THE UNUSUAL OBJECT KR AURIGAE

M.D.Popova
Department of Astronomy, Academy of Sciences, Bulgaria

E.A.Vitrichenko
Institute for Space Research, Moscow, USSR

Abstract

The photometric and spectrographic data of the peculiar variable KR Aur have been analyzed. The H_β line contour shows an accretion with velocity of 3200 km/s. The assumption is made that KR Aur may be a black hole.

Variable star KR Aur (= S 5420 = Nova Aur 1960 - 64) was detected in 1960 (Popova 1960, 1961) on the plates of the Sonneberg Observatory. Four years later Hoffmeister classified it as a slow Nova of the RT Ser type, denoting it as Nova Aur 1960-64 (Hoffmeister 1965, 1970). More detailed photometric studies were carried out by Popova (Popova 1965a,b,1974,1975) based on a greater observational material. The plate collections in the Sonneberg and Tautenburg Observatories and in Astronomical Institute Sternberg, Moscow, were inspected and more than 400 plates were used. In addition some photoelectric measurements with 600 mm telescope of Belogradchik Observatory, Bulgaria, were obtained in the last years. These studies pointed out that it concerns an unusual type of blue variable. The star remains for very long intervals of time at maximum light and falls very rapidly to a deep, relatively short minimum. So, after the light curve it may be called more "Antinova" than "Nova".

The brightness of KR Aur varies from 11^m to 18^m (B). The mean magnitude in maximum is $13^m.4$. Noteworthy is the presence of rapid rises and declines of the brightness. For instance, the observations in two consecutive nights (2439442.5 - 2439443.5) showed a decline of about 2^m. In 1963 an outburst $2^m.4$ was observed and the variable attained $11^m.3$. Based on the observed minima a cycle of 2500 - 3300 days may be assumed.

It was worth-while to obtain the spectrum of KR Aur. An attempt was made by Preston, as it was reported in Agenda and Draft Reports IAU (1967). One of the authors (P) took objective-prism spectrum at maximum with 1ṁ (1:2.1) Schmidt telescope in the Bjurakan Observatory (Arm. SSR). Because of the low dispersion - 960 Å/mm at H_γ, the unique sure information was the considerable UV excess of the variable. The observed emission could not be correctly identified.

https://doi.org/10.1017/S0252921100069293 Published online by Cambridge University Press

At our request J.Berger and A-M.Fringant from Institute of Astrophysics, Paris took on 1.5m telescope in Haute - Province six spectra with image intensifier tube. Dispersion - 90 Å/mm, exposure - 60min. An example of the registration of one of the spectra in the region of 3700 - 5000 Å is shown on Fig.1. The following details may be

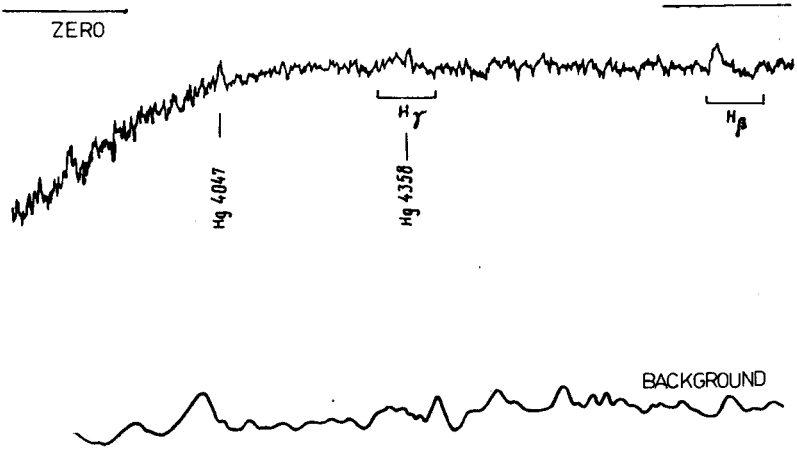

Fig.1. Spectrum of KR Aur (in density) in the region λλ 3700 - 5000Å

marked: two lines of mercury λλ 4047, 4358 (from town illumination) and the hydrogen lines H_β and H_γ. H_γ is blended by the line of mercury.

All spectra were recorded on the microphotometer for intensity in Crimean Observatory and averaged in the region of H_β. The averaged profile of H_β is given on Fig.2. The ordinate represents the intensity in fraction of continuum, the abscissa - scale for wavelength in km/sec. The red end is in the right. One can see that the profile of H_γ indicates accretion of matter on the star with an average velocity of 3200 km/sec. The profile of H_γ shows a similar structure but the blending from mercury line λ 4358 makes its analysis difficult. The known accretion on stars (Walker 1972, Conti 1972) shows velocities 100 - 400 km/sec.

The continuum of the spectrum in the visual region is flat, F=const.

The radial velocity of the star, estimated from the emission in H_β,

https://doi.org/10.1017/S0252921100069293 Published online by Cambridge University Press

is +130±30 km/sec.

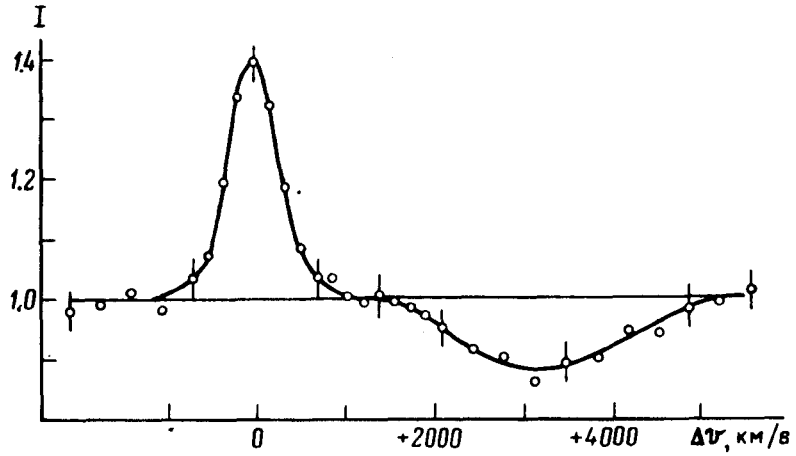

Fig.2. The contour of H_β averaged from the six spectra

At our request Shahovskoj N.M. and Efimov Ju.S. measured the polarization of KR Aur on 2.6m telescope of Crimean Obsrrvatory, USSR. A value of 0.3 ± 0.1% was obtained.

In close vicinity of KR Aur there are not detected sources of X-ray radiation, supernovae remnants, infrared sources, dark globules. There is a radio source at a distance of 11′ that possibly may be identified with KR Aur.
Coming out of the model of black hole (Bisnovatyi - Kogan, Ruzmajkin, 1974), KR Aur is at a distance of 300 ± 150 pc.

The characteristics of KR Aur do not contradict to the assumption that it is a black hole (Popova and Vitrichenko, 1977).

In addition we have a preliminary information that the significant proper motion was obtained recently for KR Aur, showing that it is in our Galaxy.

Now KR Aur is in maximum light and we attract the attention of the observers that some new observations will be very valuable to be obtained, especially spectroscopic ones with higher dispersion.

https://doi.org/10.1017/S0252921100069293 Published online by Cambridge University Press

We wish to express our thanks to Dr.J.Berger and Dr.A.M.Fringant who kindly took for us the spectra of KR Aur in Observatory Haute Provence and Dr.N.M.Shahovskoj and Dr.Ju.S.Efimov for measuring the polarization of the star.

References

Agenda and Draft Reports, IAU, 1967, Prague, 532

Bisnovatyi-Kogan G.S. and A.A.Ruzmaikin, 1974, Astrophys. and Space Sci., 28, 31

Conti P.S., 1972, Astrophys.J.(Letters) 174, 179

Hoffmeister C., 1965, Inf. Bull. IAU Var. Stars No 93, Budapest

Hoffmeister C., 1970, Veränderliche Sterne, Johan Ambrosins Barth, Leipzig

Kukarkin B.V. et al., 1971, General Catalogue of Variable Stars, Moscow, vol.III, 320

Popova M.D., 1960, MVS No 463

Popova M.D., 1961, Astr. Nachr., 286, 81

Popova M.D., 1965a, Inf.Bull.IAU Var.Stars No 97, Budapest

Popova M.D., 1965b, Var.Stars, USSR, 15, No 5, 534

Popova M.D., 1974, Late Stages of Stellar Evolution, Ed. Tayler, 192

Popova M.D., 1975, Astrophys. Investigations, Bulgarian Acad.Sci., 1, 68

Popova M.D. and Vitrichenko E.A., 1977, Astr.J.(Letters)USSR, 3, No6, 271

Walker M.F., 1972, Astrophys.J., 175, 89

D I S C U S S I O N of paper by POPOVA:

KOPAL: If the annual proper motion of KR Aur is indeed of the order of 0".01, it would follow that this star is not only within our Galaxy, but probably in our spiral arm (or, at most, one beyond it).

POPOVA: I have a preliminary telephonic information, that Mrs. Carimova from the Astronomical Institute, Sternberg, Moscow, has obtained this result, which will perhaps be published during the next months.

I would like to call the attention of observers to the fact that KR Aur is now in maximum light and it will be very valuable to obtain some new observations, especially spectroscopic observations of high dispersion.

KIPPENHAHN: May I just add a remark more on the side line? There is quite a number of prominent objects among the variables detected at Sonneberg Observatory. Hoffmeister has found HZ Her which turned out to be the famous X-ray source Her X 1, he detected BL Lac, the object astrophysicists later became excited about, and now with KR Aur he may have even found a black hole.