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ON THE UBV PHOTOMETRY OF SEYFERT GALAXIES I: NGC 1068

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RESUMEN

Se presentan observaciones fotométricas en el sistema UBV de la galaxia NGC 1068 en varias aperturas. Usando estas observaciones junto con las de otros autores, se encuentran fórmulas de interpolación para las magnitudes V, B y U de dicha galaxia en función de la apertura.

ABSTRACT

UBV photoelectric photometry of NGC 1068 is presented. These observations together with those done by other autors allow the computation of interpolation functions for the profile of this galaxy.

Key words: PHOTOELECTRIC PHOTOMETRY — SEYFERT GALAXY.

I. INTRODUCTION

The study of the variability of the nuclei of Seyfert Galaxies (and of possibly related objects like QSO's) has long been hampered by several problems like the errors in the observation, the difficulty of comparing observations done by several authors using different size diaphragms and extracting from the available data the behavior of the nuclei which is masked by the light of the rest of the galaxy. If a theoretical model for this phenomenon is to be compared with available observations, the light curve must be obtained (see for instance Daltabuit and Cantó 1974).

For this purpose a systematic UBV photoelectric photometry observing program of Seyfert Galaxies has been established at the Observatorio Astronómico Nacional, San Pedro Mártir since 1974, together with a compilation of similar observations by other autors. All the data thus obtained will be analyzed in a way to produce reliable interpolation formulae that can be used to construct light curves. In this paper we study NGC 1068.

This galaxy was observed during 16 nights in 1974 and 1975 with the 150 and 83 cm. telescopes of the Observatorio Astronómico Nacional, San Pedro Mártir. The observations are of absolute type and were done using standard stars from the list given by Johnson *et al.* (1966) and transforming the results to the UBV system defined by Johnson and Morgan (1953). The typical error of the standard star observations after the transformations is $0^m.03$.

II. RESULTS

Penston *et al.* (1974) and Lyutyi (1973) state that NGC 1068 is not variable. It can be seen that the standard deviations of their measurements are comparable to the typical observational error ($\simeq 0^m.06$). Also the maximum difference between measurements and averages is less than $0^m.08$ for the data of Penston *et al.* and $0^m.15$ for Lyutyi's data in any of the three magnitudes U, B, V. We have thus computed and used average values of the measurements. Table 1 shows the date, Julian day,

TABLA 1

OBSERVATIONS OF NGC 1068

			J.D. 244200+	a (arc sec)	V	B-V	U-V
1974	JAN	22/23	070.71	63.2	9.90	0.73	——
		23/24	071.69	63.2	9.91	——	——
		24/25	072.71	63.2	9.87	0.75	——
1974	OCT	12/13	333.88	63.2	9.88	0.74	0.80
		13/14	334.78	63.2	9.84	0.75	0.76
		14/15	335.79	63.2	9.83	0.80	0.76
		16/17	336.80	63.2	9.87	0.76	0.76
1975	FEB	10/11	423.68	33.0	10.31	0.86	0.84
		11/12	424.65	33.0	10.34	0.79	0.89
		13/14	425.65	33.0	10.38	0.82	——
1975	AUG	11/12	636.96	13.9	11.10	0.75	0.88
				27.0	10.45	0.72	——
				36.0	10.18	0.76	0.84
1975	SEP	8/9	664.87	27.5	10.42	0.82	0.85
				35.5	10.21	0.79	0.83
				63.0	9.84	0.76	0.77
1975	SEP	9/10	665.92	27.5	10.44	0.79	0.83
				35.5	10.21	0.79	0.81
				63.0	9.82	0.76	0.77
1975	OCT	6/7	692.83	17.7	10.53	0.80	0.81
				27.5	10.31	0.78	——
				35.5	10.16	0.71	——
1975	OCT	8/9	694.84	17.7	10.50	0.85	0.90
				27.5	10.38	——	——
				35.5	10.11	0.78	——
1975	OCT	10/11	696.85	17.7	10.56	0.88	0.88
				27.5	10.38	——	——
				35.5	10.13	0.83	——

diaphragm diameter, V magnitudes and B-V and U-V colors measured. These measurements do not show evidence of variability. Table 2 shows the average values of these measurements. We estimate that the probable error of these averages is $0^m.06$ basically due to centering errors.

III. DISCUSSION

Figures 1, 2 and 3 show the data of Table 2 and similar data published by other authors (Dibai *et al.* 1969; Walker 1968; de Vaucouleurs and de Vaucouleurs 1968; Lyutyi 1973; Smith *et al.* 1972; Sandage 1967; Penston *et al.* 1974 and Westerlund and Wall 1968). It can be seen on these figures that all observations agree fairly well. It seems, however, that the V magnitude reported by Walker (1968) shows a systematic difference with respect to the others of about $0^m.15$.

TABLE 2

MAGNITUDE AND COLORS OF NGC 1068 AS FUNCTIONS OF DIAPHRAGM SIZE

a (arc sec)	V	B-V	U-V
13.9	11.10	0.75	0.88
27.0	10.45	0.72	0.91
27.5	10.39	0.80	0.84
33.0	10.34	0.82	0.87
35.5	10.16	0.78	0.82
36.0	10.18	0.76	0.84
63.0	9.83	0.76	0.77
63.2	9.87	0.78	0.77

We also show on these figures the plots of functions of the type $m = -2.5 \log (b_2 a^2 + b_1 a + b_0)$ for the V, B and U magnitudes. The parameters b_2, b_1 and b_0 were obtained by least squares fits using all data that appear in each figure. These seem to be good interpolation functions for the data. The relevant parameters appear in Table 3.

IV. CONCLUSIONS

No variation greater than the reported observational errors can be found in the data analyzed. By comparing the individual observations with the appropriate values of the interpolation functions it can be seen that the overall typical observational errors in the photoelectric photometry of NGC 1068 are DV = $0^m.10$, DB = $0^m.08$ and DU = $0^m.08$.

From the interpolation formula it can be computed that for a 60″ diaphragm, B-V = $0^m.77$, U-V = $0^m.81$ and for a 8″ diaphragm B-V = $0^m.86$, U-V = $0^m.93$.

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TABLE 3

CHARACTERISTIC PARAMETERS OF THE INTERPOLATION FUNCTIONS

	b_2	b_1	b_0
V	−0.1523(−7)	0.2795(−5)	0.3954(−5)
B	−0.7794(−8)	0.1412(−5)	0.6441(−6)
U	−0.5797(−8)	0.1241(−5)	0.1812(−5)

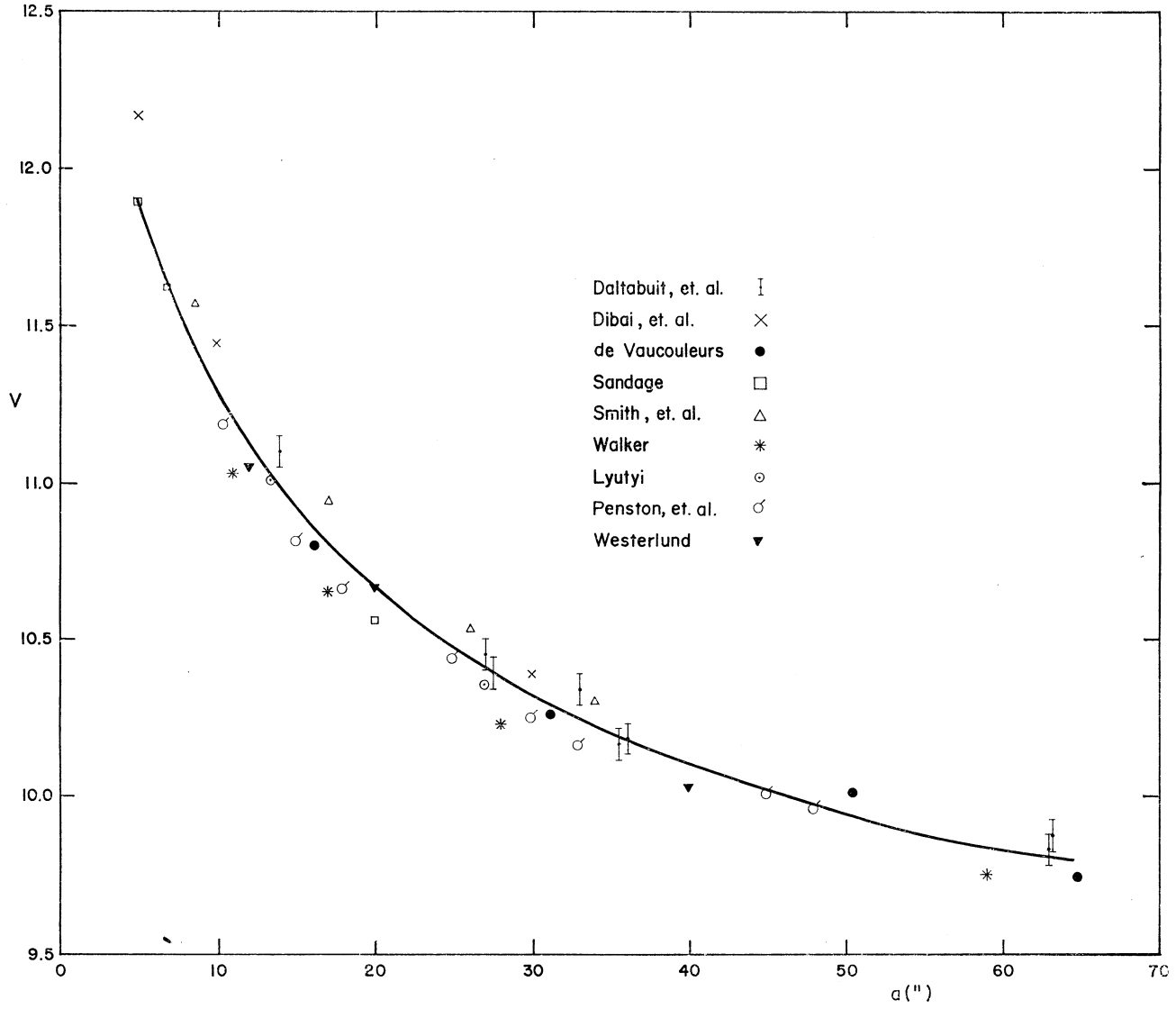

FIG. 1. V magnitude as a function of diaphragm size and the corresponding interpolation function.

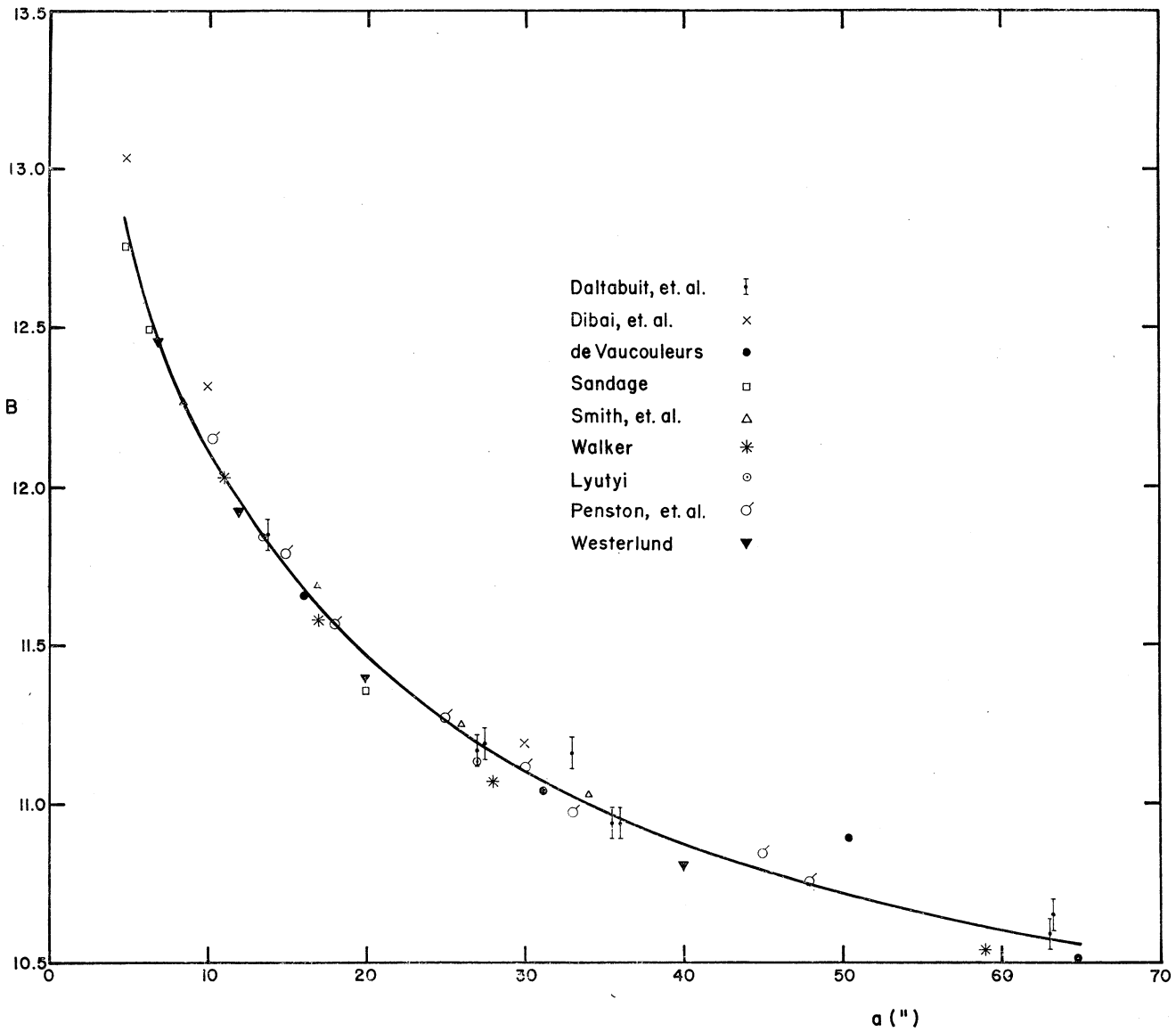

FIG. 2. B magnitude as a function of diaphragm size and the corresponding interpolation function.

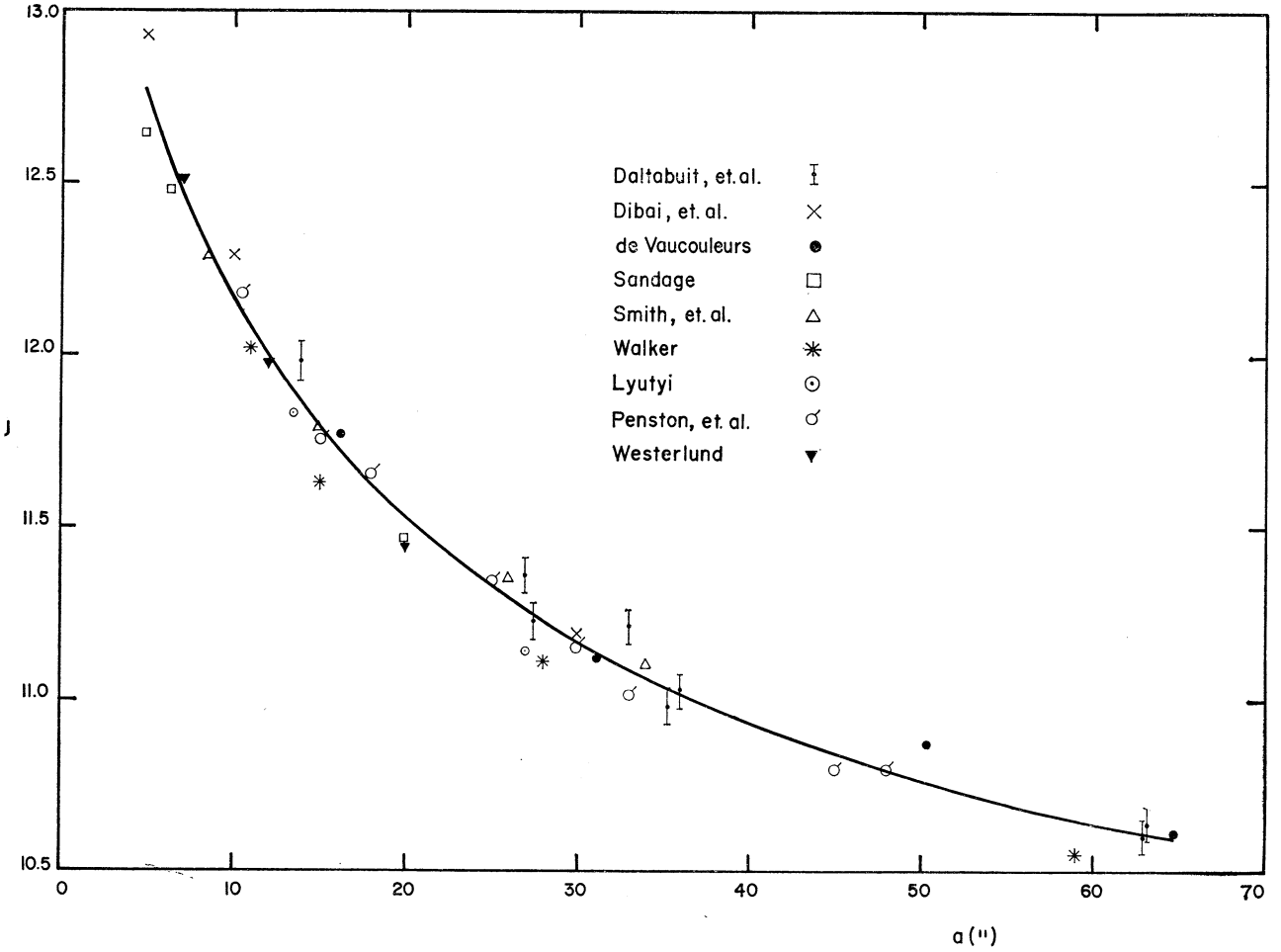

FIG. 3. U magnitude as a function of diaphragm size and the corresponding interpolation function.

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