there one relation for A-F giants and evolved Am stars and another for A-F main-sequence stars? In Figure 6, reproducing our data plus data that Hauck et al. (1985) used to determine his relation, the general trend seems to show that one relation could be sufficient for A-F main-sequence stars, A-F giant stars, evolved Am stars and δ Del stars and this assumption was already suggested by Hauck et al. (1985).

6. Conclusion

The abundance analysis has shown that Ca and Sc abundance of our stars is normal: no deficiency has been found. Thus the answer to one of the introductory questions comes immediately: the A-F giants with a blanketing parameter $\Delta m_2 \geq 0.015$ are not necessarily evolved Am stars, they could also be δ Delphini stars. The relation found between Δm_2 and [Fe/H] is encouraging and supports the possibility of using a photometric parameter to estimate the metal content of these kinds of stars. And perhaps more than that, because it appears that only one relation could be sufficient for the A-F stars. This study points out that it is important to examine the evolutionary stage of the different kinds of stars encountered.

So, with the new configuration of the Echelec spectrograph on the ESO 1.52 m telescope at La Silla we have a very interesting instrument for stellar spectroscopy, working with a wavelength range between 3500 and 5500 Å and a good linear dispersion (3.1 to 4.5 Å/mm). The spectra obtained during our observing run allowed detailed spectroscopic analysis of good quality and encourage us to pursue our programme on the spectroscopic study of A-F giant star atmospheres.

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T Tauri Stars Make Us Wonder What They Are

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Once upon a time, some 4.6 billion years ago, the sun formed in an interstellar cloud of gas and dust. The planets we see in the sky all move close to the ecliptic. It is therefore clear that at some phase the young sun was surrounded by a flat dusty disk, in which these planets agglomerated.

In cosmogony one is concerned about how the solar system came into being. A standing question has been that of universality: do planetary systems form also around other young stars, like the T Tauri stars, which are located in interstellar clouds?

From what we know, these clouds of today are not very different from those present 4.6 Gyr ago with regard to chemical composition and galactic distribution. I would think that ever since the fifties, when the T Tauri stars were recognized as very young objects, most scientists involved have been thinking of the objects as being similar to the sun, only much more active, and that they have circumstellar regions with a flat geometry. There is an early paper by Poveda (1965) with respect to this latter point. Nevertheless, during the late sixties when the infrared excess emission (from circumstellar dust) and the ultraviolet excess emission were discovered, the models always took spherically symmetric forms. One could speculate that it is generally regarded as more scientific (or maybe just simpler) to choose a spherical form when there is no evidence, other than intuition, of a flat geometry. The cosmogonist, of course, always faces a flat geometry.

By 1980 it was evident that for many of these stars the excess emission extends over the far-ultraviolet into the X-ray region. This high-energy tail of circumstellar origin was usually tied to spherically symmetric chromospheres/coronae. During the next years it was also realized that some of these stars drive powerful molecular flows into the surrounding interstellar cloud, often only in two opposite directions (bipolar flows). I left astronomy in 1983. When I came back a few years later I was surprised to see how much is accomplished in science over such a short period of time. The sky had been painted with numerous bipolar flows, some extending over tens of minutes of arc. Plasma jets were seen to shoot out from the stars. A major break-through was the mapping of rotational velocities of the stars and the discovery that some of the light variability present was of periodic nature and related to rotational modulation of bright and dark areas on the stellar surface (see the article in the *Messenger* by Bouvier and Bertout, 1985). It is certainly interesting, also from a cosmogonic point of view, that for many of the youngest T Tauri stars the angular momentum is smaller than the total angular momentum of our solar system! In other words, when the T Tauri stars contract out of interstellar cloudlets, they have found ways to get rid of angular momentum very rapidly indeed. Last, but not least, a number of independent indications that many of the T Tauri stars are surrounded by flat disks of planetary system dimensions had been found. Flat molecular disks, apparently rotating, had been discovered at some stars. The spherical geometry is gone for ever.

The concept of accretion disks, in which material is transported towards the stars, has replaced earlier views. Even the continuous excess emission is now explained as a disk phenomenon. Here, the ultraviolet excess originates in a warm boundary layer between the accretion disk and the star while the infrared excess originates further out in the disk. Some stars lack the characteristics of disks, and on these so-called "naked" T Tauri stars the X-ray variability, for instance, could have its cause in enhanced surface activity. Such activity may exist also on the "clothed" stars but

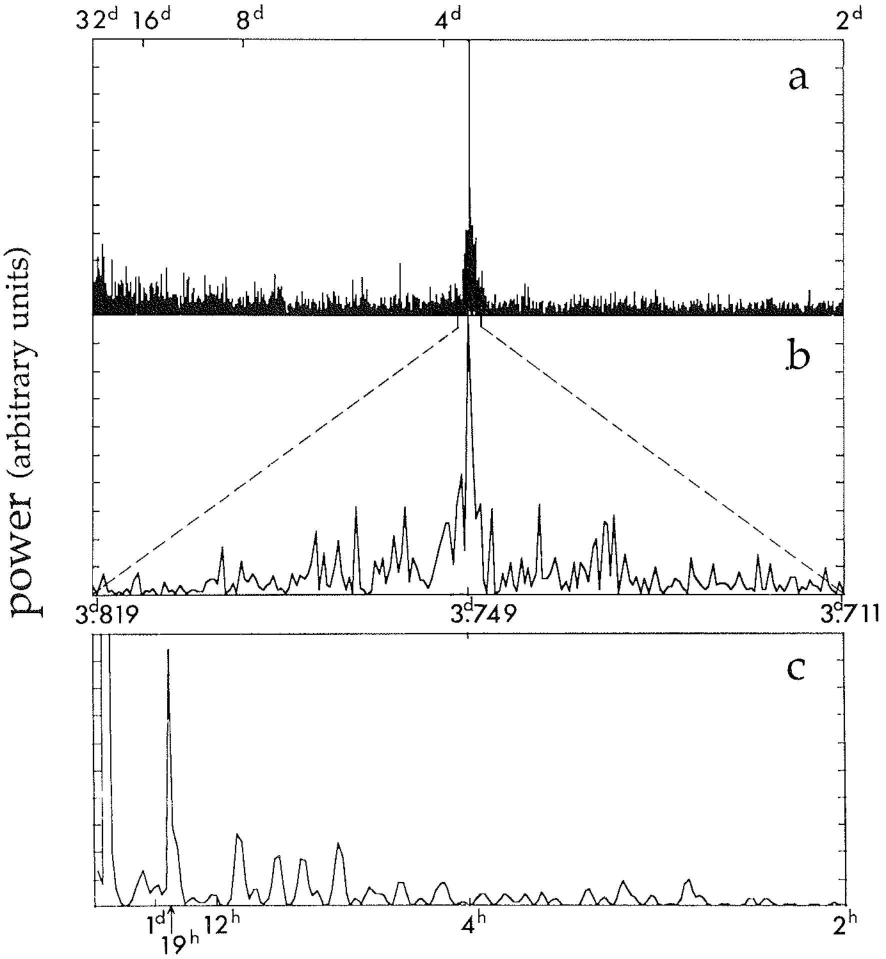

Figure 1: *The Fourier analysis of the light fluctuations of the T Tauri star RY Lupi reveals that there is a periodic component – period 3.75 days – which has been present over the last 52 years (see **a** and the enlarged fraction of the 1/Period-axis in **b**). In addition, a period of about 19 hours seems to be present when the star is faint as was the case in 1986 and 1987 (**c**). The vertical axis gives power in arbitrary units.*

for these the disk emission dominates the spectrum, at least at ultraviolet wavelengths.

These and other exciting discoveries and ideas made me continue to work in the field of star formation. In addition, my colleagues (Carl Fischerström, Peter Lindroos and René Liseau) had continued the work we started in 1980 to collect good observational material on the variability of T Tauri stars. Observations, spectroscopic and photometric, were made at ESO, at the Swedish Station on La Palma, Spain, and with the IUE satellite. A most fascinating data base of information on one star, RY Lupi, is now at hand with extensive observations collected also by other groups starting with the early work by Cuno Hoffmeister and collaborators in 1935.

The star varies by more than 3 magnitudes in the visual (the V band). Already Hoffmeister (1965) found a quasi-period of a little less than 4 days in the light fluctuations. From Fourier analysis of more than 6,000 individual measures (see Fig. 1) we found that this period of 3.75 days has been present over the last 52 years. The periodic fluctuations are severly distorted by superimposed irregular fluctuations. Although it has been quite natural to tie the photometric period to the rotational period of the star, as described above, there are two problems with this interpretation in the case of RY Lupi: 1. The degree of linear polarization of light increases when the star becomes fainter (Bouvier, 1988). 2. The spectrum (with an absorption line spectrum corresponding to spectral type G8) does not change when the star fades. As described by Liseau et al. (1986) these circumstances are not in line with current models of star spots appearing and disappearing when the star revolves.

In addition, there are several remarkable details of the variability of this star which can be summarized briefly as follows.

1. When the star fades, it first becomes redder. However, when fainter than V = 11.5 this trend is changed towards the blue but with a very large spread in colour for a given V. At close to 13th magnitude it happens that the star is bluer than at maximum brightness (see Fig. 2).

2. During these dramatic visual variations, the photospheric temperature stays constant and also the fluxes of the hydrogen line emission, the infrared excess emission and the far-ultraviolet excess emission.

3. When the star is fainter than V = 11.5 it happens that it flips in colour over very short time-scales, even less than ½ hour. On these occasions the (B-V) colour can change in either direction by more than 0.5 magnitudes while the change in V is only about 0.1 magnitude. Similar flips occur also at higher brightness levels but the corresponding colour changes are smaller, as if by con-

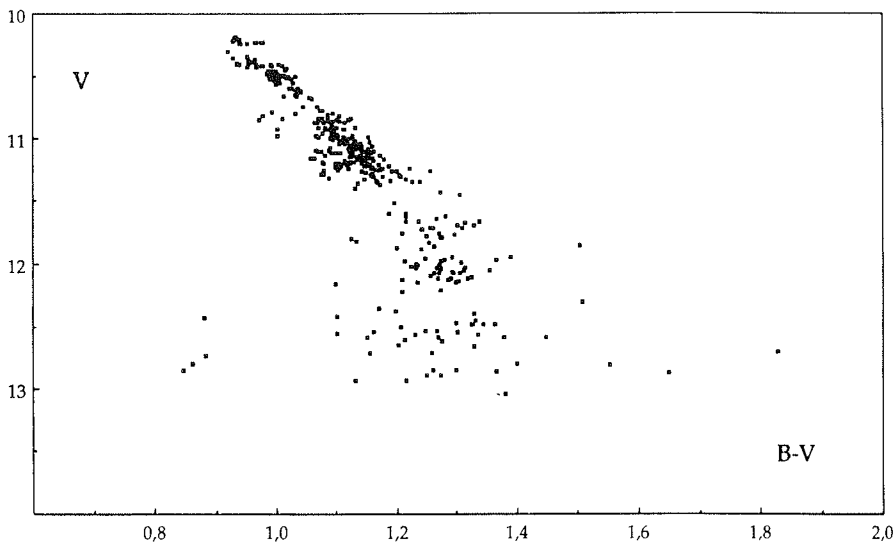

Figure 2: *Magnitude V versus colour (B-V) for all existing photometric observations of RY Lupi. Notice the large spread in (B-V) when the star is faint in the V band.*

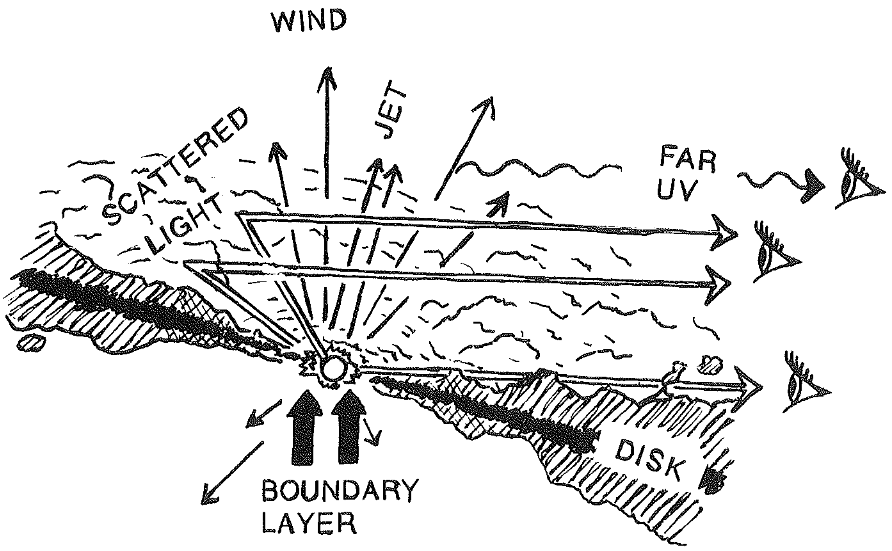

Figure 3: *The contours of a possible model of RY Lupi. The star is seen through the fluffy outskirts of an equatorial disk of dust which is inclined by 20 degrees to the line-of-sight. In the drawing the disk is cut in a plane through the star and directed to the observer to the right. On occasions, when the stellar light is almost totally blocked by foreground dust, the observer instead sees the light scattered or emitted from the extensive disk. The fluxes in the far-ultraviolet and in the emission lines stay relatively constant and must originate outside the star and the disk, like in a stellar wind or a jet. Rapid phenomena take place, possibly in the warm boundry layer between the star and the disk.*

trast. There is evidence that the flips sometimes reappear on a time-scale of close to 6 hours.

There are more peculiar things to be noted. For instance we have found evidence of a second period of about 19 hours in the light variations. The collected information on RY Lupi presents a complex but challenging picture. We cannot claim that we fully understand the unusual behaviour of this star. We have tried to bring together all pieces in what could be the contours of a model for RY Lupi. Some of the ideas can be tested by further specific observations.

In short, we find that the general pattern of variability is consistent with variable circumstellar extinction in the line-of-sight to the star. When the star fades to 13th magnitude in V, most of the stellar light is blocked and instead we see light emitted and/or scattered by circumstellar dust. Then RY Lupi must be a rare case among the T Tauri stars where the line-of-sight to the star happens to pass through the outer, fluffy regions of a flat equatorial disk of dust. On occasions the sight is clear and the star dominates the light. When the star is occulted by cloudlets of dust, we see the light from the remote side of the disk. The infrared emission from the dust grains stays constant in flux and the far-ultraviolet excess emission and the hydrogen line emission must be formed in regions outside the disk – like in a wind or jet perpendicular to the disk. These features are sketched in Figure 3.

The rapid flips are not flares on the stellar surface. They could be of circumstellar origin, like nebular flares which are discussed by cosmogonists in connection to local reheating of the early solar system material, or they are produced by instabilities in a wind or jet. Another possibility is that the flips result from scattered light from hot clumps which orbit around the star with high speed in a boundary layer between the star and the disk. The expected Keplerian orbital period close to the stellar surface is the same as the period found, namely 6 hours. It will be interesting to see if this period can be confirmed by future observers.

So far, the model outlined is very speculative and may be drastically refined by future work. Apparently, the star also changes its pattern of variability from time to time. During the period of a new series of observations, RY Lupi showed almost perfectly gray variations (only very small changes in colour). One of the problems is to understand the well established 3.75-day period. If this is a consequence of a regular structure in the rotating disk, then how could it be so stable over 52 years? Is there in fact a relation to the region of co-rotation between the star and the disk? Can stable spiral arms form in dusty disks?

All these question marks left make it exciting to continue the exploration of the T Tauri stars and their surroundings. There is still the feeling that the T Tauris also have something to tell us about the origin of our own solar system.

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Does the Mass Function of Galactic Globular Clusters Depend Upon Metallicity?

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Introduction

In the last three-four decades galactic globular clusters (GCs) have been known to constitute an excellent laboratory for the investigation of primordial star formation and chemical enrichment during the collapse of the parent galaxy. Until the advent of the CCDs, however, the study of the faint main-sequence stars, several magnitudes below the turn-off, has remained beyond our reach. The first