GLOBAL STRUCTURE OF GALAXIES AND QUANTITATIVE CLASSIFICATION

S. Okamura, K. Kodaira, and M. Watanabe
Tokyo Astronomical Observatory, University of Tokyo
Mitaka, Tokyo 181, Japan

We have been carrying out digital surface photometry of galaxies using the plates taken with the 105-cm Schmidt telescope at the Kiso Observatory, a branch of the Tokyo Astronomical Observatory. Two-dimensional V-band luminosity distributions of 261 galaxies in the Virgo and the Ursa Major regions have been compiled so far (Watanabe et al. 1982, Watanabe 1983). They form one of the largest samples of homogeneous surface photometric data. This discourse is to draw attention to some new results, which are summarized below, on the structure of galaxies derived from the analysis of the homogeneous sample. Detailed discussion will be given elsewhere (Kodaira et al. 1983, Okamura et al. 1983, Watanabe et al. 1983). Most of the sample galaxies are members of either the Virgo or the Ursa Major Clusters, both lying at nearly equal distance (Aaronson and Mould 1983). Their morphological types range from elliptical (T=-5) to Magellanic irregulars (T=10).

(1) Several photometric parameters are derived on the basis of the generalized radial profile, that is, a radial profile which would be obtained if a galaxy were to be seen face-on (Watanabe et al. 1982), within a limiting surface brightness of 26 mag arcsec^{-2}. They include the integrated magnitude, V_{26}, diameter, D_{26}, mean surface brightness, $SB = V_{26} + 5 \log D_{26} + \text{const}$, and the mean concentration index, Xl(P). The last quantity, Xl(P), is a weighted mean of five concentration indices, P_n (n=1,2,...,5), which represent the fractional luminosity included within $D_{26}/2^n$ relative to the luminosity within D_{26}. In their definition, the indices P_n are similar to the concentration indices C_{21} and C_{32} introduced by de Vaucouleurs (1977a, b).

(2) A good correlation is found between the mean concentration index and the morphological type although the scatter is relatively large. One cause of the scatter is identified with the variation of the intrinsic surface brightness among galaxies. It is suggested that the mean concentration index, when combined with the mean surface brightness, is sensitive to the bulge-to-disk ratio of a galaxy. The Xl(P) versus SB diagram may provide a useful tool to investigate the

M. Capaccioli (ed.), Astronomy with Schmidt-Type Telescopes, 383–384.
© 1984 by D. Reidel Publishing Company.

https://doi.org/10.1017/S0252921100106918 Published online by Cambridge University Press

luminosity structure of a galaxy and to characterize galaxy content of clusters of galaxies out to ∿100 Mpc.

(3) The principal component analysis of the above photometric parameters, V_{26}, log D_{26}, SB and X1(P) shows that there are two independent variables, in agreement with the results by Brosche(1973)'s pioneering work for 31 nearby disk galaxies. The two independent variables derived for the present sample closely coincide with those by Brosche who included in his analysis dynamical parameters as well as photometric parameters. This suggests that the global structure of galaxies may be characterized by photometric parameters alone without dynamical parameters.

(4) It is shown from the principal component analysis that the diameter and the surface brightness can be used as fundamental parameters to characterize the structure of galaxies. The diameter versus surface brightness diagram is constructed for 149 galaxies in the sample. In the diagram, galaxies form two distinct branches consisting mainly of elliptical and S0 galaxies and late-type galaxies respectively, which run almost perpendicular to each other. The elliptical-S0 branch corresponds to the $\mu_e - r_e$ relation of early-type galaxies found by Kormendy (1977,1980). This diagram may be used as a possible distance tool and the basis of a quantitative classification of galaxies and of a characterization of clusters of galaxies.

REFERENCES

Aaronson, M. and Mould, J. R. 1983, Ap. J., 265, 1.
Brosche, P. 1973, Astr. Ap., 23, 259.
de Vaucouleurs, G. 1977a, Ap. J. Suppl., 33, 211.
———————— 1977b, The Evolution of Galaxies and Stellar Populations, ed. B.M.Tinsley and R.B.Larson (Yale Univ. Obs., New Haven), p. 43.
Kodaira, K., Okamura, S., and Watanabe, M. 1983, Ap. J. Letters (in press)
Kormendy, J. 1977, Ap. J., 218, 333.
———————— 1980, Proc. ESO Workshop on Two-Dimensional Photometry, ed. P.Crane and K.Kjär, p. 191.
Okamura, S., Kodaira, K., and Watanabe, M. 1983, Ap. J. (in press).
Watanabe, M. 1983, Annals Tokyo Astr. Obs., 2nd Ser., 19, 121.
Watanabe, M., Kodaira, K., and Okamura, S. 1982, Ap. J. Suppl., 50, 1.
Watanabe, M., Kodaira, K., and Okamura, S. 1983, in preparation.

https://doi.org/10.1017/S0252921100106918 Published online by Cambridge University Press