SPECTROPHOTOMETRIC OBSERVATIONS OF UX ARIETIS

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Abstract. Spectrophotometric observations of the RS CVn binary UX Arietis have been presented. The comparison of the observed fluxes with model atmospheres indicates that during the four phases observed, the temperature does not vary significantly. However, brightness variation of $0\overset{m}{.}23$ are thought to be due to change in the surface emitting regions.

1. Introduction

The RS CVn star UX Ari (= HD 21242) is a non-eclipsing spectroscopic binary. The spectral types of the components of the system are given to be G5V and K0IV (Carlos and Popper, 1971). In this system, the more massive and cooler component is believed to be the source of spot activity causing variations in the light of the system. The light variations in such stars have been found to range from $0\overset{m}{.}1$ to $0\overset{m}{.}3$ in the visual band. The phases and amplitude of the light variation change with time. Spots on the surface of the cooler star corotating with the orbital period of the binary, and their drift in latitude on the surface of the star have been invoked to explain the change in the phase of minimum light as well as the amplitude of light variation. Noah *et al.* (1987) have given a spot model for UX Ari based upon the spectroscopic and photometric observations of the star. These authors have computed the spectrum from a combined G- and K-type photosphere in an 85 Å wide spectral region centered at λ6425 Å. In their computations they have assumed that the K-type component has regions of different sizes on its disc which are 1000 K cooler than the rest of the surface. Their diagram of spotted regions shows that approximately 9% of the visible disc of the star is covered by the cool spots. The star UX Ari has been observed spectrophotometrically to assess the change in temperature between the maximum and minimum of light.

2. Observations

The RS CVn variable UX Ari has been observed spectrophotometrically on four nights through the 104-cm reflector of the Uttar Pradesh State Observatory, Naini Tal. The dispersion of the scanner used is 70 Å mm^{-1}. Scanning width has been kept at 50 Å. The standard star ξ^2 Cet has also been observed on each night for converting the observed fluxes into standard ones. Cooled ($-$ 20 °C) EMI 9658 B photomultiplier and dc recording techniques have been used to secure the observations. The mean seasonal extinction coefficients have been applied to the observations to correct them for atmospheric extinction. The standard deviation of the observations of ξ^2 Cet on the nights of our observations does not exceed $0\overset{m}{.}06$ at λ5560 Å. The observations are given

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in Table I. The fluxes at different wavelengths relative to λ5560 Å have been shown in Figure 1.

The star has been observed on four nights. The phases are based on the ephemeris given by Carlos and Popper (1971); namely Primary Min. = J.D. (Hel.) 2440 133.766 + $6\overset{d}{.}43791E$, and are listed in Table II. Columns 1 and 2 of Table II list the date and mean time of our observations. Columns 3, 4, and 5 give the phase, the

TABLE I

The observed standard magnitudes ($-2.5 \log F_{\nu} + C$) of UX Ari

λ (Å)	λ^{-1} (μm^{-1})	J.D. 2446734.3132 Phase 0.26 Mag	J.D. 2446740.2003 Phase 0.18 Mag	J.D. 2446741.1622 Phase 0.33 Mag	J.D. 2446745.3491 Phase 0.98 Mag
3400	2.94	$8\overset{m}{.}656$	$8\overset{m}{.}574$	$8\overset{m}{.}709$	–
500	2.85	8.468	8.608	8.834	$8\overset{m}{.}508$
600	2.77	8.413	8.614	8.772	8.536
700	2.70	8.675	8.683	8.705	8.184
800	2.63	8.473	8.559	8.345	8.253
900	2.56	7.949	8.102	8.338	8.217
4000	2.50	7.573	7.721	7.690	7.631
100	2.44	7.364	7.556	7.542	7.324
200	2.38	7.367	7.521	7.471	7.458
300	2.32	7.258	7.254	7.333	7.363
400	2.27	7.104	7.215	7.203	7.063
500	2.22	6.933	7.090	7.012	7.060
600	2.17	6.807	7.012	6.935	6.941
700	2.12	6.801	6.993	6.863	6.904
800	2.08	6.709	6.762	6.834	6.841
900	2.04	6.702	6.820	6.813	6.716
5000	2.00	6.677	6.880	6.789	6.742
100	1.96	6.661	6.877	6.768	6.813
200	1.92	6.660	6.890	6.701	6.787
300	1.88	6.528	6.630	6.567	6.699
400	1.85	6.433	6.630	6.506	6.593
500	1.82	6.409	6.646	6.427	6.562
5560	1.80	6.385	6.616	6.417	6.510
600	1.78	6.348	6.575	6.407	6.458
700	1.75	6.312	6.521	6.341	6.458
800	1.72	6.238	6.442	6.290	6.421
900	1.69	6.173	6.416	6.283	6.338
6000	1.66	6.167	6.330	6.256	6.415
100	1.64	6.180	6.382	6.266	6.383
200	1.61	6.210	6.344	6.192	6.333
300	1.58	6.193	6.379	6.287	6.317
400	1.56	6.212	6.386	6.264	6.287
500	1.54	6.168	6.393	6.204	6.299
600	1.51	6.184	6.239	6.239	6.342
700	1.49	6.177	6.375	6.141	6.219
800	1.47	6.203	6.452	6.224	6.369
900	1.45	6.179	6.353	6.261	6.318
7000	1.43	6.189	6.442	6.295	6.384

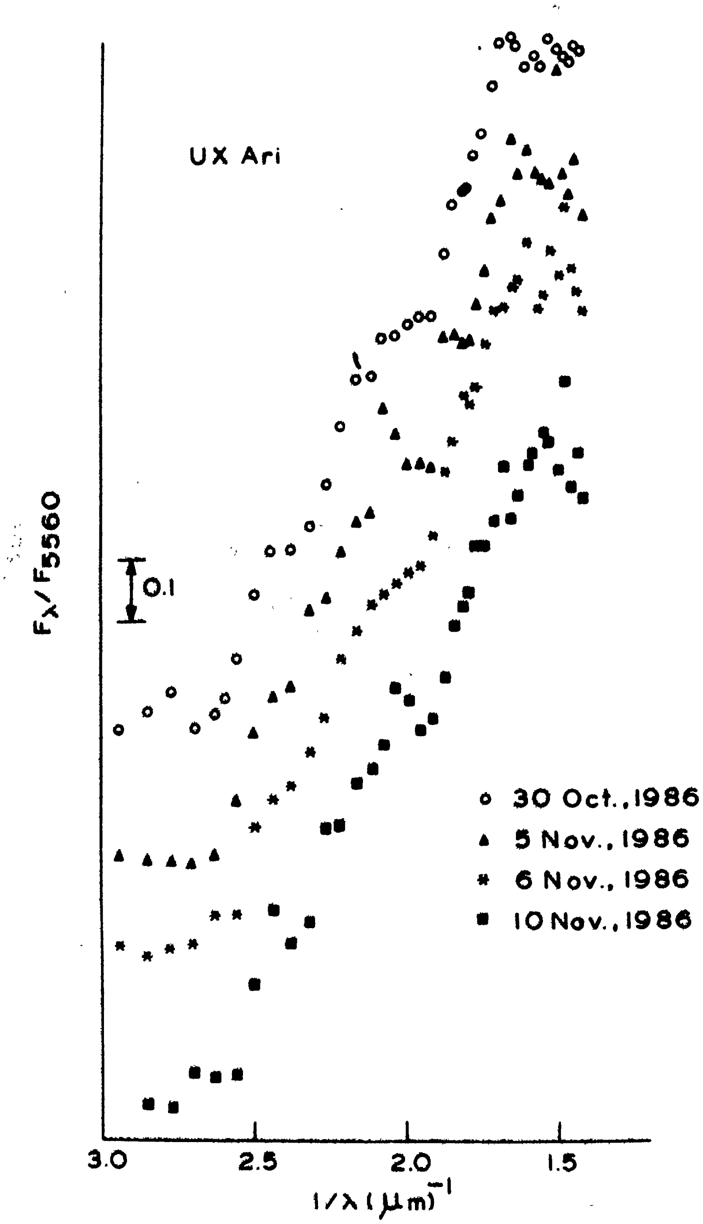

Fig. 1. Standard spectral scans of UX Ari.

slope of the energy distribution curve and the magnitudes at 5560 Å of the star on these nights. These magnitudes have been taken to be the V magnitudes of the star.

The values of amplitude ($A = 0^m.23$), magnitude ($V = 6^m.51$) and phase of wave minimum ($\phi_{min} = 0^p.18$) fairly conform to the values given by others (Sarma and Prakasha Rao, 1984; Mohin and Raveendran, 1989).

The observed energy distribution curves of UX Ari expressed as flux ratios with respect to the flux at 5560 Å have been compared by way of the apparent slopes of the fluxes between $\lambda^{-1} = 1.8$ and $2.5\ \mu m^{-1}$ with similar slopes obtained for the model

TABLE II

Observed results

Date	Time (UT)	Phase	Slope	m (λ = 5560 Å)
30 Oct., 1986	$19^h28^m.5$	0.26	0.71	$6^m.39$
5 Nov., 1986	17 45.4	0.18	0.72	6.62
6 Nov., 1986	15 46.7	0.33	0.72	6.42
10 Nov., 1986	20 25.4	0.98	0.67	6.51

atmosphere fluxes. For this comparison we have chosen Carbon and Gingerich's (1969) model atmospheres, because the lower range of temperatures encountered here is available in these models. The model atmosphere slopes for temperatures 4000, 4500, 5000, 5500, and 6000 K all for log g = 4, have been plotted against temperature. Figure 2 gives the trend of the slopes of 16 Cyg B (G5V) and η Ser (K0IV). Data for these latter stars have been taken from the catalogue of Breger (1976). 16 Cyg B and η Ser in this diagram have slopes corresponding to temperatures of 5750 and 3780 K. The temperature 5750 K for G5V star happens to be of the right order, but for η Ser there is a difference of about 1000 K for its spectral type. The two stars 16 Cyg B and η Ser are at distances of 19 and 16 pc, respectively, but 16 Cyg B is fainter by $3^m.10$ as compared to η Ser. If we add the fluxes of 16 Cyg B and η Ser after transferring the two stars to

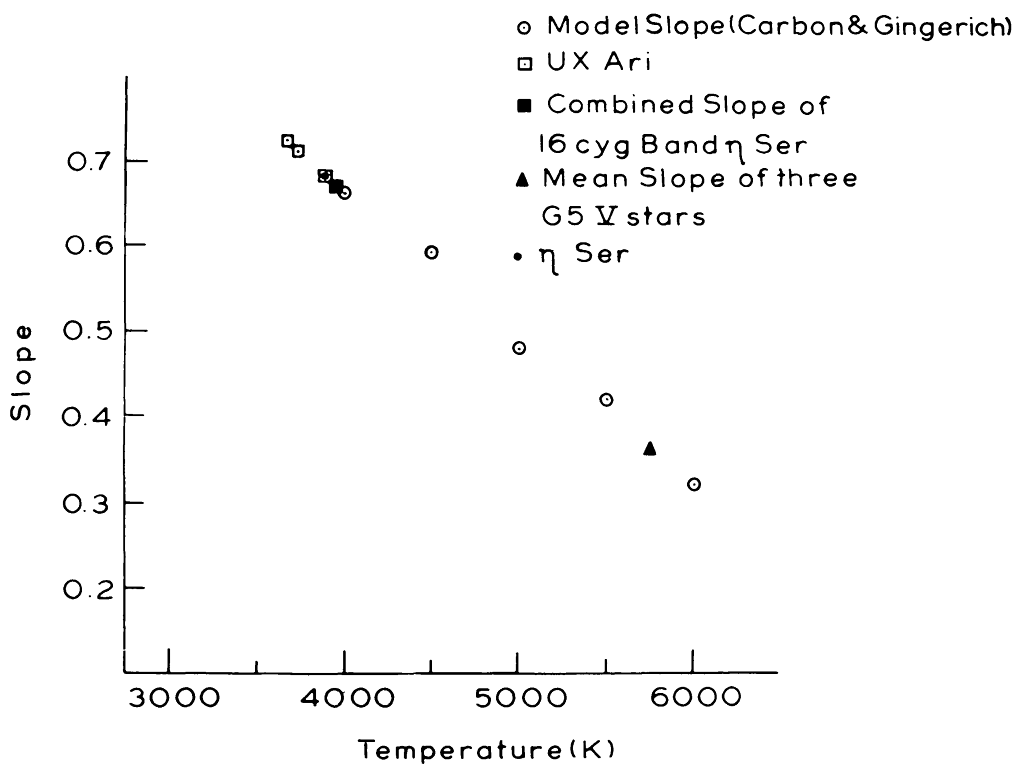

Fig. 2. Spectrophotometric slopes of the model atmospheres and various stars plotted against temperature.

the same distance to determine a combined slope of the flux ratio, we obtain a value corresponding to a temperature of 3900 K. The points for UX Ari on the four nights of our observations also lie around this value. This shows that the major contribution to the light of the system UX Ari is from the cooler component. The overall change in the temperature of UX Ari on the phases of our observations is quite small, only about 275 K. This value, however, cannot be taken to be significant. The visual magnitude of the star UX Ari on the above four phases varies from $6^m.39$ to $6^m.62$ giving a difference in the V magnitude of $0^m.23$. This magnitude difference corresponds to a brightness ratio of 1.24/1.

Dark spots on the surface of the cooler star are responsible for producing this change in brightness, although the net change in temperature of the system is not significant.

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