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VARIABLE RESIDUAL ABSORPTION SPECTRA OF AB AURIGAE

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AB Aur (spectral type A0e, V = $7^{\rm m}$) is the brightest Herbig Ae star of the northern hemisphere, and is often considered as the prototype of the pre-main sequence objects of intermediate mass (2–5$M_\odot$). This type of stars shows conspicuous signs of extended chromosphere accompanied by intense activity and strong stellar winds. On VSNET mailing list Poyner (1997) reported that AB Aur suddenly faded by one magnitude in Dec. 2, 1997. One of the authors, Fujii observed AB Aur with his low-dispersion spectrograph attached to 28-cm Schmidt-Cassegrain telescope at Fujii Bisei Observatory several times before and after the sudden fading. His spectra showed that the emission lines near HeI5876Å and NaD were drastically variable. In order to investigate the spectral variation in detail, we carried out spectroscopic observations with the grating spectrograph attached to the 1.01-m telescope (F/12) of Bisei Astronomical Observatory, Okayama, Japan.

The variability of the HeI 5876Å emission line had been reported by many authors (e.g. Catala et al. 1993, Böhm et al. 1996), among which the MUSICOS 1992 campaign was the most extensive one. The four telescopes joined the campaign monitored the evolution of HeI emission line at a spectral resolution of 30000 for about 4 days. Since the HeI profiles showed rapid and remarkable variation with the period of $\sim$ 32 hours, Böhm et al. (1996) selected several profiles which appeared most frequently in their campaign, and regarded their average as "basic"-profile. The "basic"-profile is a very broad emission which has an equivalent width of -750 mÅ and a FWHM of 350 km/sec. The residual spectra which was produced by subtracting "basic"-profile from all spectra showed an almost flat, deep broad symmetric absorption or a combination of emission and absorption. They considered that the HeI emission generated from extended chromosphere of AB Aur and the variable HeI line is composed of two components, one is the "basic"-component and another is the rotationally modulated absorption component caused by azimuthal structures of stellar surface.

We observed HeI 5876Å emission line of AB Aur on ten nights between Jan. 5 and Feb. 17 in 1998. A series of HeI spectra was obtained with linear dispersion of 13 Å/mm and resolution of 10000. The detectors used were the liquid-nitrogen-cooled CCD camera Astrocam 4200 series with UV-coated 1024 $\times$ 256 pixels EEV CCD before Jan. 29 and thereafter the Electronic-cooled CCD camera ST-6 (SBIG) with TC241 375 $\times$ 242 pixels CCD. The exposure time of all observations was 10 min. Before and after each exposure we

obtained comparison Fe-Ne frames for the wavelength calibration. To reduce and analyze our observations, NOAO IRAF (Image Reduction and Analysis Facility) software was used. The raw spectrum images were bias-subtracted and flat-fielded, then stellar spectra were extracted from spectrum images. All spectra were normalized by continuum flux. The radial velocity was corrected to heliocentric radial velocity. The standard deviation of radial velocities of NaD_1D_2 interstellar absorption lines is 5 km/sec.

The HeI 5876Å emission line of AB Aur is generally variable, showing complicated profile which consists of very broad single emission, blue-shifted single emission, or a combination of blue-shifted emission and red-shifted absorption. We have analyzed the profile variation with the following method. The "basic"-profile is defined as an average of profiles which not only frequently appeared but also had the smallest equivalent width (i.e. integrated intensity of HeI emission is maximum), because we assume that the variability of profiles is caused by an absorption component. Then, we select three spectra (Feb. 5 11:31UT, Feb. 5 11:57UT and Feb. 5 12:23UT) which have the smallest equivalent width in our observations, and we have regarded its average as our "basic"-profile.

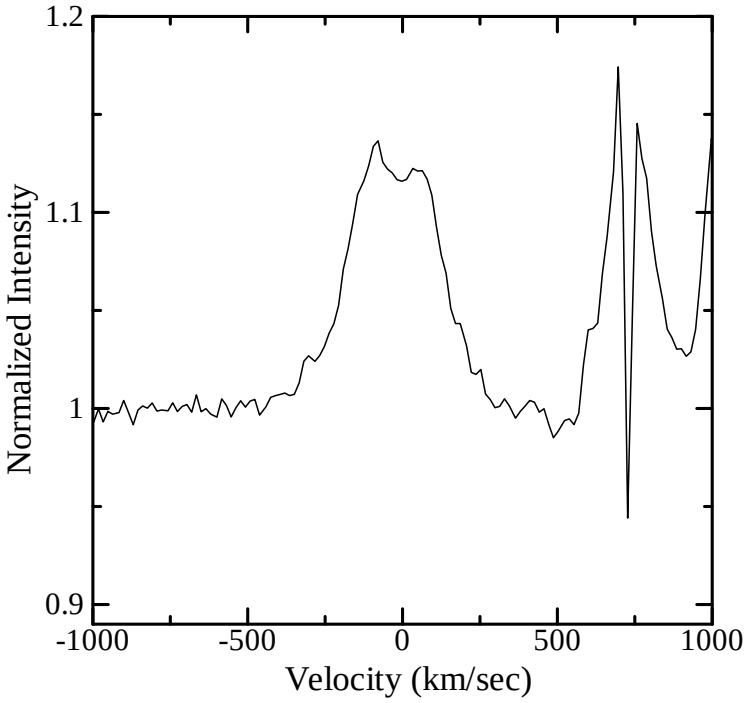

Figure 1. The "basic"-profiles of HeI which is an averaged profile of the three spectra with maximum emission feature in our observations.

Fig. 1 indicates our "basic"-profile which has a symmetric and slightly blue-shifted broad emission, i.e. the equivalent width, FWHM and the centroid-position are -925 mÅ, 330 km/sec and -7 km/sec, respectively. If we admit the heliocentric radial velocity of AB Aur is $+21 \pm 10$ km/sec (Finkenzeller, 1983), this profile suggests that the chromosphere is expanding. By the reason that the chromosphere is hotter than the photosphere, the emission line does not show the P-Cygni profile. Fig. 2 shows residual profiles which were produced by subtraction of the "basic"-profile from all spectra. It is apparent that the residual profiles appear as a sequence of single absorption component slightly redward shifted.

Fig. 3 shows the relation between the equivalent width and the central velocity of residual absorption profiles except for the almost flat spectra from Feb. 5 10:15UT to 14:05UT. The central velocity is measured by gaussian-fitting. It obviously shows that the central velocity of residual absorption widely spreads from −60 km/sec up to 100 km/sec, and the absorption intensity reveals some dependence on the central velocity, taking a maximum intensity at around 30 km/sec. This behavior may be explained by some longitude-dependent structure of cold absorbing material appeared in the outer part of the stable expanding chromosphere of AB Aur. For further investigation of the structure of absorbing material, monitoring observation of the HeI emission line with enough coverage of period is desirable.

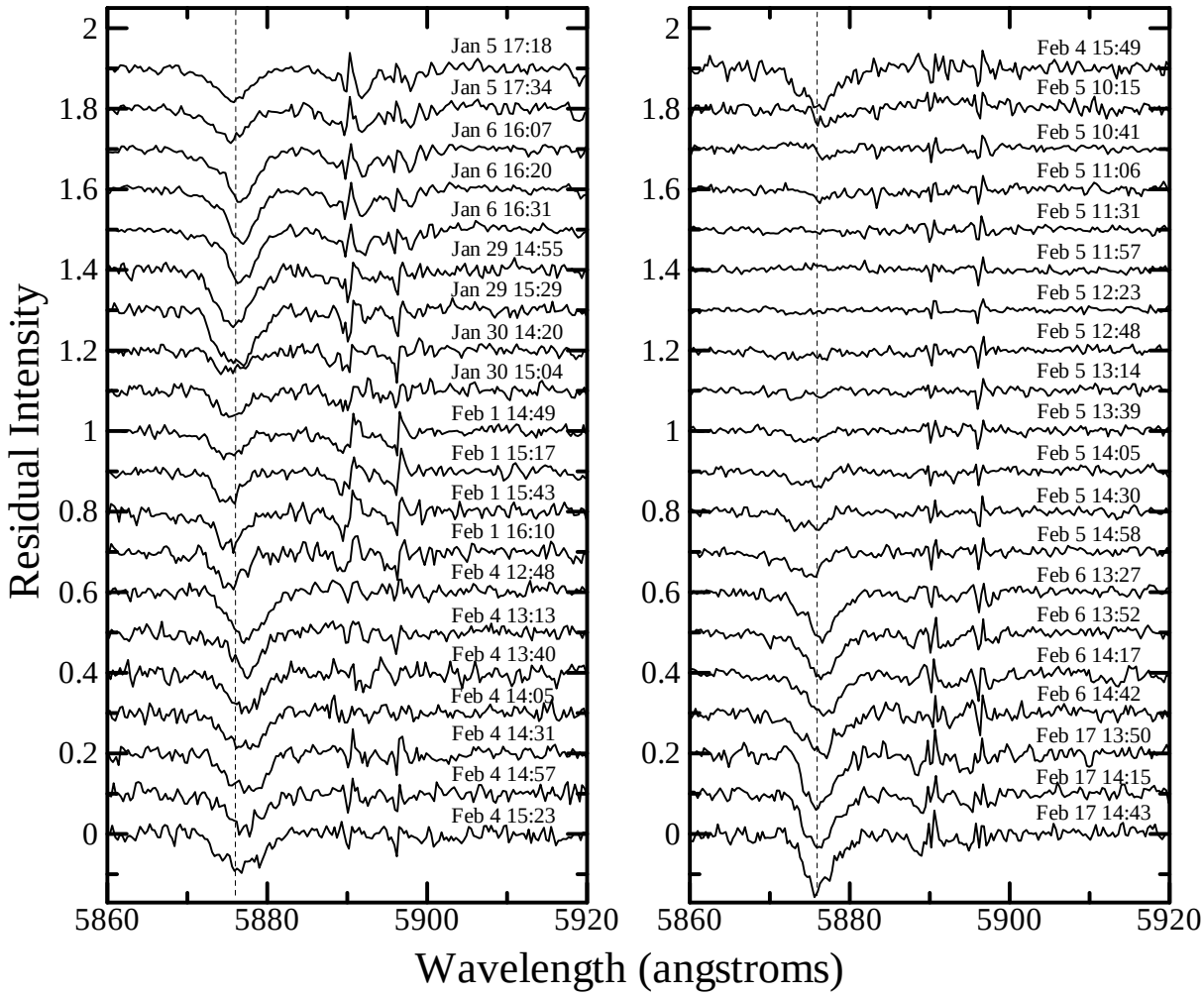

Figure 2. The residual profiles from Jan. 5 to Feb. 17 in 1998 were produced by subtracting the "basic"-profile from all spectra. The start in time of exposure is shown in UT. The vertical dash-line represents the rest wavelength.

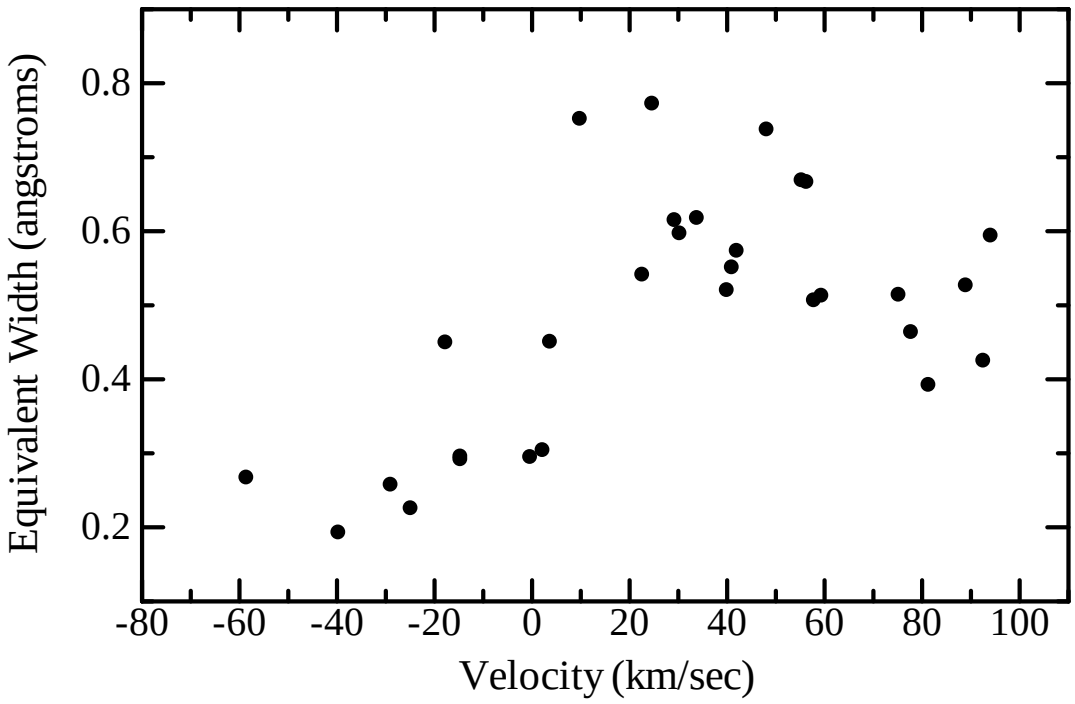

Figure 3. The relation between the equivalent width and the central velocity of residual absorption profiles is shown. The unit of equivalent width is defined by the "basic"-profile continuum level in Fig. 1.

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