Chapter 8

Line profile variations in pre-mainsequence star IRAS 04555+2949

8.1 Abstract

In our selected samples based on the IR colours similar to post-AGB and PN, some of them were found to be pre-mainsequence stars. These pre-mainsequence stars show variations in their emission line profiles, which is common in many the pre-mainsequence Herbig Ae/Be stars. Here we found that variations in line profiles observed in HD 31648 to be periodic. So we attribute these variations to be due to changes in the optical depth of the rotating disk around the star. Mostly an planet like body coming in between in the observer and the lineforming region. The amplitude of the changes seem to be less. From a high signal to noise spectra we were able to see this. Here we only present the preliminary results. We also present the spectrum of HD 36112, which again a Herbig Ae/Be star, which so very similar spectrum.
8.2 Introduction

Many pre-mainsequence stars with IR excess were found to be probable candidates for proto planetary system. HD 31648 (IRAS 04555+2949) is a pre-mainsequence star, which has a spectral type A2e. It is located in the Tarus-Auriga star forming region at a distance of 140 pc. HD 31648 is found to have a rotating disk of gas and dust (Manning et al 1997). It is thought to be a young counterpart of β Pic. β pic is one of the best known example of a mainsequence star with a disk (Backman and Paresce, 1993). From the CO (2-1) spectral line mapping and modelling the variability, Manning et al (1997) found that HD 31648 has a rotating disk which is gravitationally bound to the central star.

Study of HD 31648 will enable us to understand more about the origin of the debris disks and the early stages of the formation of planetary system. We present here the variability of lines profiles, which show periodicity close to the rotational period of the rotating disk. The variations of emission line profile indicates the variations in the optical depth of the emitting region.

8.3 Observations

All the spectra were obtained using 2.3m telescope at Vainu Bappu Observatory, Kavalur, which is equipped with a OMR spectrograph. We used 1200l/mm grating. The spectral resolution is 2.0 at 5000Å. Except for 6 continuous nights of observations, all the other observations are done on random dates.

8.4 Results and discussions

We see periodic variations in the line profiles of HeI 5876Å, HeI 6678Å and the NaI D emission lines of HD31648. We also see variations in Hα line profile. It changes
from P-Cygni to single peak emission. The calcium triplet lines and \( \text{O}1 \ 7777 \text{Å} \) triplet lines show emission and they show variability in the line profiles. The presence of sodium and calcium lines in emission in the spectra shows the presence of warm gas probably close to the star. The equivalent widths of SiII 6347Å and 6372Å also show variations. From the spatial direction of the spectra, we found that the emission at H\( \alpha \) is extended. The variation in the line profile of the He I 5876Å shows 6-7 days period. The He I 6678Å line also varies the similar way. The gaseous disks, which are seen in many of the pre-main-sequence stars are potential sites for studying planets in their formation. Observing the variations of emission lines originating from these gaseous disks will give information on the structure of the disk. Any structural changes in the disk will give rise to variations in the optical depth and this in turn gives variations in the intensity as well as in the profiles of the emission lines. We observed variations in the emission line profiles of HD31648 which originates from the disk. We found that the line profiles seem to repeat. So the disk might be rotationally supported one. In the case of HD36112 we see sharp decline in the intensity of HeI 6678Å line in one of the epoch. Here we show that these variations can due to planetsimals moving in the disk crossing the line of sight. We have found the disk extension in H\( \alpha \) is more than 100AU, which is typical size of \( \beta \) Pic type proto-planetary disk.

8.5 conclusion

We found the changes in the profiles to be periodic so it can not be due to some sporadic events which are seen in pre-main-sequence stars. The magnitude of the variability is also quite less. So the variations could be either due to emission from a object or a spot which is rotating or due to dense clump coming in the observers line-of-sight, and which is rotating in a disk around the star. This can be confirmed by looking for radial velocity changes in these emission lines. Our data was of poor resolution for that. From a high resolution and high signal to noise spectrum one
Figure 1(a): The HeI 5876 and the NaI D lines seem to show variations in the timescale of days. The plot with the dotted lines is show that the line profiles looks alike on those days.

might be able to resolve it. From multiwavelenght imaging and spectroscopy can model and understand these proto planetary disks.
Figure 1(b): The spectra in this figure is part of the same spectrum shown in Fig. 1a so it corresponds to the same dates. The plot in the dotted line shows again that the profiles are similar for those epoch of observations.
Figure 2: Low resolution spectrum of HD 31648 and HD 36112

Figure 2(continued): Low resolution spectrum of HD 31648 and HD 36112.
Figure 3 (continued): Low resolution spectrum of HD 31648 and HD 36112.

Figure 4 (continued): Low resolution spectrum of HD 31648 and HD 36112.
Figure 5(continued): Low resolution spectrum of HD 31648 and HD 36112.

Figure 6(continued): Low resolution spectrum of HD 31648 and HD 36112.