MASS ACCRETION RATE IN PRE-MAIN-SEQUENCE STARS AT DIFFERENT EVOLUTIONARY STAGES..

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Introduction

Near-infrared surveys have shown that for young stellar clusters older than 1 Myr there is a steady decline with time in the fraction of stars showing infrared excess emission. The mean disk lifetime derived from the infrared excess is $\sim$ 3 Myr. Such short-lived disks put a tight constraint on the planet formation timescale. The drawback of using the evolution of NIR excess as a disk clock is that it is only sensitive to the warm dust. A more reliable estimate of the disk lifetime might come from the evolution of the mass accretion rate. We present here a multi object spectroscopy project of 11 young stellar clusters in the age interval 1 – 80 Myr aimed at measuring the accretion timescale in pre-main-sequence stars.

Disk dispersion

Many mechanisms are responsible for the dispersion of material in a disk orbiting a star during its pre-main-sequence evolution. These are: viscous accretion, photoevaporation, stellar encounters and stellar wind. Among these, viscous accretion is the most efficient way of removing material. Also the formation of planets via coagulation of dust particles in bigger and bigger bodies plays an important role in removing disk material, however, planet formation is likely in competition with disk dispersion. It has been shown indeed that viscous accretion linked with photoevaporation may open large cavities in protoplanetary disks without the need of forming a planet (e.g. Goto et al. 2006, HD141569). A measure of the mass accretion timescale is crucial for the understanding of disk evolution and to test the predictions of planet formation theories.

The project

Different authors in the last years made measurements of mass accretion in disks based either on the emission of Hydrogen lines or on the continuum veiling. Most of these works are focused on a small time interval ($\sim$ 1 – 3 Myr). The systematic scatter of different data-sets does not allow us to clearly see a trend of mass accretion with time. In October 2006 we started a large spectroscopic campaign of 11 young stellar clusters with VIMOS at ESO-VLT (Paranal, Chile) aimed at tracing the evolution of accretion with the age of the cluster. Using the multi-object spectrograph of VIMOS, we are obtaining spectra (R = 2150, spectral range = 5900 - 7200 Å) of 200 – 600 objects within the inner 21 $\times$ 28 arcmin^2 of each cluster down to a limiting R magnitude of $\sim$ 19. As a probe of mass accretion we use the Hα emission for two main reasons: 1) Hα is one of the most common accretion indicator in PMSs (e.g. Jayawardhana et al. 2006); 2) it is the strongest line produced in the magnetospheric accretion columns and is easy to detect also for low brightness objects.

The clusters sample

The cluster selection is based on the following criteria: 1) to cover a wide range in ages, 1 – 80 Myr (relevant to disk dissipation); 2) upon their vicinity to the sun, to allow Hα detection in objects with masses down to the deuterium burning limit; 3) to not be affected by high extinction (Tab. 1).

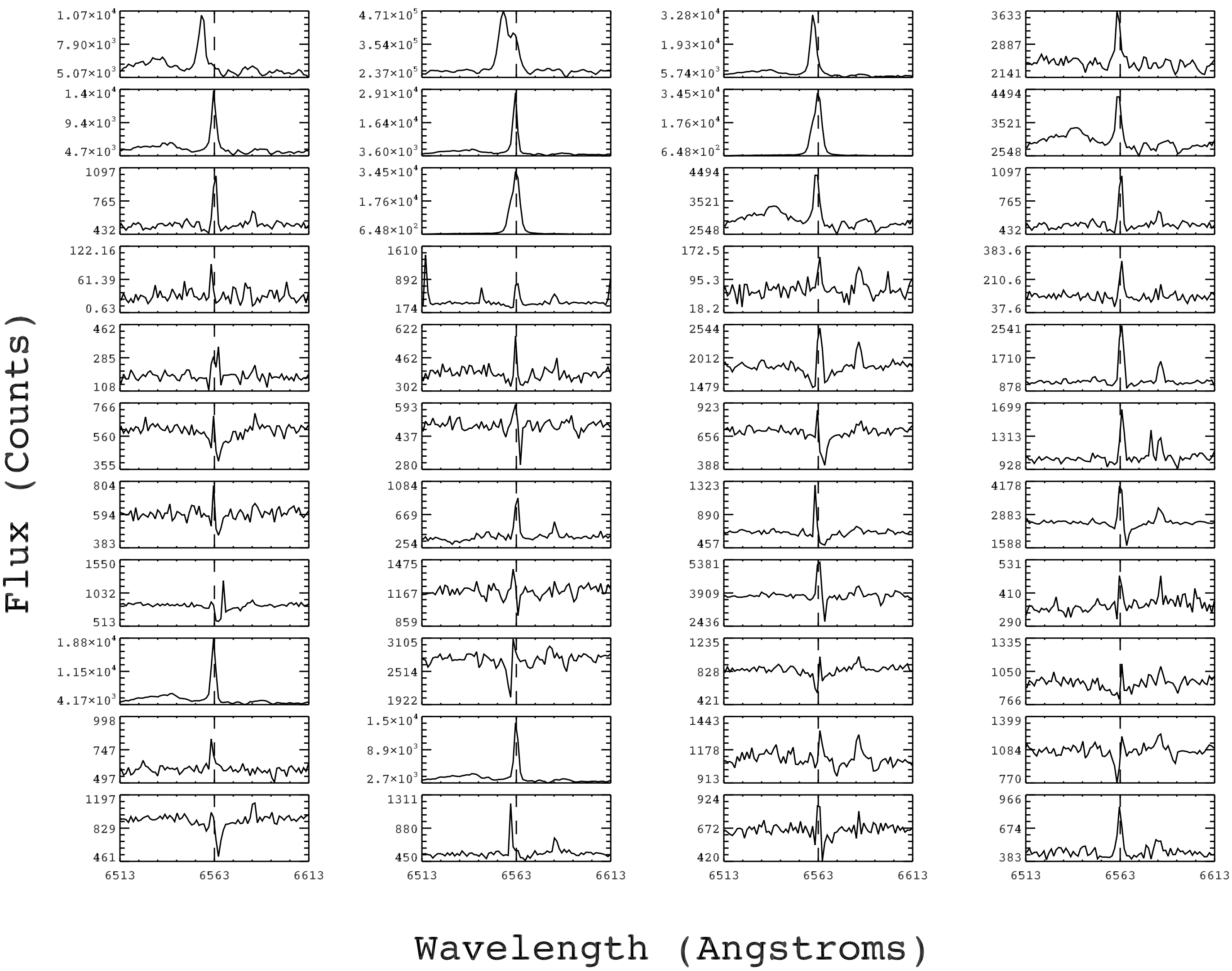
Cluster	Age [Myr]	Age [log(yr)]
Tau Aur	1	6
Lupus	1.5	6.2
Sig Ori	3	6.5
Upper Sco	5	6.7
Bochum 11	6	6.8
NGC 2264	9	6.95
Ascc 58	11	7.05
NGC 4755	16	7.2
Collinder 65	25	7.4
NGC 2547	40	7.6
NGC 2353	80	7.9

Initial results

Here we show the first spectra (blow-up around Ha) extracted form the young cluster σ Ori (Fig. 1). Shown are only the Hα emitters (20 % of all the stars in our sample). A large fraction of these appear to be accreting stars ($\sim$ 60 - 70 %). Given the spatial distribution of the cluster, we expect $\sim$ 30 % of the sample to be cluster members. This gives a fraction of accretors in s Ori of $\sim$ 40 – 50 %, slightly bigger than the typical value of $\sim$ 30 – 40 % found previously for this cluster (e.g. Oliveira et al. 2006, Barrado y Navascues et al. 2003). A possible explanation of this discrepancy is that our measurements extend to objects fainter than the R = 19 mag limiting magnitude of previous spectroscopic surveys of σ Ori.

Future work

We are right now reducing and analyzing the rest of the sample. Based on the analysis of the spectra and of the Hα profile, we will determine the fraction of accretors in each cluster. The next step will be to plot such a number as a function of cluster age and to look for a trend in the fraction of accretors with the age of the cluster. We will also attempt to measure the mass accretion rate in each stars from empirical correlations such as that of the Hα full width at 10% (Natta et al. 2004). The large number of spectra in our sample will allow us to compare the accretion properties of low- and high-mass clusters members as a function of cluster age.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6613
Wavelength (Angstroms)