Discovery of Disk Origin Narrow Metallic Absorption Lines Observed during the 2009–2011 Eclipse of ϵ Aurigae

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The long period (27.1 yr) eclipsing binary ϵ Aur (HD 31964) consists of an F0 Ia supergiant star (primary) and an unseen secondary which is believed to be embedded in a thick opaque disk. The central problem concerning this system is that whether the primary star is a ordinary massive supergiant (~15 $M_{\odot}$), as its spectrum implies, or a less massive star at the post-AGB stage of evolution. We initiated spectroscopic observations of ϵ Aur on 2008 October 1 using the HIDES spectrograph (Okayama Astrophysical Observatory) and the GAOES spectrograph (Gunma Astronomical Observatory). The principal aim of the long-term monitoring observation is to clarify the nature of the primary by means of analyses of line profile variations.

ϵ Aur (HD 31964) has recently finished a two years long eclipse starting in 2009 August and ending in 2011 August. From observations obtained during the eclipse, we noticed temporal appearances of low excitation absorption lines of neutral iron peak elements [1]. Several 0 eV lines of Fe I are detected near the end of the first half of the eclipse. They had migrated toward shorter wavelength and became much strong after the third contact and then disappeared after the fourth contact (Figure 1). The radial velocity measured for these lines follows that of the K I line at 7699 Å, implying that these lines originate in a rotating disk around the secondary star which occults the primary star (Figure 2). A close inspection of the data shows that the velocity of the Fe I line is larger than that of the K I line. This means that the Fe I line is formed at a inner part of the disk than the formation region of the K I line.

Similar behaviours are found for low excitation lines of several iron peak elements such as Sc I, Ti I, V I, Cr I, and Mn I. These lines are observed for only a short period between the third contact (2011, March) and the fourth contact (2011, August).

These observations demonstrates that the disk around the secondary is axially non-symmetric and a clump of relatively cool gas is concentrated in a relatively small localized region of the disk located at the egress side.

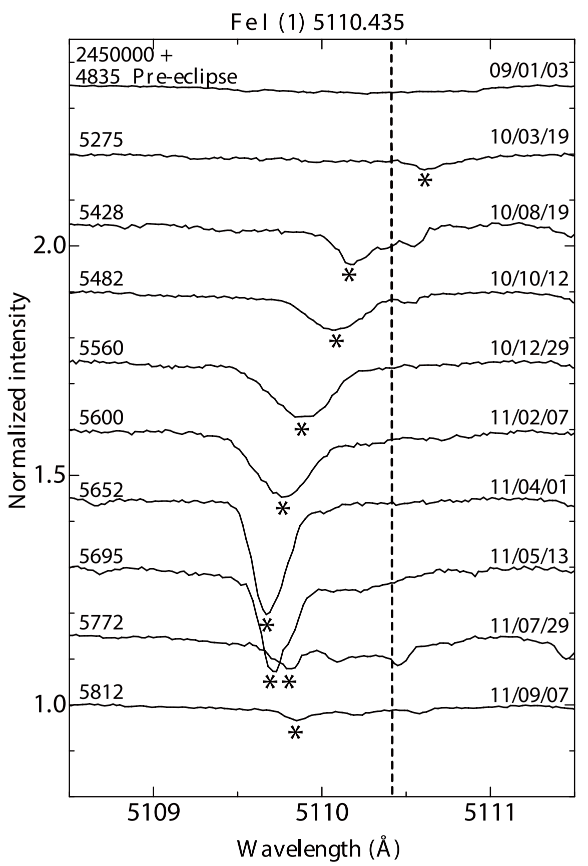

Figure 1: Time variation of an temporal absorption line. Vertical dashed line shows the rest wavelength. No trace of the line is visible outside of the eclipse phase.

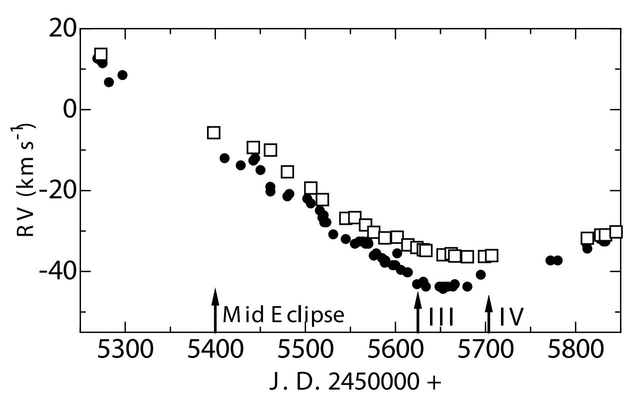

Figure 2: Variation of radial velocities of a Fe I line at 5110.435 Å (filled dots) and the K I resonance line at 7698.97 Å (open squares). Symbols III and IV indicate epochs of the third and the fourth contacts, respectively.

Reference

[1] Sadakane, K., Kambe, E., Hashimoto, O., Honda, S., Sato, B.: 2013, *PASJ*, **65**, L1.