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X-RAY AND UV VARIABILITY OF MCG 8-11-11 IN 1983-86.

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1. INTRODUCTION

The Seyfert galaxy MCG 8-11-11 has been the target of a programme of coordinated observations in the X-ray, UV and optical bands. Preliminary results on the first observations were reported in Tanzi et al. (1984). A preliminary account of the complete series of X-ray and UV observations is given here.

2. OBSERVATIONS

a) X-ray

Nine X-ray observations (see Table 1) were carried out with Exosat in a standard weak source configuration. The Medium Energy proportional counter (ME) data cover the energy range 1-8 keV. The thin Lexan and Aluminium-Parylene filters were used with the Low Energy telescope (LE1) yielding two broad band measurements in the nominal energy range 0.02-2.5 keV.

No evidence of variability within each observation was found in either ME or LE data. The whole of each observing run was therefore combined to derive count rates and spectra.

The ME background was subtracted using the standard technique of swapping the two halves of the ME experiment in all but two cases, when no swap was performed. For the latter slew manoeuvre data were used. The background was found satisfactorily stable in all cases except for observation 8.

The integrated LE and ME count rates, corrected for dead time and position effects, are plotted as a function of time in Fig. 1.

The ME count rate spectra and the LE filter data were simultaneously fitted with a power law plus absorption by cold gas (cross sections after Morrison and McCammon, 1983). The uncertainties on the spectral parameters were estimated using chi-square grids. The results are reported in Table 1 and Fig. 2.

b) Ultraviolet

Ultraviolet spectra were obtained with IUE within 2 days from each of the X-ray observations, except for observation 7, when the target acquisition procedure failed. Both cameras (SWP 1200-2000 A and LWP 2000-3000 A) were used, except for observation 8).

All spectra are somewhat underexposed. Continuum fluxes in selected wavelength bands of 50 A were measured and best fitted with a single power law in the 1300-2800 A range, with a fixed reddening A_V=1.2 (see Clavel & Joly, 1984), using the extinction law of Seaton (1979). The results are reported in Table 1 and Fig. 1.

3. DISCUSSION

The average value of the column density determined from our observations is 1.9×10^{21} atoms/cm^2. This agrees well with the interstellar column of 2.1×10^{21} atoms/cm^2 derived from 21 cm measurements (Stark et al., 1986) and with the adopted interstellar extinction according to the relation of Bohlin (1975).

The spectral parameters are also close to those measured for the same source with the Einstein SSS (Petre et al. 1984). The average slope in the X-ray band is typical of Seyfert galaxies according to the HEAO-1 results (Rothschild et al. 1983).

Despite substantial variations in the X-ray intensity (a factor 2 maximum to minimum, and a factor 1.6 in 25 days) variations in spectral shape are small. It is worth noticing that there is a tendency for higher intensity spectra to be somewhat steeper. A similar behaviour is reported by Halpern et al (1985) for 3C 120, by Lawrence et al. (1985) for NGC 4051, by Morini et al. (1986) for Fairall 9, and by Perola et al. (1986) for NGC 4151.

In the UV range the spectrum is steeper than in the X-ray band and lies above the extrapolation from X-ray energies. An UV excess is therefore apparent. There is a significant correlation between spectral slope and intensity in the UV band, in the sense that the spectrum hardens with increasing intensity, a fact which is rather common in Seyferts (e.g. Ulrich, 1986).

The relation between the UV and X-ray light curves is intriguing. No peculiar variations are present in the first four observations. The X-ray flux, which is high in March 1985, falls to a low value in October 1985 and rises to its maximum in November 1985, while the UV flux is near the average in March and reaches its maximum in October. Unfortunately no UV observations are available in November 1985. Besides showing the necessity for a more frequent coverage, the present observations suggest that the UV excess apparent in the overall spectrum is either uncorrelated to the X-ray emission, or responds with a delay of nearly 200 days.

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Table 1 - Journal of observations and summary of results

Obs.	EXOSAT Observations					IUE Observations			
	Epoch year day	Energy index	N_H (10^{21} cm^{2})	χ^2_{red}	L_X	Epoch day	Energy index	χ^2_{red}	L_U
1	1983 312	0.70 +.10 -.10	1.75 +.75 -.75	0.75	1.0	312	1.53 +.10 -.10	8.8	1.6
2	1984 027	0.80 +.15 -.10	2.75 +1.3 -.75	1.31	1.3	026	1.75 +.09 -.09	6.3	1.7
3	1984 279	0.70 +.10 -.05	1.90 +.45 -.45	1.39	1.2	279	1.37 +.07 -.07	6.3	2.3
4	1984 306	0.70 +.05 -.05	1.90 +.45 -.30	1.18	1.5	306	1.67 +.07 -.08	7.6	1.9
5	1985 077	0.80 +.10 -.20	2.00 +.50 -.50	1.29	1.8	078	1.56 +.10 -.10	2.7	1.9
6	1985 282	0.75 +.10 -.05	1.40 +.20 -.20	0.54	1.2	282	1.19 +.07 -.07	5.0	3.6
7	1985 308	0.90 +.05 -.05	1.90 +.10 -.30	1.31	2.0	308	observation not performed		
8	1986 040	0.55 +.05 -.05	1.20 +.40 -.20	1.44	1.4	038	no SWP data available		
9	1986 057	0.75 +.10 -.05	2.25 +.50 -.25	0.94	1.5	056	1.46 +.10 -.10	6.8	2.0

Notes to table 1:

L_X is the luminosity at the source in the 0.5-8 keV band, computed with the hydrogen column density derived from the best fit. L_U is the luminosity at the source in the 1000-3000 A band, computed with A_V = 1.2. Both luminosities are in units of 10^{44} erg/s.

All uncertainties given on best fit parameters are 90% confidence limits. The number of degrees of freedom for the X-ray fits is 28, and for the UV fits varies between 9 and 19.

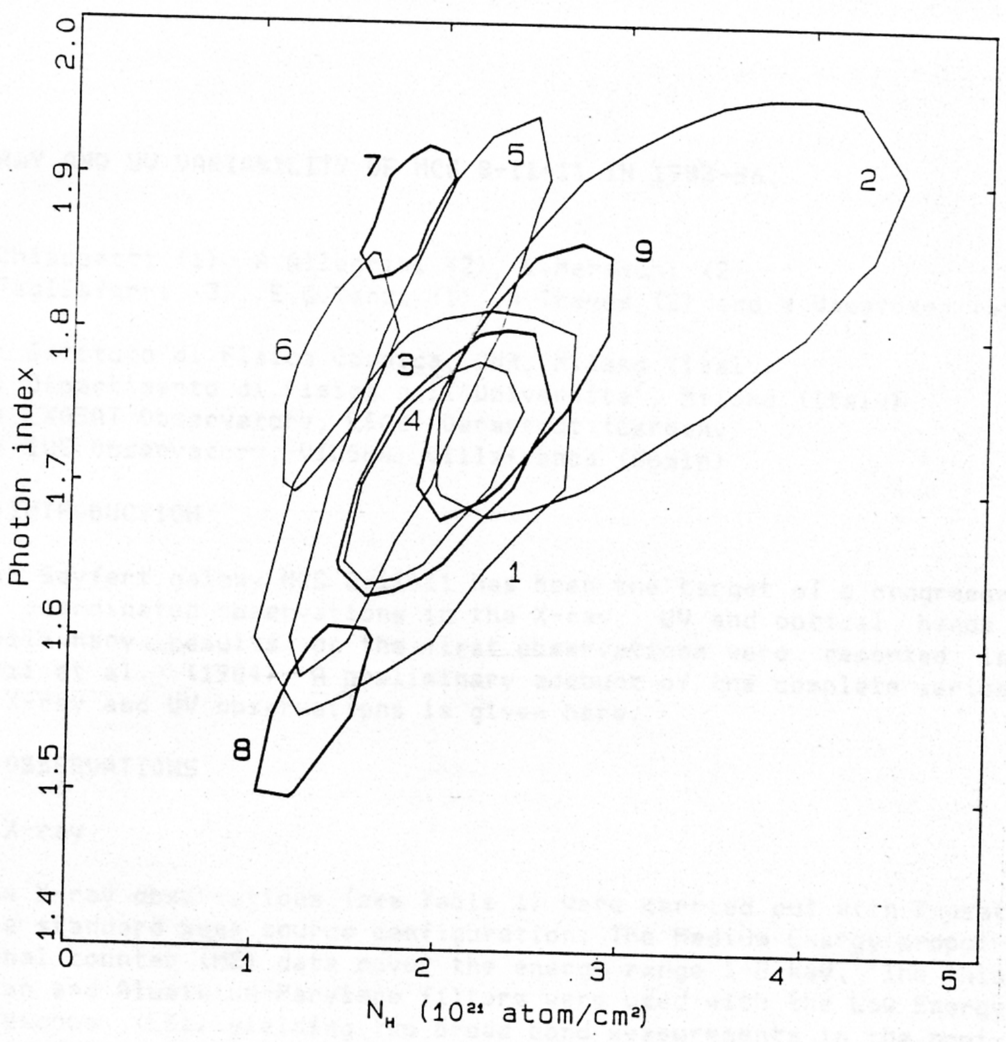

Fig.2 : 90% confidence contours from the X-ray best fits.