View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

provided by Caltech Authors - Main

Up2010: Have Observations Revealed a Variable Upper End of the Initial Mass Function?
ASP Conference Series, Vol. 440
Marie Treyer, Ted K. Wyder, James D. Neill, Mark Seibert, and Janice C. Lee, eds.
©2011 Astronomical Society of the Pacific

Hα and UV imaging of Low Surface Brightness Galaxies and Extended UV Disks

Ted K. Wyder[1] and Marie A. Treyer[1,2]

[1]*California Institute of Technology, MC 278-17, 1200 E. California Blvd., Pasadena, CA 91125, USA*

[2] *Laboratoire d'Astrophysique de Marseille, 38 rue Frédéric Joliot-Curie, 13388 Marseille, France*

Abstract. GALEX observations have revealed UV emission extending far beyond the optical and H-alpha disks of several nearby spiral galaxies, raising the question of possible massive star deficiency, i.e., deviations from the standard 'universal' stellar initial mass function (IMF) at the upper end, in certain low density environments. We have undertaken an Hα imaging survey of low surface brightness galaxies observed by GALEX and with existing HI maps with the aim of investigating the variation of the Hα/UV ratio with the local density. Here we present preliminary results for 14 such galaxies observed with the Large Format Camera on the Palomar 200 inch telescope using custom narrow band filters.

1. Introduction

Although both Hα and UV emission from galaxies are indicators of the recent star formation rate, they are sensitive to different stellar mass ranges, and thus the Hα/UV ratio can provide constraints on the shape of the high mass end of the stellar initial mass function (IMF). Some recent studies have detected a drop in the Hα/UV ratio in nearby dwarf and low surface brightness (LSB) galaxies (Lee et al. 2009; Meurer et al. 2009) and in the outer regions of some, but not all, extended UV (XUV) disk galaxies (Thilker et al. 2005; Goddard et al. 2010).

In order to better understand whether this drop in the Hα/UV ratio seen in some XUV disks and LSB galaxies is a universal property of star formation at low density, we have begun a project to obtain Hα imaging of a sample of LSB galaxies as well as some XUV disks from the 200 inch at Palomar Observatory. Although rare, there are examples of giant LSB galaxies that are both luminous and very diffuse, and we have been careful to include in our sample LSB galaxies spanning a wide range of luminosities. We will thus be able to explore whether the variations in the Hα/UV are indeed primarily a function of surface brightness or luminosity. We present some preliminary results from this project here.

2. Observations

As a part of a study of the star formation law at low density, we compiled a list of LSB galaxies with both UV observations from *GALEX* and existing resolved HI maps in the literature (Wyder et al. 2009; van der Hulst et al. 1993; Pickering et al. 1997; de Blok et al. 1996). All of the galaxies have $\Sigma_{gas} < 10$ $M_\odot$ pc^{-2} and $\Sigma_{SFR} < 10^{-4}$ $M_\odot$ yr^{-1} kpc^{-2}.

We have obtained narrow band Hα images for 14 LSB galaxies plus an additional two XUV disks using the Large Format Camera (LFC) on the 200 inch telescope at Palomar Observatory. Table 1 summarizes the basic data taken from Wyder et al. (2009) for the subset of the galaxies with Hα images presented here. The SFRs listed assume the standard conversion factor between UV luminosity and SFR taken from Kennicutt (1998) for a Salpeter (1955) IMF extending from 0.1 to 100 $M_\odot$. The galaxies range in absolute magnitude from dwarfs such as LSBC D563-04 with $M_r = -17.8$ up to UGC 6614 with a total absolute magnitude of $M_r = -21.8$.

Table 1. LSB Galaxy Sample

Galaxy	M_r mag	$\mu_{r,1/2}$ mag arcsec^{-2}	SFR $M_\odot$ yr^{-1}	$\log \Sigma_{SFR}$ $M_\odot$ yr^{-1} kpc^{-2}
UGC 6614	−21.8	21.4	1.9	−3.7
UGC 5999	−18.4	23.8	0.3	−3.4
LSBC F568-1	−18.9	23.5	0.3	−3.4
LSBC F579-V1	−19.5	23.0	0.3	−3.6
LSBC D563-04	−17.8	23.2	0.2	−3.8

3. Results and Conclusions

In Figures 1−3, we show images of five of the LSB galaxies in addition to NGC 4625, which has an XUV disk discovered by Gil de Paz et al. (2005). In each figure the continuum-subtracted Hα image is shown in grey scale while the overlaid contours indicate the FUV emission. The lowest FUV contour in the figures is plotted at a surface brightness of 27.5 mag arcsec^{-2}, corresponding to $\Sigma_{SFR} = 2.6 \times 10^{-4}$ $M_\odot$ yr^{-1} kpc^{-2}.

In the case of the giant LSB galaxy UGC 6614 shown in the left panel of Figure 1, star formation is mainly located along an inner ring and two long thin spiral arms that wrap around the galaxy. For the other LSB galaxies, the star formation is more widely distributed in a more irregular morphology. All of the LSB galaxies have HII regions lying primarily within regions with a FUV surface brightness above 27.5 mag arcsec^{-2}. In general there is a good correspondence between the brightest FUV clumps and the brightest HII regions. In many cases what appears as one clump in the UV at the GALEX resolution can be resolved into multiple clumps in the Hα images, each presumably corresponding to a separate young stellar cluster or OB association. There is fainter FUV emission in most galaxies detected below the 27.5 mag arcsec^{-2} isophote that generally lacks corresponding Hα emission although this may be due to the depth of the Hα data.

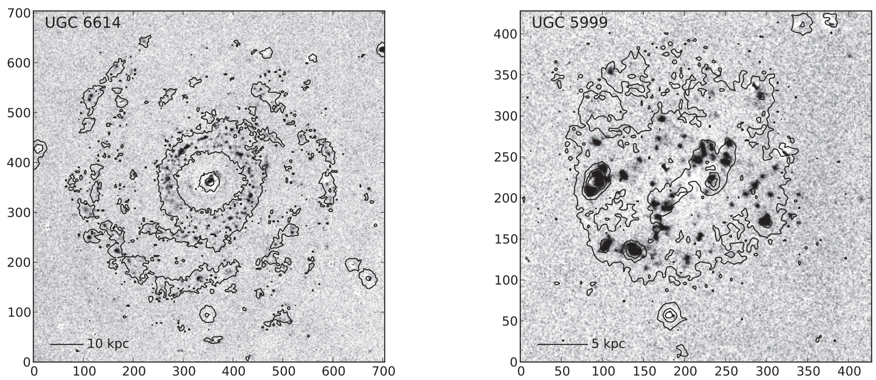

Figure 1. Hα images of the LSB galaxies UGC 6614 (left) and UGC 5999 (right) with FUV contours superimposed. The outermost contour corresponds to a FUV surface brightness of 27.5 mag arcsec^{-2}.

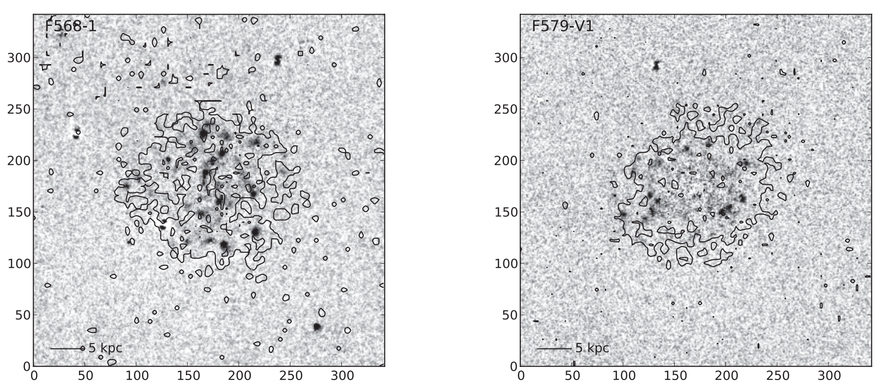

Figure 2. The same as Figure 1 except for LSBC F568-1 and LSBC F579-V1.

In the case of the XUV disk galaxy NGC 4625 shown in Figure 3, we have detected HII regions throughout its disk. In contrast to that galaxy, we have not detected any Hα emission in the prominent UV ring around the S0 galaxy NGC 934. In Figure 4, we overplot a FUV contour at a surface brightness of 28.5 mag arcsec^{-2}, a magnitude fainter than in the other figures, as the average surface brightness in this ring is fainter than in the other galaxies. However, since the Hα data is not yet calibrated, it is not possible yet to determine whether the upper limit on the Hα/UV ratio is significant. In the future we plan to calibrate all of the Hα images so that we can place more quantitative constraint on the variation of the Hα/UV ratio, and in turn the form of the massive end of the stellar IMF as a function of density.

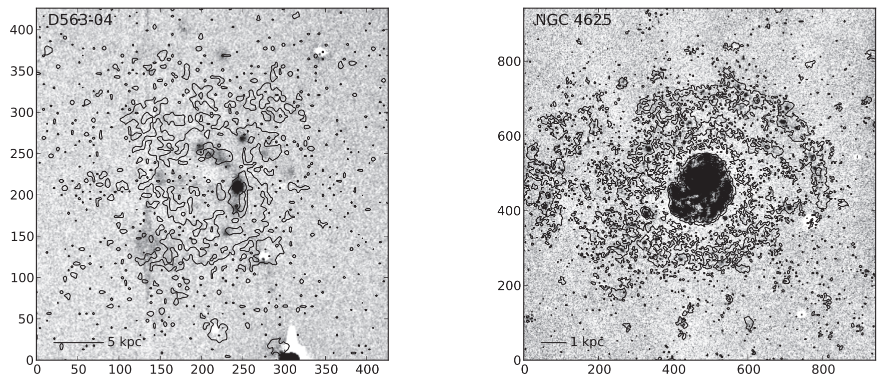

Figure 3. The same as Figure 1 except for LSBC D563-04 and the XUV disk galaxy NGC 4625.

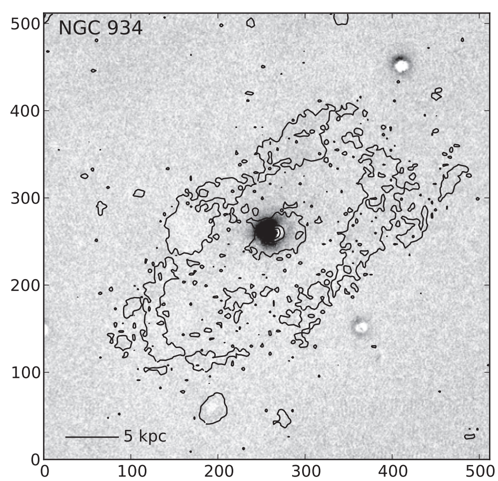

Figure 4. Hα image with FUV contours overlaid of the S0 galaxy NGC 934, which has a prominent ring of UV emission around it. The UV emission in this galaxy is fainter than in the other galaxies presented here and we plot the contour at a level of 28.5 mag arcsec^{-2}, or one magnitude fainter than in the other figures. No Hα emission was detected in the UV ring.

Acknowledgments. GALEX is a NASA Small Explorer, launched in 2003 April. We gratefully acknowledge NASAs support for construction, operation, and science analysis for the GALEX mission, developed in cooperation with the Centre National dEtudes Spatiales of France and the Korean Ministry of Science and Technology.

References

de Blok, W. J. G., McGaugh, S. S., & van der Hulst, J. M. 1996, MNRAS, 283, 18
Gil de Paz, A., Madore, B. F., Boissier, S., Swaters, R., Popescu, C. C., Tuffs, R. J., Sheth, K., et al. 2005, ApJ, 627, L29
Goddard, Q. E., Kennicutt, R. C., & Ryan-Weber, E. V. 2010, MNRAS, 405, 2791
Kennicutt, R. C., Jr. 1998, ARA&A, 36, 189
Lee, J. C., Gil de Paz, A., Tremonti, C., Kennicutt, R. C., Salim, S., Bothwell, M., Calzetti, D., et al. 2009, ApJ, 706, 599
Meurer, G. R., Wong, O. I., Kim, J. H., Hanish, D. J., Heckman, T. M., Werk, J., Bland-Hawthorn, J., et al. 2009, ApJ, 695, 765
Pickering, T. E., Impey, C. D., van Gorkom, J. H., & Bothun, G. D. 1997, AJ, 114, 1858
Salpeter, E. E. 1955, ApJ, 121, 161
Thilker, D. A., Bianchi, L., Boissier, S., Gil de Paz, A., Madore, B. F., Martin, D. C., Meurer, G. R., et al. 2005, ApJ, 619, L79
van der Hulst, J. M., Skillman, E. D., Smith, T. R., Bothun, G. D., McGaugh, S. S., & de Blok, W. J. G. 1993, AJ, 106, 548
Wyder, T. K., Martin, D. C., Barlow, T. A., Foster, K., Friedman, P. G., Morrissey, P., Neff, S. G., et al. 2009, ApJ, 696, 1834