VARIABILITY IN THE OPTICAL CONTINUUM OF TYPE 1 SEYFERT NUCLEI*

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1. INTRODUCTION

In 1979 we started a monitoring program of Seyfert galaxies, using various telescopes at ESO (La Silla, Chile). At present this program is still continuing, but here we discuss only the photometric data obtained in the period 1979-1982.

One of the aims of the program is to study the variability of the optical continuum radiation coming from active galactic nuclei and to identify the components that are responsible for the variability.

Although by no means statistically complete, our observing sample should be representative of Seyfert galaxies in general. We selected the Seyferts that were known in 1979 and satisfied the following criteria:
i) visual magnitude brighter than 15,
ii) declination below about 15 degrees,
iii) right ascension in the range 22 to 13 hours. Objects outside this range, but satisfying the other two conditions were observed in one period, August 1980.

Ideally an object is observed each year on 14 consecutive nights with the Walraven photometer attached to the 90 cm Dutch telescope at La Silla. We thus get an idea of the long term variations but also of the day-to-day variability.

The Walraven system has a number of advantages over the standard UBV photometry: it has five passbands (observed simultaneously), out of which three are in the range 3000 to 4000 Å. These passbands are relatively narrow (about 200 Å). Because of this the Walraven photometer is very suitable for studying the time-evolution of the so called 3000 Å bump in low redshift AGN's. More details on the Walraven photometry can be found in de Ruiter and Lub (1986).

2. VARIABILITY

We present the results concerning the period December 1979 till December 1982.

* Discussion on p.93

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Out of eleven type 1 Seyferts that were observed regularly, ten showed significant variations on timescales of one year, from 0.1 to 0.6 mag. in the visual (the strongest variability was observed in Fairall 9 and 3C 120). The only object that remained constant, NGC 7603, is known to exhibit strong variations in the strength of the Balmer lines (Tohline and Osterbrock, 1976). The four type 2 Seyferts included in our program all remained constant, with an upper limit to variations of the order of 0.05 mag. This same upper limit applies to short term variations, i.e. in none of the Seyferts did we find significant changes on timescales of one day to one week. This tells us, incidentally, that such short term variability must be very rare.

3. COMPOSITION OF A SEYFERT TYPE 1 SPECTRUM

For each of the ten Seyferts that had varied we selected the phases when the object was brightest and faintest and compared the corresponding five-point spectra after correction for interstellar extinction and emission lines (whose strengths are known since we also have spectra obtained simultaneously with the photometry). Subtraction of the "faint" from the "bright" spectrum then gives the variable components. Assuming that the variability is caused by a Balmer continuum of constant temperature that changes its intensity and a power law component with variable spectral index, good fits to the difference spectra can be obtained. The procedure failed only for AKN 120: this object varied in all five passbands by the same factor.

The Seyfert spectra will also contain constant components; a normal galaxy spectrum will contribute a significant fraction of the total intensity in the V and B bands. Fitting the one constant and two variable components to the five-point spectra, in most objects a constant excess was left in the W band (at about 3200 Å). We identify this excess with the UV bump seen in AGN's below 3000 Å; it may be the black body radiation discussed by Malkan and Sargent (1982).

In summary, we suggest that the optical variability in the continuum of type 1 Seyfert spectra is caused by two components; the first is a Balmer continuum (with a temperature around 10000 K) that changes in intensity, the second is a power law with variable spectral index. In all cases the power law flattens when the object becomes brighter.

In order to reproduce a Seyfert spectrum we also need a normal galaxy component, which is important in the visual and to a lesser extent in the blue, and an ultraviolet component, only important in the W passband.

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