The Metallicity of Pre-Main Sequence Stars and the Evolution of Proto-Planetary Disks

Yusuke Taguchi[1]; Yoichi Itoh[2]

[1] Mathematical and Material Sci., Kobe Univ.; [2] Grad. School Sci/Tech, Kobe Univ.

http://harbor.scitec.kobe-u.ac.jp/~yuske

Are we alone? Is there anybody else out there in this vast universe? One of the first positive answers to this question was brought about by Mayor & Queloz in 1995. After their first discovery, continuous reports of new detections have been made, and it is now considered that roughly 5% of all stars accompany an extrasolar planet. Furthermore, from recent observations of high resolution spectroscopy, it was found that planet harboring objects are relatively metal rich (eg. Sadakane et al. 2001), and from the direct proportion of the abundance of iron to volatile elements, Takeda et al. (2001) have concluded that extrasolar planetary systems are more easily formed in high metallicity interstellar clouds.

If this is the case, could there possibly be a relationship between the metallicity of the central star and the evolution of a proto-planetary disk into a planetary system? Surprisingly, there is no such research that focuses on this topic. In a recent study on the metallicity of pre-main sequence stars conducted by Padgett (1996), she measured the iron abundance of T Tauri stars embedded within 4 different star forming regions using moderate dispersion spectroscopy (R=26,000) in the visual spectrum. She concluded that there is no significant difference in metallicity among the 4 regions. Unfortunately, there is no discussion based on each of the individual objects. For example, if we use her data and plot a diagram showing the relation between [Fe/H] and the equivalent width of Halpha (Figure 1), the [Fe/H] and Halpha seems to show a weak trend of direct proportion, but due to the lack of data and large errors, we can not strongly conclude that such a relation exists. If there is a direct proportion, the result may be explained by an increase in the infall rate of material on to the central object, due to the instability in the proto-planetary disk caused by proto-planets (Clarke & Syer 1996). On the contrary, if there was an inverse proportion, an explanation may be that the higher the metal abundance, the faster planetesimals evolve, which increases the accretion rate of dust, or makes a gap in the circumstellar disk, causing the accretion rate of matter falling on to the central object to calm down.

We are currently carrying out research to study the metallicity of T Tauri type stars embedded in the Taurus molecular cloud by measuring their iron abundance, and finally to understand the evolution of proto-planetary disks. We have conducted observations using high spectral resolution in the visual spectrum, with the Okayama Astrophysical Observatory"s (National Astronomical Observatory of Japan) 188cm telescope equipped with HIDES (HIgh Dispersion Echelle Spectrograph) in November of 2002. I will do a simple explanation of the background science and make a presentation of the results. The objects found to have high metallicity from the results of this research will be primary targets for the search for proto-planets, conducted by large aperture telescopes such as Subaru.

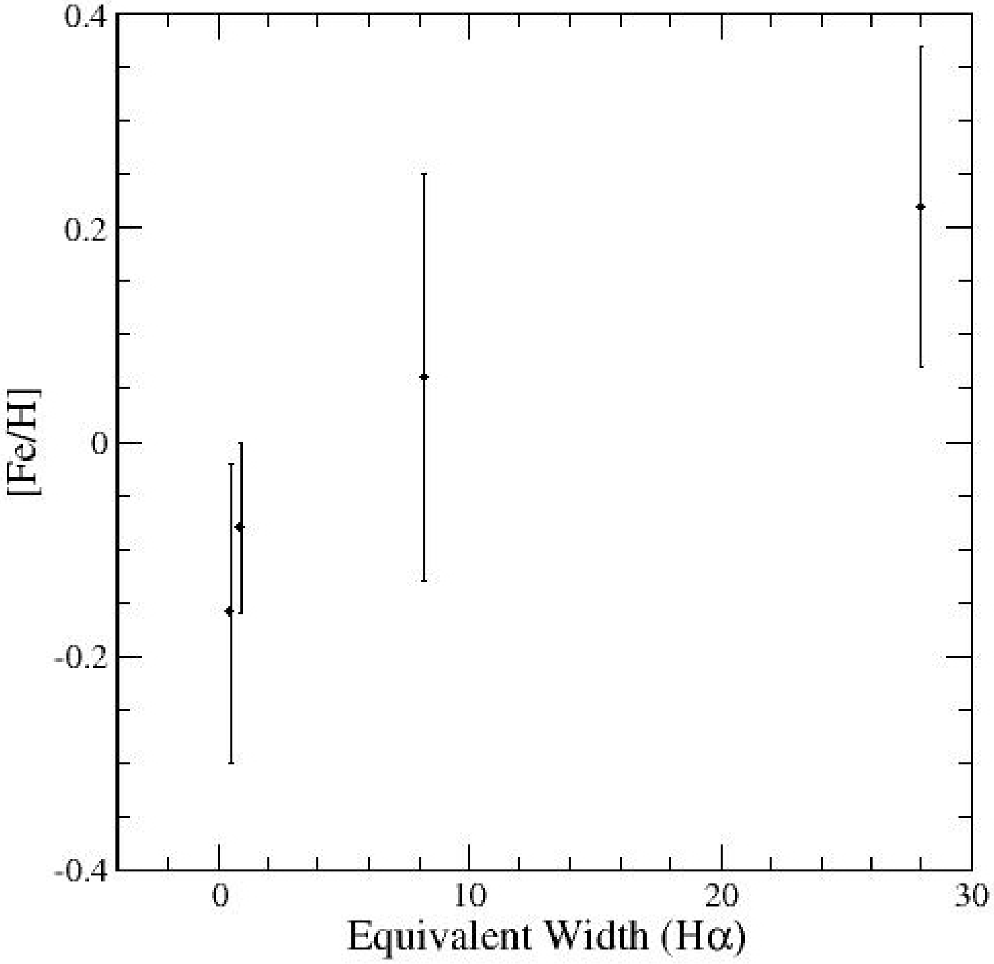

Figure 1--The metallicity versus equivalent width of Hα plot of T Tauri stars embedded in the Taurus molecular cloud. The data is from Padgett (1996).