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UBV PHOTOMETRY OF SEYFERT GALAXY NUCLEI

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Abstract

Magnitudes for the following objects are reported: ESO 113-IG 45, NGC 985, ESO 141 - G 55, MKN 509, II Zw 136, NGC 7213, MCG-2-58-22, and NGC 7469. NGC 7469 and II Zw 136 are previously known variables. MKN 509 and MCG-2-58-22 are thought to be reported as variables here for the first time.

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The nuclei of many Seyfert galaxies are variable. A well known example is the bright galaxy NGC 4151. The causes of nuclear brightness changes are not well understood, but they may be related to quasar variability. Thus, understanding the Seyferts may help to explain their more distant cousins.

In 1980 the author began to measure the **UBV** magnitudes of some southern hemisphere Seyfert galaxy nuclei with the 24" cassegrain telescope at Cerro Tololo Observatory in Chile. The eight objects listed in Table I were selected and at least two observations of each object were planned as a test for variability.

The procedure at the eyepiece was to select a diaphragm size about as large as the visible nucleus. The nucleus was centered in the diaphragm and a photon count was made. The nucleus was then moved away and re-centered, and another photon count was made. If the two counts disagreed, a slightly larger diaphragm size was tried. In this way, the smallest size that would give reproduceable results was found. This selection minimized background light from the extended galaxy. The diaphragm size finally selected always turned out to be 11 or 16 arcseconds, and the same size was always used on a given nucleus even when observed on different nights.

Long observations were taken to reduce the error from random noise in the photon counts. Generally, 4 100-second counts were made in each filter. Thus the integration time per observation was about twenty minutes. Observations of the brighter reference stars of Landolt (1973), and some check stars defined by Graham (1982), were of much shorter duration. Extinction stars were also measured. While careful observing procedures were employed, the faintness of the nuclei and the difficulty of centering them contributed to an estimated error of about 0.03 - 0.04 magnitude. The observations were tied in to the **UBV** system in a way consistent with Hardie's (1962) method.

The date of observation, magnitude, colors, and diaphragm diameters corresponding to each observation are shown in Table II. The colors of the nuclei are peculiar. While the **B-V** index would indicate one temperature, the **U-B** index for the same object points to a much higher temperature. Comparison of these indices shows that the nucleus emits too much ultraviolet light, a phenomenon known as "ultraviolet excess." This effect has been found in other Seyfert galaxies.

Notice that four of the six nuclei observed twice appear to be variable, having changed by more than 0^{m}.1 in **V**. The time between observations of these objects is generally about one year. The variable nuclei Seyferts - NGC 7469, MKN 509, II Zw 136, and MCG-2-58-22 - are listed in Table III along with their change in **UBV** magnitudes,

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in the sense: second observation minus first observation. The larger changes happen at short wavelengths, and the direction of the change is consistent across all passbands, as demonstrated in Figure 1. Figure 1 also includes data for the two non-variable nuclei as a comparison.

After completing this research, the author found that the General Catalogue of Variable Stars (Kukarkin et al. 1969) lists NGC 7469 and II Zw 136 as previously known variables. The brightnesses and amplitudes reported there are consistent with the results reported in this paper.

The observation of Seyfert galaxy nuclei is a field that is wide open to observers with experience in **UBV** photometry and access to moderate-sized telescopes. Visual observers can contribute to this field too, although the brightness changes of Seyfert nuclei are not as large in visible light as in **B** and especially **U**.

Thanks are due to Dr. C.-C. Wu for providing finder charts and coordinates for the Seyfert galaxies.

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TABLE I

Seyfert Nuclei Observed

Name	R.A. (1950)	Decl.
ESO 113-IG 45	01h 21m 51$2	-59° 03' 58"
NGC 985	02 32 10.5	-09 00 21
ESO 141 - G 55	19 16 57.0	-58 45 52
MKN 509	20 41 26.3	-10 54 17
II Zw 136	21 30 01.2	+09 55 01
NGC 7213	22 06 09.5	-47 24 52
MCG-2-58-22	23 02 07.2	-08 57 19
NGC 7469	23 03 44.6	+08 36 16

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TABLE II

Magnitudes and Colors

Name	Julian Date	V	B-V	U-B	d*
ESO 113-IG 45	2444901.7	13^{m}54	+0^{m}28	-1^{m}02	11
NGC 985	4903.7	14.45	+0.68	-0.74	16
ESO 141 - G 55	4433.8	13.70	+0.26	-0.99	11
	4896.5	13.65	+0.30	-1.00	11
MKN 509	4903.6	13.67	+0.44	-0.94	11
	5261.5	13.35	+0.34	-1.01	11
II Zw 136	4903.6	14.60	+0.20	-1.33	11
	5261.6	14.93	+0.24	-0.81	11
NGC 7213	4433.9	12.04	+0.97	+0.39	16
	4896.6	12.00	+0.93	+0.45	16
MCG-2-58-22	4901.7	14.30	+0.51	-0.84	11
	5261.6	14.10	+0.38	-0.94	11
NGC 7469	4903.6	13.39	+0.64	-0.55	11
	5261.6	13.27	+0.48	-0.64	11

*d = diaphragm diameter in arcseconds

TABLE III

Amplitudes

Name	ΔV	ΔB	ΔU
MKN 509	-0^{m}32	-0^{m}42	-0^{m}49
II Zw 136	+0.33	+0.37	+0.89
MCG-2-58-22	-0.20	-0.33	-0.43
NGC 7469	-0.12	-0.28	-0.37

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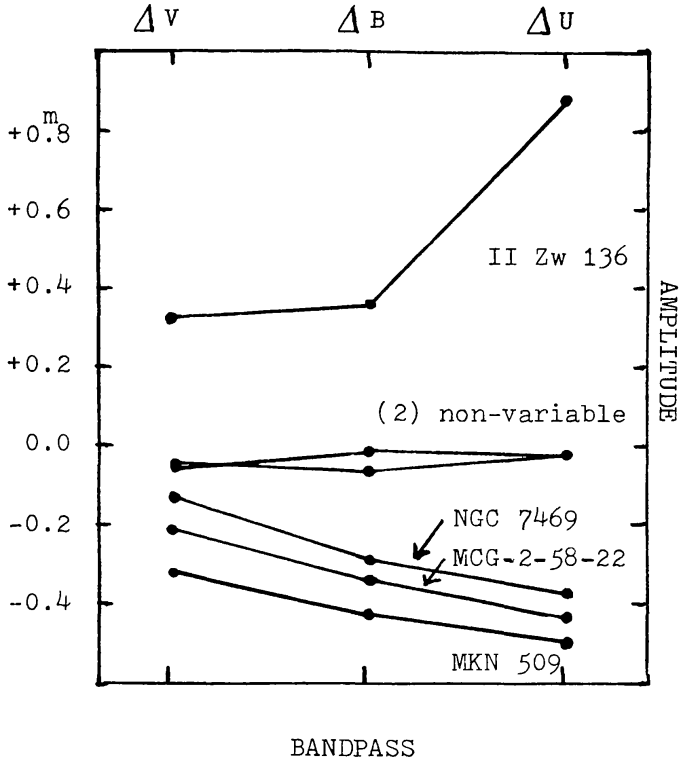

Figure 1. Magnitude changes as a function of passband for 5 Seyfert galaxy nuclei.

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