"THE MASS DISTRIBUTION OF THE YOUNG STELLAR POPULATION IN CHAMAELEON I AND IN Rho OPHIUCHI"

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Abstract

We obtain the mass distribution and the age distribution of the young stars associated with Chamaeleon I and Rho Ophiuchi, two nearby sites of star formation. Our method consists in determining the temperature and the luminosity of each object in order to locate it on the HR diagram, and then comparing the position on the HR diagram with the evolutionary tracks and isochrones presented by Cohen and Kuhi (1979). The star-formation process is found to have started more recently in ρ Oph than in Cham I.

I. Introduction

The mass distribution of the pre-main-sequence (PMS) stars embedded in a molecular cloud is determined by the process of fragmentation of the cloud which leads to star formation, in a way which is not well understood. It would be of interest to know the mass distribution of the young stars in different clouds in order to investigate the influence of the physical parameters of the clouds in this process. In the present work we obtain ~~the~~ mass distribution of the young stars embedded in the Chamaeleon I and Rho Ophiuchi molecular clouds, two prominent nearby sites of star formation.

The only way to estimate the mass of PMS stars is to compare their position on the H-R diagram with a grid of evolutionary tracks for protostars of different mass. The position of the stars relative to the isochrones also provides an estimate of their age. A determination of the temperature and luminosity of the stars is thus required as a first step.

The luminosity function of the young stars in ρ Oph has recently been investigated by Wilking, Lada and Young (1989), and in a previous work we have compared the luminosities of the objects embedded in Rho Oph and in Cham I (Gregório-Hetem et al., 1990). We use here the same method, based on model fitting of the observational data, to estimate both the luminosity and the temperature of the stars. While the luminosity distributions of the stars of the two regions are similar, striking differences appear between the mass distributions.

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II. The Method

The spectral energy distribution of each star was constructed from the visible and near-infrared photometric data found in the literature, and from the IRAS far-infrared data of the Point Source Catalog.We found enough data for 39 pre-main-sequence stars in each cloud; these are probably the most luminous stars of each association. The list of stars and the references for photometric data are basically the same used by Gregório-Hetem et al. (1990).

For each object, the energy distribution was fitted by a model of a central star represented by a blackbody with temperature T_*, surrounded by a series of spherically symmetric dust shells forming an envelope with internal radius R_o and temperature T_o, and with density decreasing outwards like $r^{-1.5}$ and temperature decreasing outwards like $r^{-0.4}$. Both the extintion and the emission of the shells are taken into account; the adopted dependence of opacity on wavelength is $\tau(\lambda)=\tau(1\mu m)\lambda^{-1}$. The adjustable parameters are T_*, T_o, R_o, and the optical depth of the envelope. This simple model provides good fits to the energy distributions; the temperature T_* obtained from the fit is in good agreement with the temperature corresponding to the spectral type, when it is known.The luminosity of the objects is obtained by integrating the flux over the whole wavelength range, and assuming a distance of 140 pc to Cham I (Rydgren, 1980) and of 160 pc to ρ Oph (Bertiau , 1958).

We used the temperature and luminosity derived from our model to plot the positions of the stars on the HR diagram, to compare them with the convective-radiative evolutionary tracks of pre-main sequence stars collected by Cohen and Kuhi (1979), and with the corresponding isochrones. The number of stars in a given mass interval is simply obtained by counting the stars situated between the evolutionary tracks of the corresponding mass. We selected for convenience the logarithmic mass intervals with limits 0.1, 0.2, 0.4, 0.8, 1.6 $M_\odot$. Cohen and Kuhi did not present evolutionary tracks for 0.4 $M_\odot$ and 1.6 $M_\odot$, but instead for the neighbouring values 0.35 and 1.5 $M_\odot$; however an approximate interpolation is easily done. We somewhat arbitrarily, corrected the 0.2 $M_\odot$ track of Cohen and Kuhi originaly taken from Grossman and Grabosky (1971),turning it similar to the tracks for lower and for larger mass and thus removing a cooling phase during the contraction, which seems unlikely to exist.

III. Results and Discution

We present in figures 1 to 4 the mass distribution and the age distribution of the young stars associated with the two regions. One can see that Cham I contains stars which are considerably more massive than those of ρ Oph. The maximum of the mass distribution is around .3 $M_\odot$ in ρ Oph and 1.2 $M_\odot$ in Cham I. The age distributions of the objects belonging to the two associations are also considerably different. While in ρ Oph most of the stars are younger than $3{*}10^5$ years, in Cham I most of the stars are older than $3{*}10^6$ years. This does not mean that the star formation process has ceased in Cham I; the presence of Herbig-Haro objects indicates that some star formation may be still on-going about 10^7 years in clouds with characteristics similar to those of ρ Oph and Cham I.

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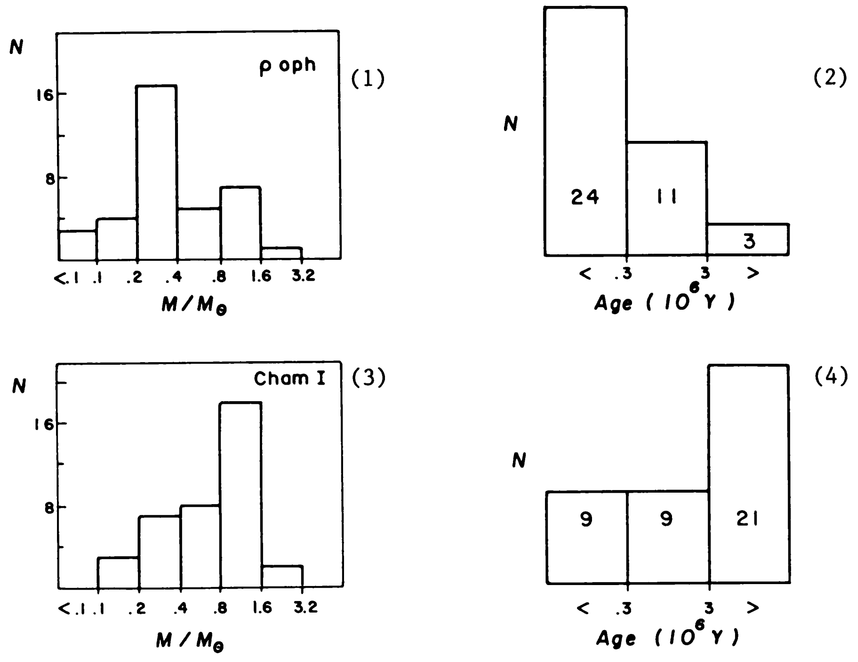

Figures 1 to 4

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