SURFACE PHOTOMETRY OF PURE DISK GALAXIES

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ABSTRACT:

Surface photometry from U.K.S.T.U. plates in U, B_J and R_F is presented for the three Sculptor Group galaxies NGC 7793, NGC 247 and NGC 300. Their photometric parameters are derived and compared to those of M33. Our color maps are used to sort out the data into blue and red pixels where the blue pixels profiles are expected to be rather irregular, representative of the clumpy locations of areas of recent star formation while the red pixels profiles should approximate the smoother distribution of the old disk population.

What do we mean by "pure" disk galaxies? We call pure disk galaxies (PDG), late-type spirals (Scd-Sd-Sdm) showing no apparent bulge or in which the bulge contributes very little (<2-3%) to the total luminosity. Our aim is to combine photometry with kinematical data to study the mass distribution of PDG and especially the ratio of unseen halo mass to luminous disk mass (Carignan, 1983; Carignan and Freeman, 1983) using the light distribution as a tracer of the luminous mass component. Because they have no bulge, PDG are ideal candidates for that kind of work since we only have one luminous component to model.

In this paper, we want to concentrate on the results of the surface photometry for three such systems in the Sculptor Group. The photometric parameters for NGC 7793, NGC 247 and NGC 300, derived from their total B_J light profiles are given in Table 1. As we can see, the three galaxies exhibit an exceptionnally wide range in central disk surface brightness from the bright disk of NGC 7793 at $B(0)_c$= 20.33 to the low surface brightness disk of NGC 247 at 23.44. This is even fainter than Romanishin and Strom (1979) mean value of 22.88 for their sample of 12 LSB galaxies. NGC 300 has a more "normal" $B(0)_c$= 22.23. However, this is still within the observed range when one considers that in Freeman's (1970) sample, seven galaxies had a $B(0)_c$ 1.5 magnitude brighter than its mean value of 21.65 and one system IC 1613 was even fainter than NGC 247 at $B(0)_c$ = 23.7.

M. Capaccioli (ed.), Astronomy with Schmidt-Type Telescopes, 385–387.

The three Sd galaxies being of equivalent absolute magnitude ~-18, the fitted scale lengths of their exponential fall-off vary accordingly to their surface brightness from 1 to 3 kpc. Again, this is very similar to Freeman's (1970) mean for all morphological types of 2.1 ± 1.3 kpc, Schweizer's (1976) value of 2.7 ± 0.5 kpc mainly for Sc's and Romanishin and Strom (1979) 2.1 ± 0.7 kpc where all the distances are adjusted for H_0 = 100 km/sec/Mpc.

When compared to the northern Scd galaxy M33, the Sculptor Group galaxies appear to be slightly smaller with a mean face-on diameter of $\langle D(0) \rangle$ = 9.9 ± 1.0 kpc compared to 12 kpc for M33 and a mean absolute magnitude of -18.11 ± 0.17 compared to -18.51. In that respect, they are probably closer to the LMC which has D(0) = 8.25 kpc and M_T^o=-18.17.

As for the radial dependance of colors, no significant gradient greater than 0.2 magnitude has been seen. While this does not tell us anything on the run of $(M/L)_{disk}$ with radius, it is at least consistent with it being constant.

Since we want to use our luminosity profiles as tracers of the luminous mass component, we had to study the effects of recent star formation and "patchy" internal absorption. To do this we followed Talbot et al. (1979) and sorted out the data into red and blue pixels profiles adopting a separating color of $(B_J - R_F)$ = 1.0 (~(B-V) = 0.65). However, it should be emphasized that this cannot be considered as a complete decomposition which would require a more thorough analysis (cf. Jensen et al., 1981 for M83). What we are doing here is just plotting the mean surface brightness of blue and red pixels as a function of radius.

The most important result in the case of NGC 7793 is the persistence of the type II (Freeman, 1970) profile for the red pixels which confirms the dynamical significance of such a feature. This goes against Talbot et al. (1979) suggestion that most type II profiles could be due to an excess of young blue light producing a "hump" that mimics a type II profile as in the case of M83.

As for NGC 247, the red pixels profile is almost a pure exponential on the whole radius range. On the other hand, the blue pixels profile shows three interesting features. First, it confirms the region of higher internal absorption between 5' and 7' which is seen on short exposure plates and in the isophotes map. In that region, the blue pixels are 0.3 - 0.4 magnitude fainter while the red pixels are almost unaffected. This is followed by a region where the blue pixels surface brightness stays more or less constant while crossing the broad northern spiral arm before reaching the exponential fall-off region.

We also obtained very interesting results for the more complicated profile of NGC 300. First, the hump seen around 3!5 again seems to be a feature of the old disk being clearly present in the red pixels profile. Because at high surface brigthness, this feature is quite important dynamically. On the other hand, the hump ~ 10' seems mainly due to young blue light so that the true scale length of the disk, when taking out the effect of this hump, is substantially smaller. As for the blue pixels profiles, it illustrates very well Schweizer's (1976) results that the arms light falls-off more gradually than the disk light.

https://doi.org/10.1017/S025292110010692X Published online by Cambridge University Press

I would like to thank the staff of the U.K.S.T.U. for kindly taking the plates used in this work and Dr. K.C. Freeman for many valuable discussions.

TABLE 1:
Photometric Parameters for the Scultor Group Galaxies and Comparison with M33.

	M33*	NGC7793	NGC247	NGC300
Morphological type	SA(s)cd	SA(s)d	SAB(s)d	SA(s)d
Distance (Mpc)	0.72	3.38	2.52	1.90
Face-on diameter D(0) (kpc)	12.0	8.8	10.8	10.1
Corrected total magnitude B_T^o	5.79	9.33	9.00	8.38
Absolute magnitude M_T^o	-18.51	-18.31	-18.01	-18.01
Exponential disk parameters				
Central surface brightness $B(0)_c$	21.05	20.33	23.44	22.23
Scale length α^{-1} (kpc)	1.65	1.08	2.93	2.06
Maximum rot. vel. V_{max} (km/sec)	107	95	108	87
Hydrogen mass to luminous mass ratio M_{HI}/M_{lum}	0.05	0.12	0.09	0.25
Luminous mass to blue luminosity ratio M_{lum}/L_B	5.0[1]	2.0[2]	5.0[2]	2.5[2]

* parameters from de Vaucouleurs, 1959 and de Vaucouleurs and Caulet, 1982.
[1]) Kalnajs, 1983.
[2]) Carignan, 1983.

REFERENCES

Carignan, C. 1983, in The Milky Way Galaxy, I.A.U. Symposium no. 106, in press.
Carignan, C. and Freeman, K.C. 1983, in preparation.
de Vaucouleurs, G. 1959, Ap.J., 130, 728.
de Vaucouleurs, G. and Caulet, A. 1982, Ap. J. Suppl. Ser., 49, 515.
Freeman, K.C. 1970, Ap. J., 160, 811.
Jensen, E.B., Talbot, R.J. and Dufour, R.J. 1981, Ap. J., 243, 716.
Kalnajs, A. 1983, in Internal Kinematics and Dynamics of Galaxies, I.A.U. Symposium no. 100, 87.
Romanishin, W. and Strom, S.E. 1979, in Photometry, Kinematics and Dynamics of Galaxies, ed. D.S. Evans, Univ. of Texas at Austin, p. 151.
Schweizer, F. 1976, Ap. J. Suppl. Ser., 31, 313.
Talbot, R. J., Jensen, E.B. and Dufour, R.J. 1979, Ap. J., 229, 91.