LITHIUM ABUNDANCE AND SPACIAL DISTRIBUTION OF T TAURI STARS

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ABSTRACT. We determined temperatures and Lithium 6707 A resonance line equivalent width of a sample of 62 T Tauri stars. Lithium abundances were then estimated by using a grid of curves of growth. The lithium abundance is shown to decrease with the distance of the stars to the nearest dense core of a molecular cloud. This effect is interpreted as being due to the ages of the stars, the youngest ones being closer to still active star formation regions.

1.Introduction

We report the preliminary results of an investigation of the relation of the Li abundance in T Tauri stars with their distance to the nearest star-forming region. The lithium abundance is potentially an age indicator; it is believed that the youngest T Tauri stars present the same Li abundance of the interstellar medium, and that the surface abundance gradually decreases with time, due to the combined effect of convection and destruction in the stellar interior (Spite and Spite, 1982; Duncan and Jones, 1983). It would be of great interest to be able to estimate the age of T Tauri stars, in order to study their evolution as well as the evolution of the star-forming regions.

2.Observational data

Our program stars have been observed in a recent survey for new T Tauri stars (TTS) based on the IRAS point source catalog (Gregorio-Hetem *et al.*,1991). In the part already completed of the survey, we obtained Coudé spectra of 62 TTS (including previously known TTS), with the 1.6 m telescope of the Laboratorio Nacional de Astrofísica, Brazópolis, Minas Gerais. The observed spectral region is 6550-6750 A, which contains Hα and the Li resonance line at 6707 A; the resolution is 0.1 A. We also made UBVRI photometric measurements of most of the program stars with a 0.6m telescope at the same observatory.

3.Temperature and Li abundance determinations

Since the surface lithium abundance is known to be a function of both age and mass (or temperature), we determined the temperatures of the stars of our sample by fitting, with a model, our photometric data and the IRAS data. The model consists of a central star, represented by a blackbody, surrounded by a spherically symmetric circumstellar dust shell (CDS). Good fits are obtained by taking CDS density decreasing like $r^{-1.5}$ and temperature decreasing like $r^{-0.4}$, and an extinction law like λ^{-1}. The internal radius of the CDS is fixed by considering that the radiative equilibrium temperature of the dust grains cannot exceed typical evaporation temperature of about 400 K. In some cases an optically thick, geometrically thin disk with temperature decreasing outwards like $r^{-0.75}$ is needed to obtain a good fit. The stellar temperatures obtained in this way are in general in good agreement with the spectral types, when they are known.

Lithium abundances were estimated by comparing the stellar temperature and the equivalent width of the Li I λ6707 line with a grid of curves of growth presented by Duncan (1991), from Kurucz and Bell and Gustafsson model atmospheres, for log g = 4.0 and log g = 3.75.

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4. Results and discussion

We present in Figure 1 log Li abundance as a function of log T. The well known depletion of Li in low temperature TTS can be observed. We remark that we obtain, for many TTS with T > 5000 K, abundances of the order of log N(Li)= 4, on the log N(H) = 12 scale. This is much larger than the accepted primordial abundance of Li, log N(Li) < 3 (Boesgard and Steigman, 1985). One possibility would be to suspect that the model atmospheres are not correct. Another possibility would be a segregation mechanism to act during the last stages of formation of stars, if for instance Li is tied to dust grains submitted to radiation pressure, so that its accretion on the star is delayed, resulting in a relative enrichment of the photosphere.

We present in Figure 2 log of Li abundance versus distance of the TTS to the nearest dense core of a star forming molecular cloud. The distances are projected distances measured in degrees; the reason for the use of angular units is that the distances of most of the relatively isolated TTS are not known. At 150 pc, which is the approximate distance of nearby star-forming cloud complexes like ρ Oph and Cham I, one degree correspond to about 3 pc. Most TTS are situated within 2 degrees of a molecular cloud core; up to such separation they can be considered as belonging to the same association. The relative position, in galactic coordinates, of the TTSs studied here and of the cloud complexes nearest to them are illustrated in Figure 3. For the stars situated at $d > 2°$, we observe in Figure 2 a tendency of Li abundance to decrease with d.

The obvious interpretation is that this is an effect of age, the more isolated TTS being the oldest ones. Since we do not observe any systematic variation of temperature with distance, we can eliminate the possibility of the more distant TTS being less massive stars. This could be the case if the more distant stars were objects ejected from star-forming regions with larger velocities. Such a mass-selection effect can probably only be observed if stars of a same association (within 2°) are compared.

From the log N(Li) versus T and versus age relation presented by Basri, Martin and Bertout (1991), we conclude that Hen 1, the TTS with highest galactic latitude discovered in our survey, is $5*10^7$ years old, and that the group of TTS situated around the "isolated" TTS TW Hya, is about $3*10^7$ years old.

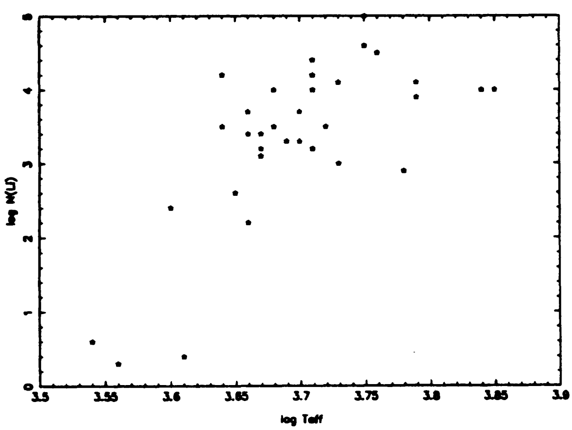

Figure 1: log of Lithium abundance versus log of effective temperature of T Tauri stars.

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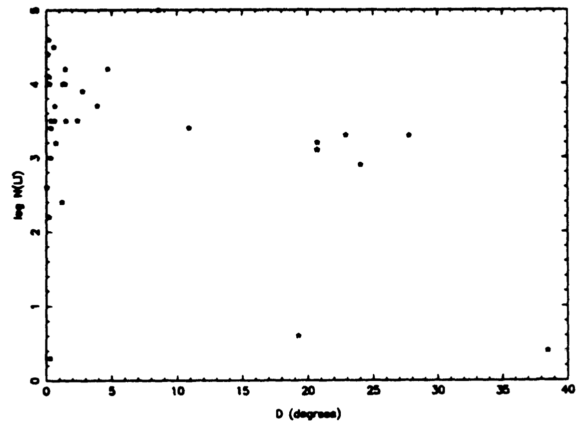

Figure 2: log of Lithium abundance versus projected distances to the nearest dense core of a star forming molecular cloud.

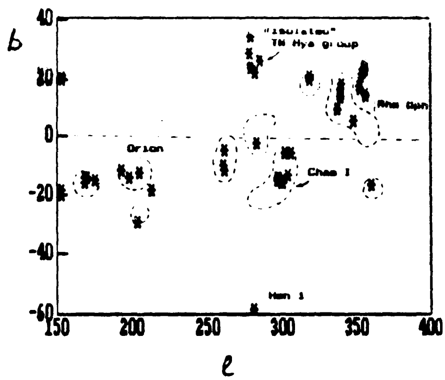

Figure 3: The spatial distribution of the T Tauri stars of our sample, in galactic coordinates. Some of the most important star-formation regions are indicated.

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