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SIZE VS ABSOLUTE MAGNITUDE RELATION FOR HARO AND Im GALAXIES

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ABSTRACT

The size vs absolute magnitude relation for Haro galaxies has been re-examined. It does not appear to differ significantly from the relation for Im galaxies.

From the spectroscopic and photoelectric observations for Haro galaxies, DuPuv (1970) discussed the relationship between Haro and irregular I galaxies, and suggested that Haro galaxies do not have the usual properties of irregular I galaxies. One of his arguments supporting this view was that on the size vs absolute magnitude diagram, sizes of Haro galaxies were typically 3 to 4 times smaller, at a given magnitude, than those of irregular I galaxies.* On his diagram, magnitudes and sizes of irregular I galaxies were observed by himself and their sizes were measured on the *Palomar Sky Survey* prints (DuPuy 1972). This difference of photometric systems may have disturbed his results. Therefore, we re-examine this diagram.

Thirteen Im galaxies are picked out from the catalogue of DE VAUCOULEURS (1963) whose B(0) magnitudes are tabulated in the *Reference Catalogue of Bright Galaxies* (DE VAUCOULEURS and DE VAUCOULEURS 1964), and they are tabulated in Table 1. The angular sizes of Haro and Im galaxies are measured on the blue prints of the *Palomar Sky Survey*, and for the formers they are in good agreement with DuPuv's measurements except for Haro 9 and Haro 21. *B* magnitudes for Haro galaxies are taken from Tables I and III of DuPuv (1970). The column (3) of Table 1 gives the geometric mean sizes of the major and minor axes of individual galaxies. The column (4) gives the absolute magnitudes, i.e., $M_B = B(0) - 0.33 - (m-M) - 0.25 \operatorname{cosec} |\delta|$. A correction of 0.33 mag is adopted in transforming the B(0) system to the *total* magnitude system for Im galaxies. But this correction is not applied to Haro galaxies, because the diaphragm sizes of DuPuv's photoelectric observations are large enough to observe the *total* magnitudes. In Figure 1, total absolute *B* magnitudes are plotted

^{*)} Recent observations of Markarian galaxies (SARGENT 1970, ULRICH 1971, WEEDMAN 1972) show that some of them are quite similar to Haro galaxies in respect of blue colors, absolute magnitudes, linear sizes, and emission line features. SARGENT (1970) found that a few Markarian galaxies have much more compact images and much smaller linear sizes than irregular I galaxies of comparable absolute magnitudes.

| NGC | Distance (Mpc) | Mean size (kpc) | M _B |
|------|---------------------|-----------------|----------------|
| (1) | (2) | (3) | (4) |
| 1156 | 6. 3 ^{a)} | 3.2 | -17.1 |
| 1569 | 2.5 ^a) | 0.9 | -16.6 |
| 2366 | 3. 3 ^{a)} | 3.1 | -16.8 |
| 2537 | 6.0 ^b) | 1.8 | -17.1 |
| 3396 | 21.5 | 7.0 | -19.4 |
| 3738 | 12.0 ^{c)} | 7.5 | -18.8 |
| 4038 | 19.2 | 18.8 | -20.9 |
| 4214 | 3. 8 ^a) | 7.0 | -18.1 |
| 4449 | 3. 3 ^d) | 3.1 | -17.4 |
| 4485 | 11.3 | 5.1 | -18.3 |
| 4532 | 27.4 | 8.9 | -20.2 |
| 6052 | 64.0 | 11 | -21.1 |
| 6822 | 0.5 ^{a)} | 1.5 | -15.2 |
| | | 1 | |

Table 1. Linear sizes and absolute magnitudes for Im galaxies.

Column 2: Unless otherwise noticed, distances are determined from the recession velocities by using H=75 km/sec/Mpc. Ref. a) ROBERTS (1969), b) DE VAUCOULEURS (1968), c) HOLMBERG (1964), d) HITCHCOCK and HODGE (1968).



Fig. 1. Size vs absolute magnitude diagram. Straight full and dotted lines indicate the loci of least squares fits for Haro and Im galaxies, respectively. Dots with brackets are neglected in least squares fits.

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against the mean sizes of Haro and Im galaxies. On this diagram, four Haro galaxies Nos. 25, 31B, 36, and 41 are not plotted, because they are not typical ones as stated in DuPuy's notes. Straight full and dotted lines indicate the loci of the least squares solutions for Haro and Im galaxies, respectively. The slope 5 ($=|dM_B/d \log D|$) of the line and a small dispersion around the line for Haro galaxies indicate that the surface brightnesses of Haro galaxies are nearly similar to each other, regardless of their absolute magnitude and of Markarian's UV continuum class. The surface brightnesses of Haro galaxies are slightly brighter than those of Im galaxies but the difference is quite small contrary to DuPuy's description.

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REFERENCES

DuPuy, D. L. 1970, Astron, J., 75, 1143.

DuPuy, D. L. 1972, private communication.

НІТСНСОСК, J. L., and НОДСЕ, P. W. 1968, Astrophys. J., 152, 1067.

HOLMBERG, E. 1964, Arkiv för Astronomi, Band 3, nr 30.

ROBERTS, M. S. 1969, Astron. J., 74, 859.

SARGNT, W. L. W. 1970, Astrophys. J., 159, 765.

ULRICH, M-H. J. 1971, Astrophys. J., 163, 441.

VAUCOULEURS, G. DE 1963, Astrophys. J. Suppl. 8, 31.

VAUCOULEURS, G. DE 1968, in *Galaxies and the Universe*, ed. A. and M. Sandage (University of Chicago Press, Chicago) in press.

VAUCOULEURS, G. DE, and VAUCOULEURS, A. DE 1964, Reference Catalogue of Bright Galaxies (University of Texas Press, Austin).

WEEDMAN, D. W. 1972, Astrophys. J., 171, 5.

Note added in proof (August 26, 1974): Since this paper was received, Bottinelli, Chamaraux, Gouguenheim, and Heidman nhave considered the same problem and reached to a similar conclusion. (1973, Astron. Astrophs., 29, 217)