Dust distribution around Herbig Ae/Be stars revealed by 10 micron band spectro-astrometric observations with Subaru/COMICS

Yoshiko Okamoto[1]; Hirokazu Kataza[2]; Mitsuhiko Honda[3]; Itsuki Sakon[4]; Takuya Yamashita[5]; Hideaki Fujiwara[6]; Takashi Miyata[7]; Shigeyuki Sako[3]; Takuya Fujiyoshi[8]; Takashi Onaka[3]

[1] Ibaraki Univ.; [2] ISAS; [3] Department of Astronomy, University of Tokyo; [4] Dep. of Astronomy, Univ. of Tokyo; [5] National Astronomical Observatory,Japan; [6] Dept. of Astronomy, Univ. of Tokyo; [7] Insititute of Astronomy,University of Tokyo; [8] Subaru Telescope, NAOJ

Protoplanetary disks contain large amounts of dust grains, which emit differently according to physical conditions of the disks and according to planetary system evolution.

So far, disk dust spectra have been discussed based on aperture observations even under the ground-based observations. Many type of dust features have been detected and they were interpreted that they suggest different disk structures, optical depth, grain growth, and grain annealings, and so on. There, spatial distributions of the spectra have been rarely not discussed. However, if we resolve the disk spectra spatially, we can discuss how different kinds of dust grains distribute in the disks. Also spatial distributions of temperature and radiative environment of dust grains can be revealed. They are very interesting from the point of view of understanding the initial and on their way conditions to planet formation.

Motivated by such ideas, we are making 10 micron band observations of Herbig Ae/Be stars with a high spatial resolution using COMICS on the 8.2m Subaru Telescope. In the 10 micron band, dust grains of silicate and PAHs have strong spectral features. They change according to sources, which are suitable to be used for investigation of disk dust properties. In addition, because infrared radiation at wavelengths longer than the 10 micron band is dominated by disk emission rather than photometric emission, no coronagraph mask is required to observe the disk emission at those wavelengths. It is a large merit different from the near-infrared observations, so that mid-infrared observations can directly probe the inner disk regions, where planets are formed. Among such long wavelength infrared radiation, 10 micron band is the band where the most high spatial resolution can be realized by using ground-based large telescopes.

The spatial resolution of the 10 micron band observations with the Subaru is 0.3 arcsecond. It, however, corresponds to a relatively large radius, 30AU, for nearby (about 100AU) Herbig Ae/Be stars. Thus it is not practical to spatially resolve the 10 micron band disk emissions in usual reduction method, which discusses spatial variance of spectra pixel by pixel. In our observations, we have developed the 10 micron band spectro-astrometry method to discuss spatial distributions of observed spectra in detail. There, we obtain spectra of high signal to noise ratio by integrating relatively long time and investigate their spatial profiles by measuring/fitting the central peak positions and extension. We have observed about ten Herbig Ae/Be stars located nearby, that is less than about 200 pc, by this method. Targets were selected as those belonging to the group I and having silicate and/or PAH features. The Herbig Ae/Be stars of group I shows prominent far-infrared disk emission. By our observations many objects are really resolved in dust features and/or long wavelength continuum emissions. So far the followings have been reveald.

- By combining data of targets and standard stars, baseline of spatial extension along the wavelength can be determined observationally well. Our spectro-astrometry method developed here is much sensitive detection method for the spatial extention than the usual imaging observations.

- PAH emissions (7.7/8.6/11.3micron) around almost all group I Herbig Ae/Be stars observed are found to be extended spatially more than the adjacent continuum emissions. The extention is larger than a few tens of AU.

- Amorphous silicate emission around an relatively early Herbig Be star is spatially resolved. Its size reach a few hundereds of AU.

- Many observed objects were resolved not only in dust features but also in continuum emission, especially at long wavelengths (lambda longer than 10 to 11 micron).

We will explain our results more in detail in this presentation.