*From Interacting Binaries to Exoplanets: Essential Modeling Tools*
*Proceedings IAU Symposium No. 282, 2011*
*Mercedes T. Richards & Ivan Hubeny, eds.*

doi:10.1017/S1743921311027062

# Recent Spectral Observations of Epsilon Aurigae in the Near-IR

**Lubomir Iliev**

Institute of Astronomy, National Astronomical Observatory Rozhen
Bulgarian Academy of Sciences,
72 Tsarigradsko Shossee Blvd., BG-1784, Sofia, Bulgaria
email: liliev@astro.bas.bg

**Abstract.** High resolution spectral observations of $\epsilon$ Aur were carried out in the near-IR spectral range. Observations were obtained with the Coudé-spectrograph of the 2m RCC telescope at National Astronomical Observatory Rozhen and cover all main phases of the current eclipse. Results revealed for the first time absorption components in O I and Ca II triplets and variations of N I lines. Estimation of the electron density was done using lines from the Paschen series of hydrogen.

**Keywords.** Stars: variable, Stars: binaries: eclipsing, Stars: individual: $\epsilon$ Aur

## 1. Introduction

$\epsilon$ Aur exhibits distinguishing features of a classical binary system of Algol-type, but also attracts attention with a long list of yet unsolved problems. Kloppenborg *et al.* (2010) reconstructed 2-D images of $\epsilon$ Aur that demonstrate an eclipsing body moving in front of the central star. They estimated the mass of the primary F type star as 3.6 $M_\odot$ and the mass of the eclipsing disk. Analysis of the spectral energy distribution (SED) done by Hoard, Howel & Stencel (2010) reveal that the system of $\epsilon$ Aur consists of a post-asymptotic giant branch F type star and a B type MS star with mass 5.9 $M_\odot$ which is surrounded by a disk of gas and dust.

Spectral observations in the near-infrared proved to be a reliable and sensitive instrument for studying evidence of circumstellar matter in B, A and F type stars (see e.g. Slettebak 1986, Munari & Tomasella 1999) and could be used to answer questions about the origin and interaction of different components of the system of $\epsilon$ Aur.

## 2. Observations, results, discussion

All observations were carried out at the Coudé-spectrograph of the Rozhen 2m RCC telescope with a spectral resolution of R=21000 at wavelength 850 nm. They were obtained in 5 characteristic moments of the 2009-2011 eclipse of the $\epsilon$ Aur system: ingress and regress parts of the eclipse, first half, central part and second half of the totality. The O I triplet at 777 nm was chosen as the main target of the observing runs as it is a sensitive indicator of luminosity effects. Strong lines of the infrared Ca triplet, Paschen series of the hydrogen and N I were also studied. The investigation of these lines shows no existence of sharp absorption cores or emission features that are usually connected with the presence of cool or hot gas formations in the binary system.

Observations from March 2010 and March 2011 included the hydrogen Paschen series. Lines from this series were resolvable up to quantum number n=25 (see Fig. 1a). Applying

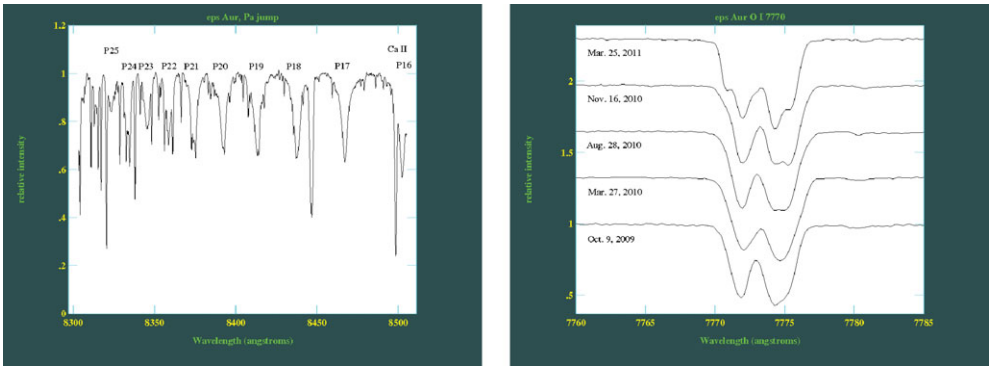


**Figure 1.** (a) Paschen series jump of eps Aur on frame from March 27, 2010. Continuum rectification was done on the red slop of the series. (b) O I 777nm triplet profiles obtained at different stages of the eclipse. Component structure developed after mid-eclipse.

the Inglis-Teller formula with coefficients given by Allen (1973), we estimate the electron density in the atmosphere of the visible component of $\epsilon$ Aur:

$$logN_e = 12.215449$$

This value is higher than expected for the F type giant or supergiant star and could be regarded as evidence of the existence of circumstellar gas formations around the primary, or as is supposed by Chadima *et al.* (2011), around the complex structure of the secondary.

Frames of the O I triplet feature (777.195, 777.418, 777.54 nm) were taken during all sets of observations. From August 2010 additional absorption components started to develop (Fig. 1b) and on March 25, 2011 there are already both redshifted and blueshifted ones. The displacements of the lines are 40.514 km s$^{-1}$ and 44.396 km s$^{-1}$, respectively. Although not so prominent as those seen in the O I triplet, lines of the Ca II infrared triplet (849.8, 854.2, 866.2 nm) also show the presence of components starting from November 2010. Absorption component structures in these lines are observed in the spectrum of $\epsilon$ Aur for the first time and are also evidence for gas structures in the system.

We search our spectra for variations in the lines of Paschen series of H I and some strong lines of N I during the eclipse. In neither of them were there any absorption components.

It should specially be noted that N I lines at 862.9 and 856.7 nm followed the same trend already observed for K I lines. They increased their equivalent length by 15% and 21% respectively during the ingress phase of the eclipse.

## References

Allen, C. W. 1973, in: *Astrophysical Quantities*, 3rd ed., The Athlone press

Chadima, P., Harmanec, P., Bennett, P. D., Kloppenborg, B., Stencel, R.,Yang, S., Bozic, H., Slechta, M., Kotkova, L., Wolf, M., Skoda, P., Vortruba, V., Hopkins, L. J., Buil, C., & Sudar, D. 2010, *A&A*, 530, 146

Hoard, D. W., Howel, S. B., & Stencel, R. E. 2010, *ApJ*, 714, 549

Kloppenborg, B., Stencel, R., Monnier, J., Schaefer, G., Zhao, M., Baron, F., McAlister, H., Ten Brummelaar, T., Che, X., Farrington, C., Pedretti, E., Sallave-Goldfinger, P. J., Sturmann, J., Sturmann, L., Thureau, N., Turner, N., & Carroll, S. M. 2010, *Nature*, 464, 870

Munari, U. & Tomasella, L. 1999, *A&ASS*, 137, 521

Slettebak, A. 1986, *PASP*, 98, 867

https://doi.org/10.1017/S1743921311027062 Published online by Cambridge University Press