

## CHANGES IN THE LOW DISPERSION IUE SPECTRA OF $\mu$ Cep\*

D. Jevremović and I. Vince

*Astronomical Observatory, Volgina 7, 11050 Belgrade, Yugoslavia*

*E-mail:darko@aob.aob.bg.ac.yu , ivince@aob.aob.bg.ac.yu (Internet)*

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**SUMMARY:** We analysed low dispersion IUE spectra of cool dusty supergiant  $\mu$  Cep observed from 1979 to the end of 1989. We have found changes of "active regions" and continua's flux in these spectra similar to variations of optical linear polarisation degree during this period..

### 1. INTRODUCTION

Chromospheric activity of cool stars can be studied by analysing the near UV 2000 - 3200Å spectral region. This region contains several emission features which provide useful information about the nature of chromospheric activity of cool stars. Sten- cel et al. 1986 (SCH) identified these features in a sample of 14 late type stars with different gas to dust index (Hagen et al. 1983).

Dupree (1991) pointed out that there exists 420-day periodic modulation of the a Ori optical (at 4530 Å) and UV (at 3000 Å) continua, and in the cores of the Mg II (k 2795 Å and h 2802 Å) resonance lines. These observation results are mainly explained

by pulsation of stellar atmosphere.

In this paper we examine if there are any changes of flux in the active regions in red supergiant  $\mu$  Cep (HD 206936, M2Ia) by analysing its low dispersion IUE spectra.

### 2. ARCHIVAL SPECTRA AND REDUCTION

There are only nine long wavelength (LW) low dispersion spectra of  $\mu$  Cep in IUE archive. Dates of observations, IUE archive image numbers, durations of expositions and the program identifications (ID) of these spectra are given in Table 1.

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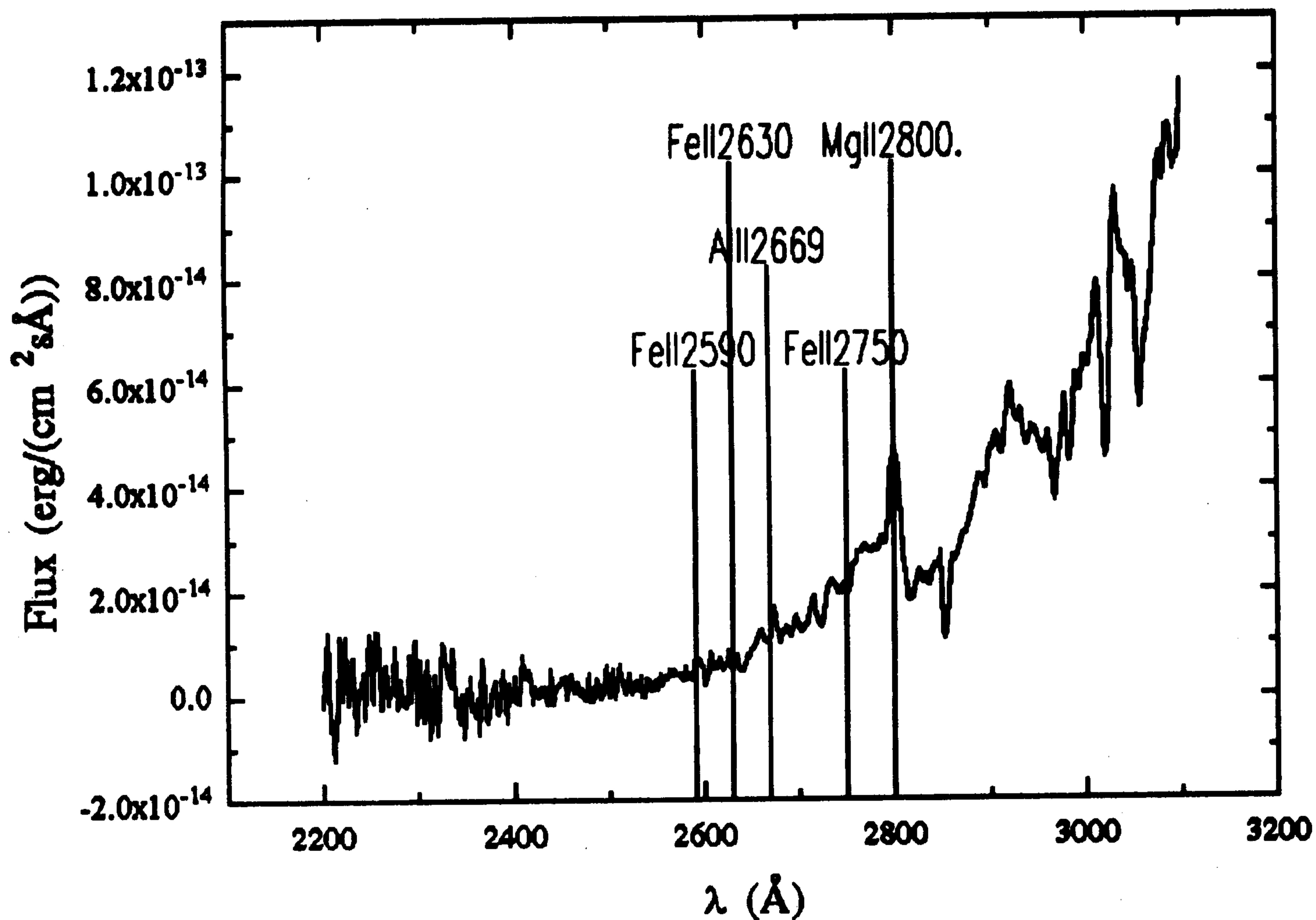
\* Based on the IUE archival research

**Table 1.** The IUE data of long wavelength low dispersion spectra of  $\mu$  Cep

Date	Image number	Exposition (s)	Program ID
July 20, 1979	LWR 5118	300	MLBFS
July 22, 1979	LWR 5149	1800	MLBFS
March 16, 1980	LWR 7204	2400	UK256
March 16, 1980	LWP 7205	18240	UK256
July 20, 1980	LWR 8300	2700	CCCRS
August 3, 1984	LWP 3928	3000	GC250
July 3, 1988	LWP 13554	3600	SACKW
November 16, 1989	LWP 16794	7800	LSLKC
December 30, 1989	LWP 17037	8100	SBLCW

We re-extracted these spectra from "line by line" files and applied to them absolute calibration given by Turnose et al. (1982). The LWR 5118 spectrum is underexposed and we did not use it in our further analysis. LWR 7204 and LWR 7205 spectra

are averaged with exclusion of the saturated regions in LWR 7205. We also obtained the integral flux of the 2500 - 3000 Å continuum region. A typical IUE LW spectra of  $\mu$  Cep with labeled active regions is shown in Fig. 1.

**Fig. 1.** IUE LWR 17037 spectrum of  $\mu$  Cep. Vertical lines show the active spectral regions.



## 3. CHANGES IN ACTIVE REGIONS

Stencel et al.(1986) identified eight active regions in spectra of cool giants and supergiant stars. Jevremović (1994) by examining the high dispersion

IUE LWP 8306 spectrum of  $\mu$  Cep found five active regions. Comparison between identification by Stencel et al. and Jevremović can be found in Table 2.

Table 2. Identified active regions in the low dispersion IUE spectra of  $\mu$  Cep

Active region	Wavelength coverage	Element and multiplet	Number of lines in SCH	Number of lines in Jevremović (1994)
Fe II 2590	2575-2610 A	FeII UV 1	3	3
		FeII UV 64	3	3
Fe II 2630	2605-2640 A	FeII UV 1	10	10
		FeII UV 64	1	1
		FeII UV171	1	1
Al II 2669	2660-2690 A	AlII UV 1	1	1
		CrII UV 7	0	2
		CrII UV 8	0	2
Fe II 2750	2710-2765 A	FeII UV 32	7	7
		FeII UV 62	8	4
		FeII UV 63	3	2
Mg II 2800	2780-2815 A	MgII UV 1	2	2

The obtained integrated flux in the active regions and continua 2500 - 3000A with corresponding 10 Figures 2-7.

All identified active regions of spectra and the continua show significant flux changes during the observed period. At the beginning of the observed period (1979 - 1980) the average flux was in all cases smaller than at its end (1988 - 1989).

The FeII 2750, MgII 2800 and AlII 2669 regions and continua have similar behaviour: rapid

increasing at the beginning, then decreasing to the secondary minimum at the middle and increasing to the end of the observed period. Similar variations are observed in degree of linear optical polarization during the same period (Arsenijević and Jankov(1990), Jevremović (1994)). Other two regions (FeII2590 and FeII 2630) have similar behaviour from the middle to the end, but just opposite at the beginning of observed period. We are not able to explain this behavior of active regions and continua properly yet.

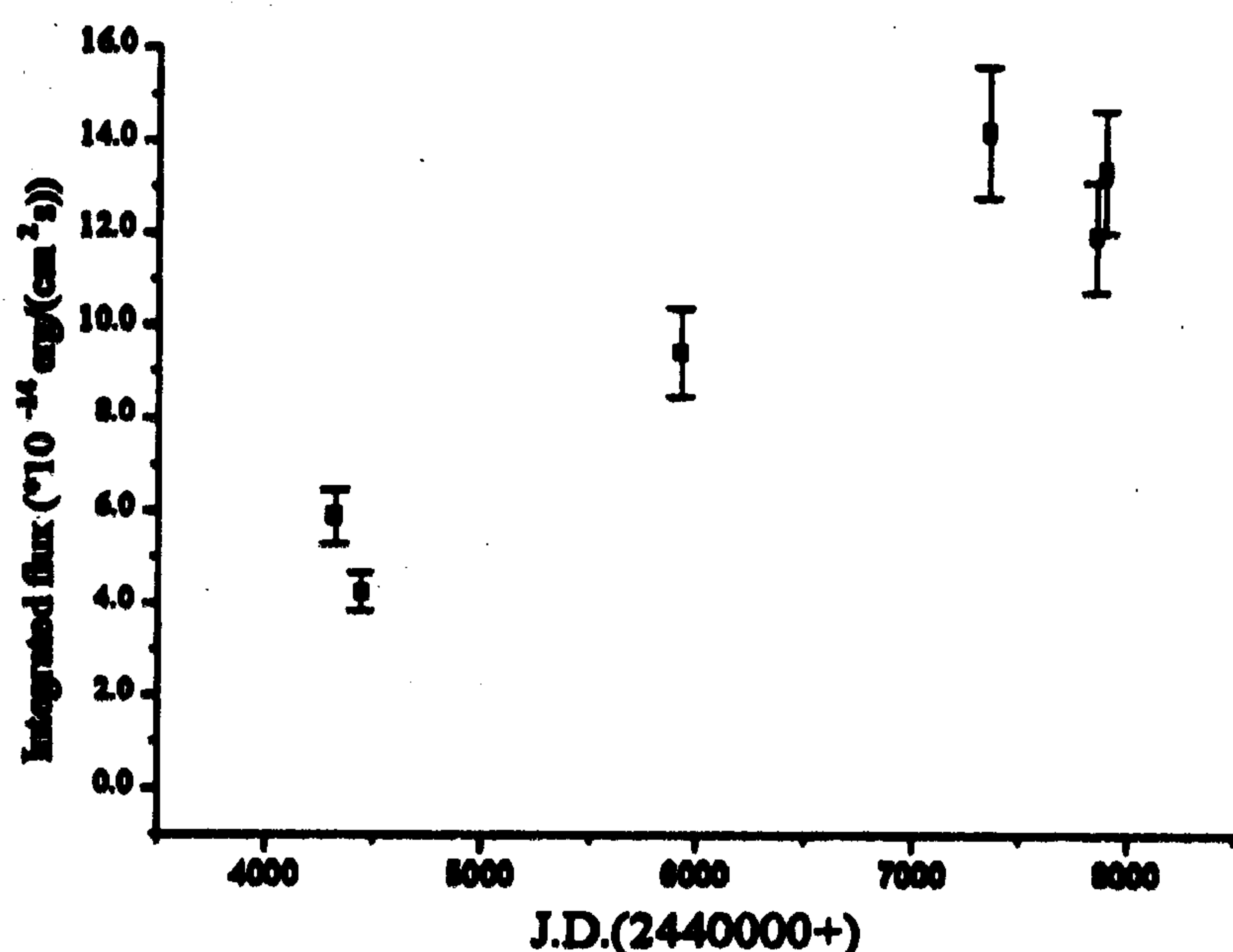


Fig. 2 Changes in integrated flux in FeII 2590.

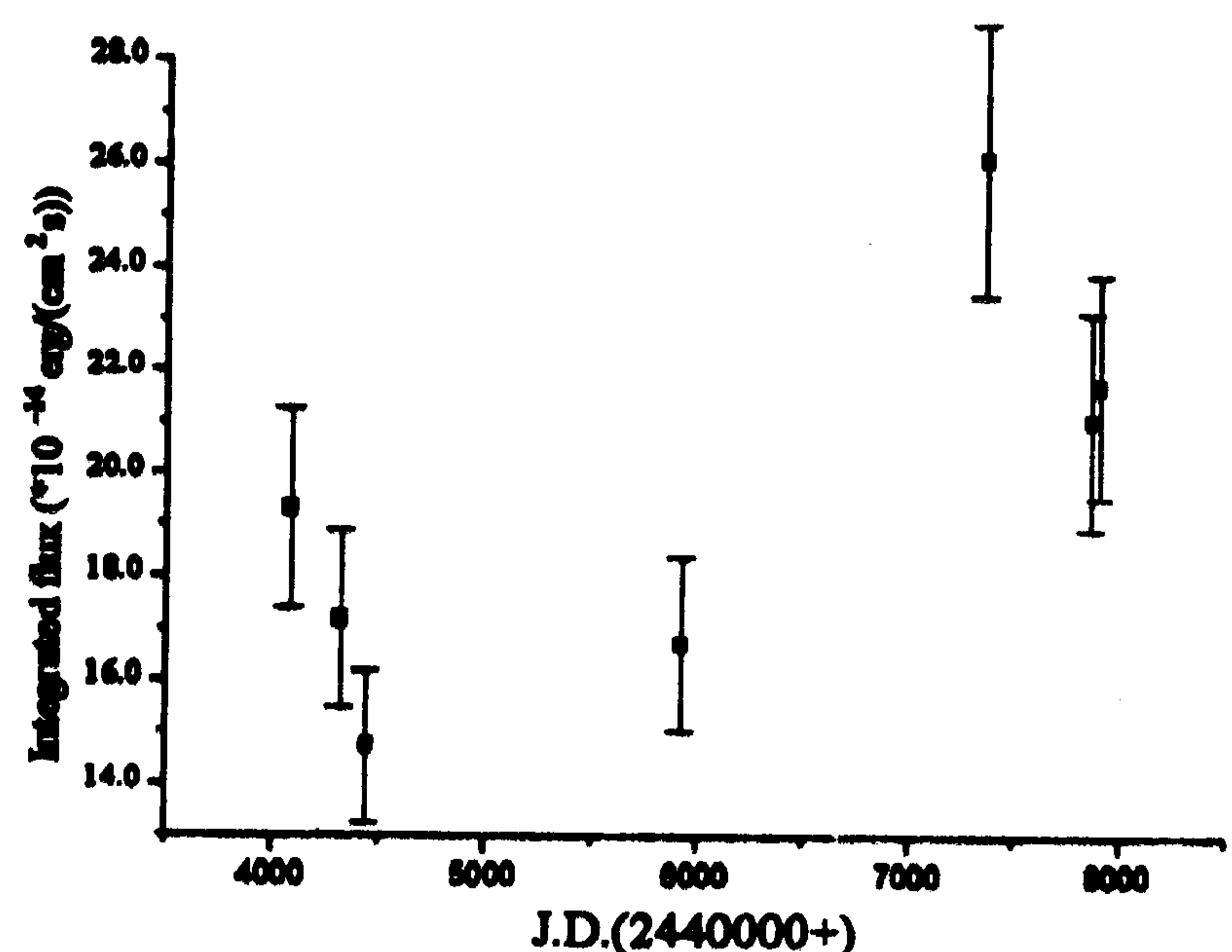


Fig. 3 Same as Fig. 2 for FeII 2630.



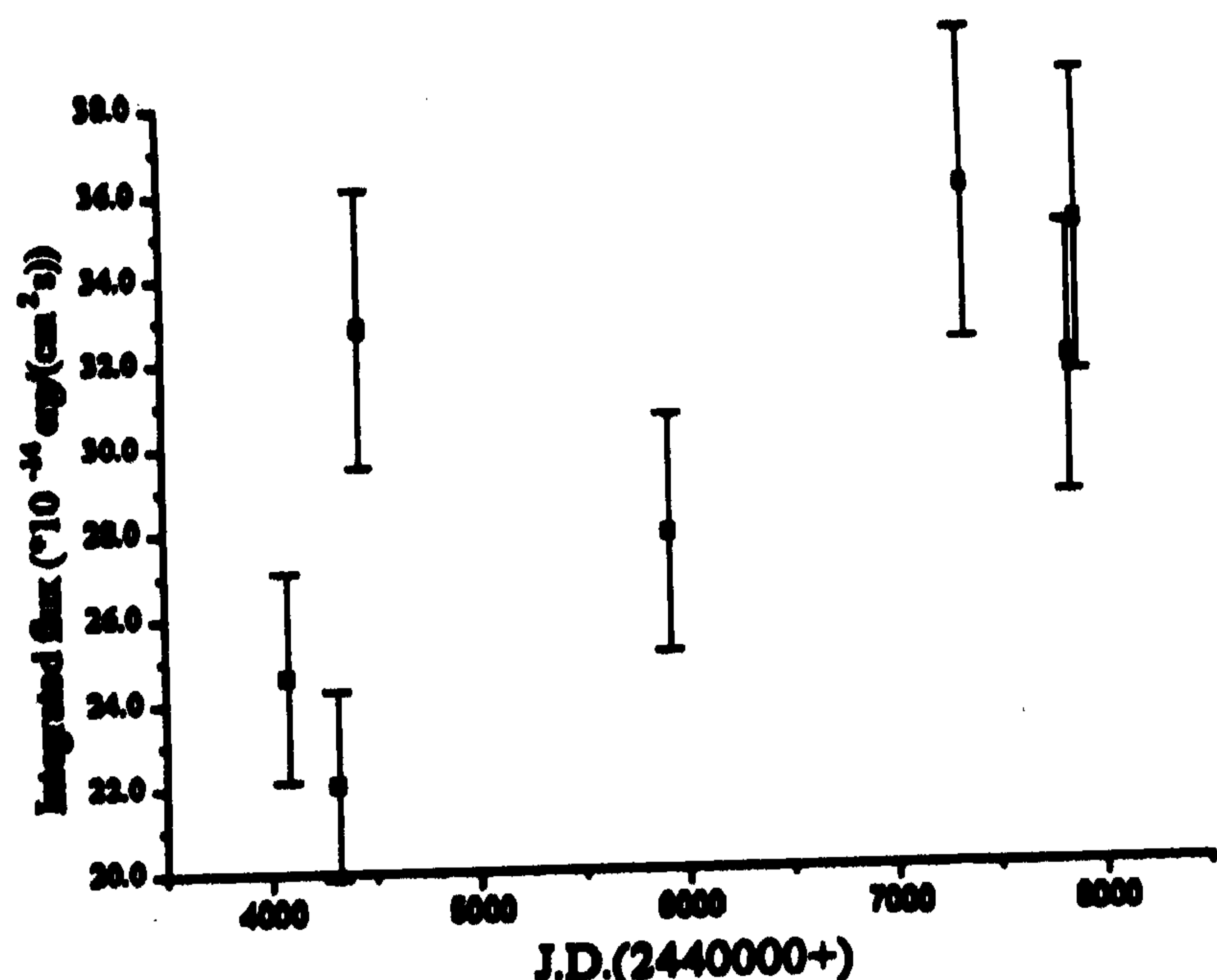


Fig. 4 Same as Fig. 2 for AlII 2669.

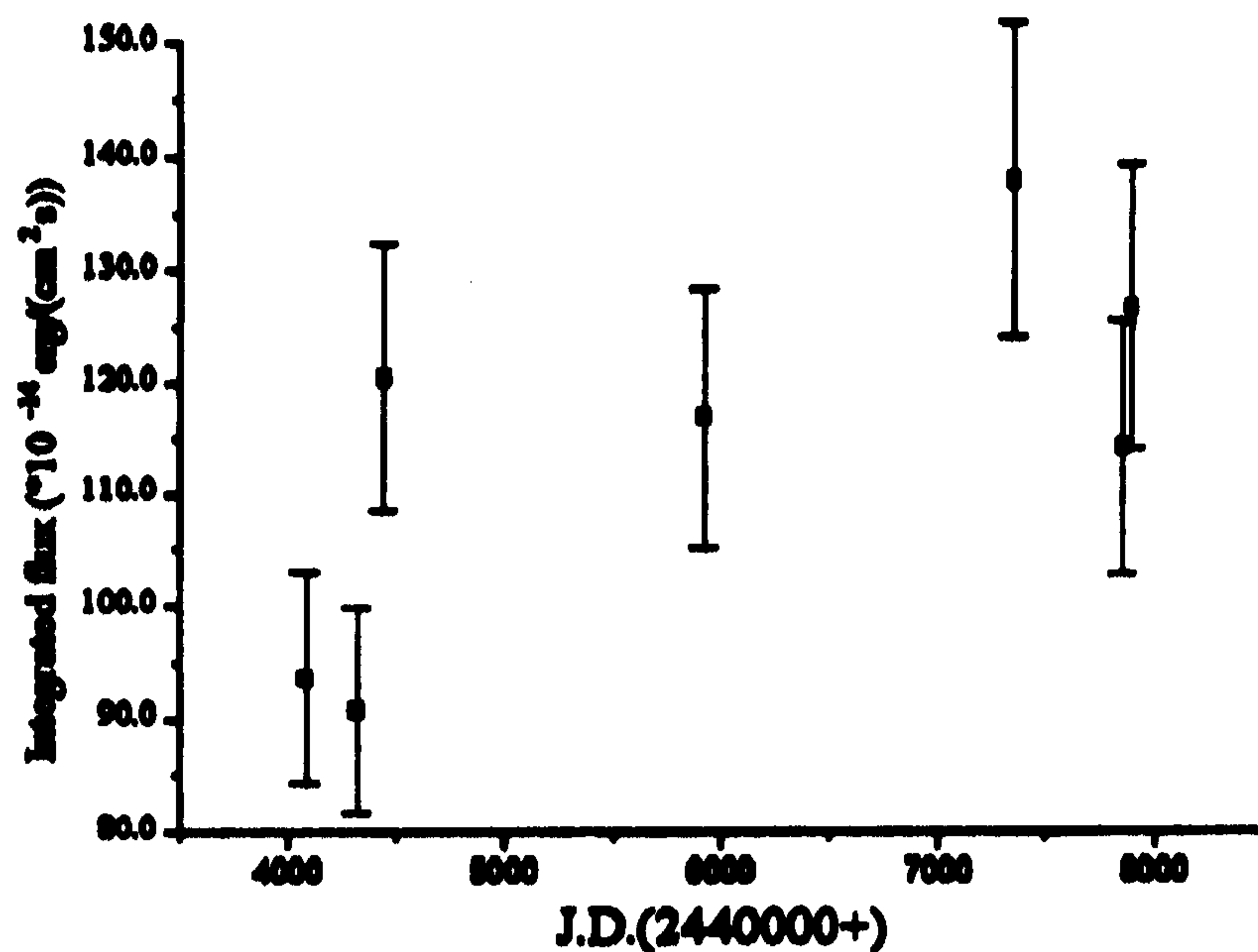


Fig. 6 Same as Fig.2 for MgII 2800.

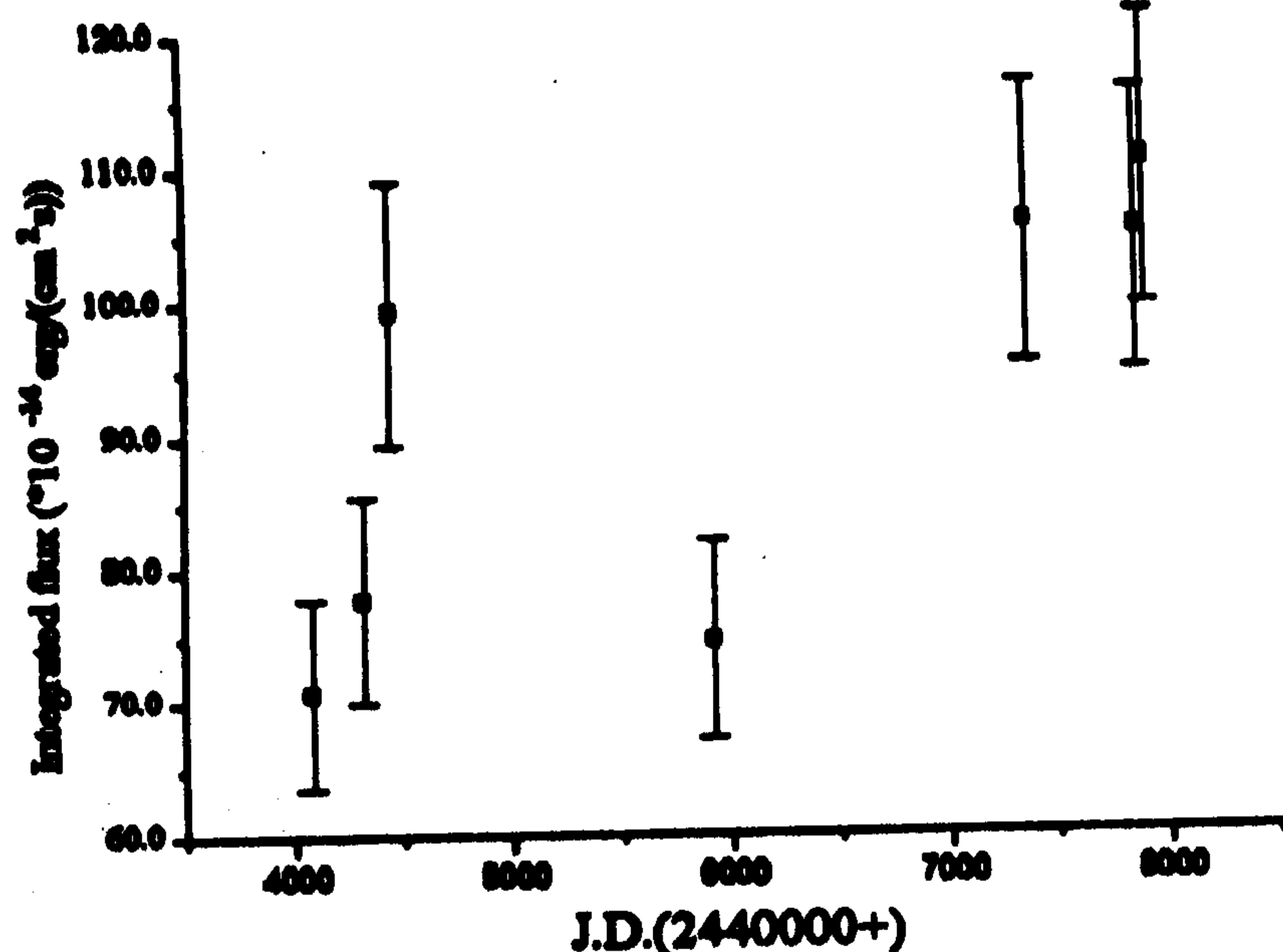


Fig. 5 Same as Fig. 2 for FeII 2750.

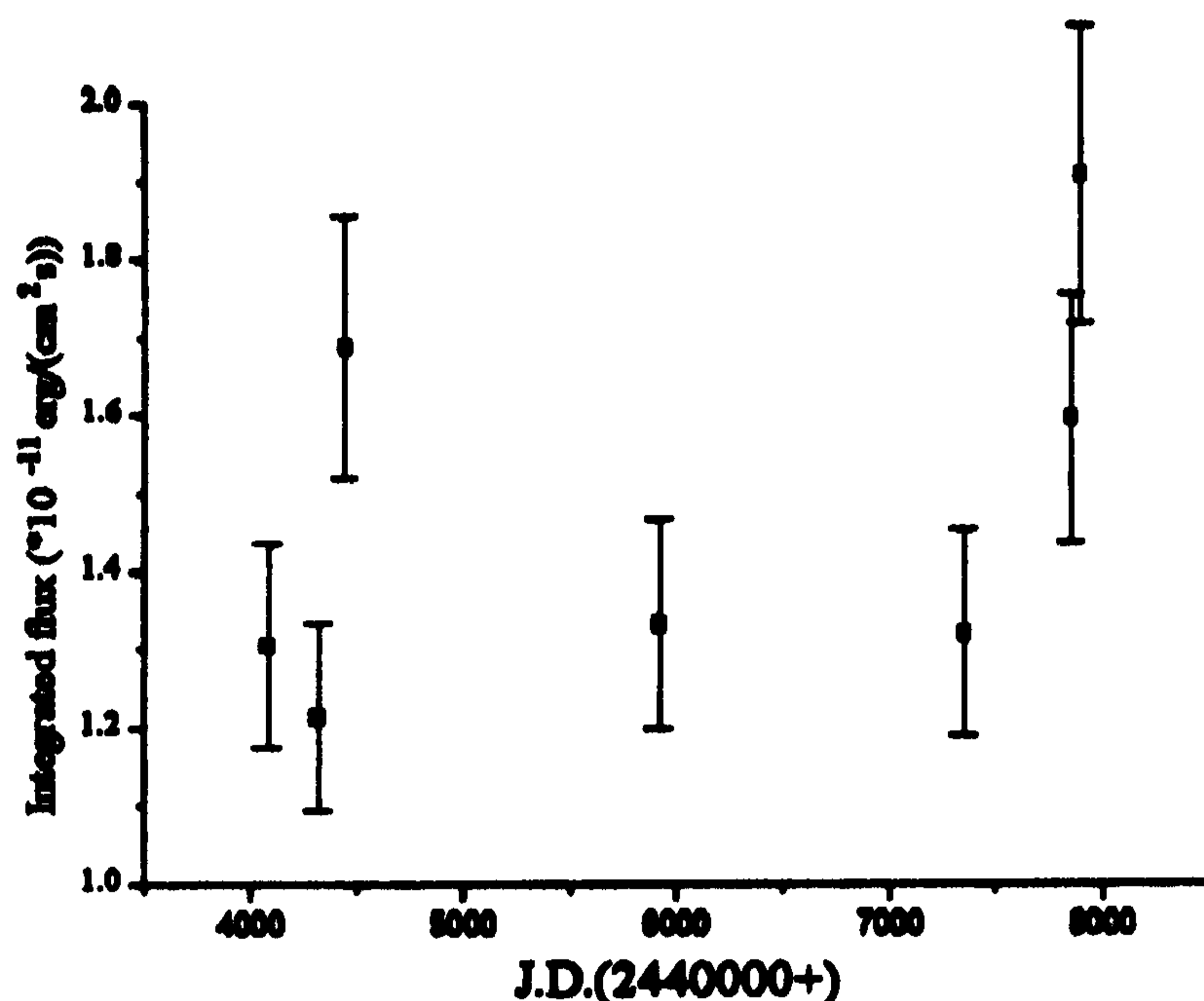


Fig. 7 Same as Fig.2 for continuum 2500-3000.

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**ПРОМЕНЕ У IUE СПЕКТРИМА  $\mu$  Сер НИСКЕ РЕЗОЛУЦИЈЕ**

**Д. Јевремовић и И. Винце**

*Астрономска опсерваторија, Волгина 7, 11050 Београд, Југославија*  
*E-mail: darko@aob.aob.bg.ac.yu , ivince@aob.aob.bg.ac.yu (Internet)*

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**Претходно саопштење**

Анализирани су IUE спектри ниске резолуције хладног суперфина  $\mu$  Сер из периода 1979-1989. Нађене су промене у флуksу активних обла-

сти сличне променама процента оптичке линеарне поларизације из тог периода.