ensures good completeness (Salzer 1989). Apart from the two large spiral galaxies with nuclear star formation (SBN: starburst nucleus), the sample consists of galaxies with luminosities:$-12.8 < M_B < -16.3$, and is dominated by high-excitation objects with blue colours. The low mean luminosity is of course a consequence of the higher intrinsic space density of low luminosity systems, and thus adds the low-luminosity end to our previous investigations of luminous BCGs.

The sample was observed with CIGALE on the ESO 3.6m telescope in April 2004 during 3 nights under good conditions. The pixel size of CIGLALE's photon counting system is 0.41 arcsec pix^{-1}, and Table 1 lists the other important parameters of the observations, together with the galaxies' properties from the literature.

The data were reduced using the ADHOC software, dedicated for data reduction of CIGALE. Maps of continuum flux near the Hα line, of the monochromatic Hα flux, of the radial velocities (the velocity field) and position-velocity (PV) diagrams were presented in the conference poster. Fig. 1 shows these for UM523 as an example.

Due to space limitations, the reader is referred to the electronic version of the poster for the figures of the other galaxies (included in these proceedings or obtainable from http://thomasmarquart.net/bcg/cambr_poster.pdf).

3. Preliminary Results

To obtain a rough estimate of the dynamical mass of each object, a very simple approach is chosen, namely plugging in half of the maximum difference in velocity and half of the spatial difference that lies between the chosen velocity points into Kepler's laws: $M(R) = \frac{v^2 R}{G}$. Since it is difficult to choose an inclination for many of the objects, no correction for inclination has been applied and therefore all masses have to be treated as lower limits. Furthermore,

Table 1. The volume-limited sample of emission line galaxies. The left half lists general properties of the targets. In the right half, the free spectral range (FSR, equivalent to the spectral coverage) is given, together with the number of channels into which the FSR is divided, and the exposure time per channel.

Name	type[b]	v (km s^{-1})	M_B^a (mag)	FSR (km s^{-1})	# chan	s chan^{-1}
UM422	SS	1592	-13.8	156	48	90
UM439	DHIIH	1099	-15.7	378	24	180
UM446	SS	1802	-15.1	378	24	200
UM452	DHIIH	1435	-15.8	156	48	90
UM456	DHIIH	1760	-16.3	378	24	160
UM461	SS	1044	-14.3	156	48	90
UM462	DHIIH	1050	-16.1	156	48	75
UM463	SS	1300	-13.3	156	48	75
UM465	DANS	1125	-16.7	378	24	160
UM477	SBN	1326	-18.8	378	24	160
UM483	DHIIH	2320	-16.5	378	24	160
UM491	DHIIH	1975	-16.2	378	24	160
UM499	SBN	2145	-19.0	378	24	160
UM500	SS	2030	-14.1	156	48	90
UM501	MI	2025	-15.6	378	24	200
UM504	DHIIH	2076	-15.7	378	24	120
UM523	IP	921	-15.9	378	24	180
UM533	MI	880	-15.5	156	48	90
UM538	SS	1050	-13.0	378	24	140
UM559	SS	1245	-13.1	378	24	200

[a] according to Salzer et al. (1989), using $H_0 = 75$ km s^{-1} Mpc^{-1}; [b] see Salzer (1989) for the key to the classification

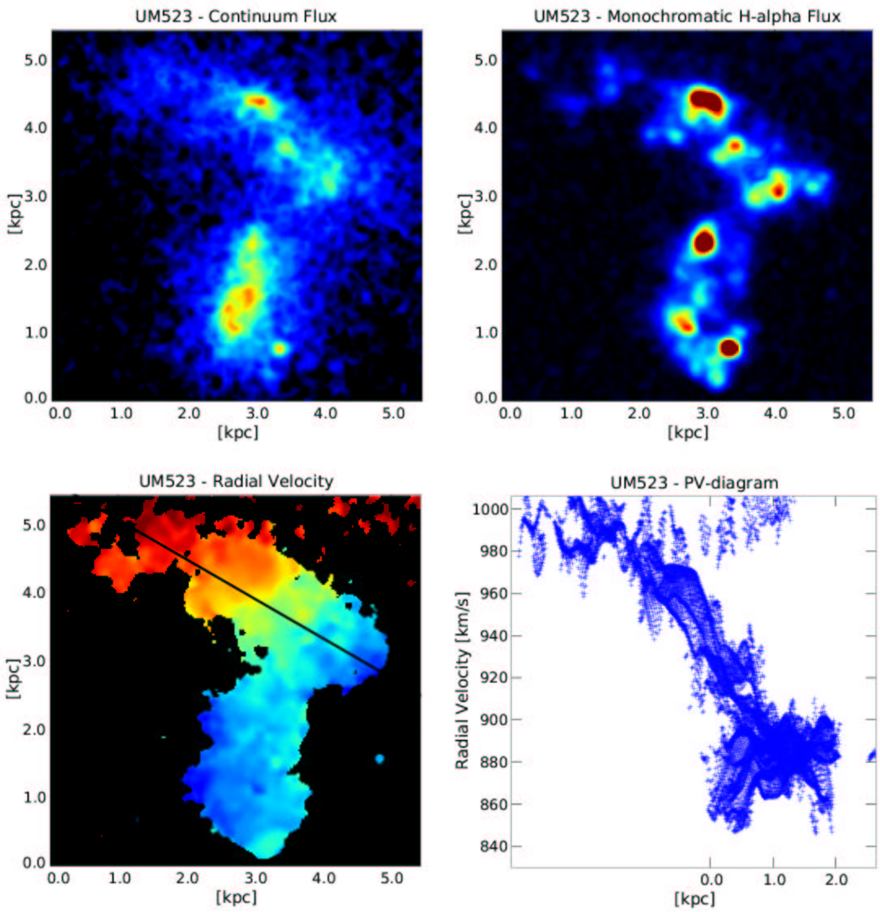

Figure 1. UM523 – *Top left:* continuum image (near the Hα line). *Top right:* map of the monochromatic flux of the Hα line. *Bottom left:* map of the the line-of-sight velocity (the velocity field). *Bottom right:* position-velocity (PV) diagram, derived along the axis indicated in the velocity field.

this approach of course neglects all effects that are not Keplerian motion, like infall or outflow of gas, or non-relaxed motions due to interactions or merging. Additionally, a low value of the dynamical mass may simply mean that the system is not rotationally supported, but by velocity dispersion instead. Figure 2 shows how the derived masses correlate with the absolute B magnitude.

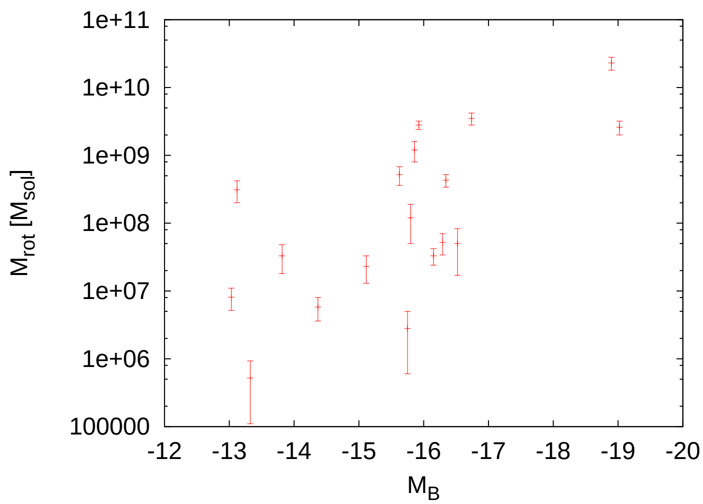

Figure 2. Derived rotational mass plotted against absolute B-band magnitude (Salzer et al. 1989; using $H_0 = 75$ km s^{-1} Mpc^{-1}).

We have obtained our own deep photometry for the sample and we expect the scatter to reduce significantly once the measured luminosity matches exactly the region in which the dynamics are measured. In addition, the contribution from the velocity dispersion has not yet been taken into account.

4. Discussion and Future Prospects

The obvious next task is to investigate the line width of the Hα line throughout these galaxies. Östlin et al. (2001) found already in the first sample that rotation cannot account alone for the stability of many of the systems and therefore the mass derived from the velocity dispersion has to be added to the one from rotation.

The line shape yields additional information. Double or asymmetric profiles hold clues about uncoupled dynamical components and infall or outflow of gas. Modelling of both the line shapes and the velocity fields will answer the question whether these can be understood with strongly simplified physical scenarios (e.g., rotation plus global outflow).

Deep photometry from the U to the K band has been or will be obtained, to model the stellar populations and to derive an M/L ratio that can be used to obtain the photometric masses of these galaxies, which can then be compared to the masses from the dynamical analysis. Thus we will be able to estimate the dark matter content.

Comparing the motion of the gas with that of the stars in the galaxies is an important test of whether the ISM dynamics really can be used to derive masses, as is often assumed. Especially in systems of relatively low mass, feedback from supernova winds could invalidate this assumption. Östlin et al. (2004) have piloted a study of the CaII triplet of absorption lines and spatially-resolved data from integral-field spectroscopy is underway. The direct comparison of the stellar to the Hα velocity fields will answer the above question.

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