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Stellar Parameters Determination in T Tauri Stars

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Abstract: The application of the well-known photometric and spectroscopic analysis in the determination of the stellar effective temperatures and the surface gravity is in most CTTS cases unrelyable and mislead by uncertainties. The present work, based upon the application of a spectroscopic LTE analysis method to a sample of TTS spectra, tried to perform a more accurate derivation of these key atmospheric parameters. The presence of excess continuum emission superimposed to the spectra analysed and its hypothetical contribution to the values estimated through this method has been probed as well. The results estimated were not at all conclusive, essentially due to the high degree of uncertainty affecting the quantities found.

Fig. 1 – Credits: Hubble Heritage Team

T tauri stars (TTS) are young solar-mass stars situated in dense Star Forming Regions. Evidence for their kinematic association to the original cloud clearly indicate that TTS are still undergoing key evolutionary steps towards the Main Sequence[1]. The observational features of TTS are the existence of a considerable amount of excess radiation emission on determined ranges of the spectrum (mainly UV, Optical and IR) and a low excitation emission spectrum seemly proceeding from different phenomena. Attempts for modelling these stellar objects were carried out during the years but a lack of understanding on the many physical mechanisms underlying the overall TTS activity and characteristics impede further analysis. The determination of the fundamental atmospheric parameters is therefore a primal step on setting constraints on the models used.

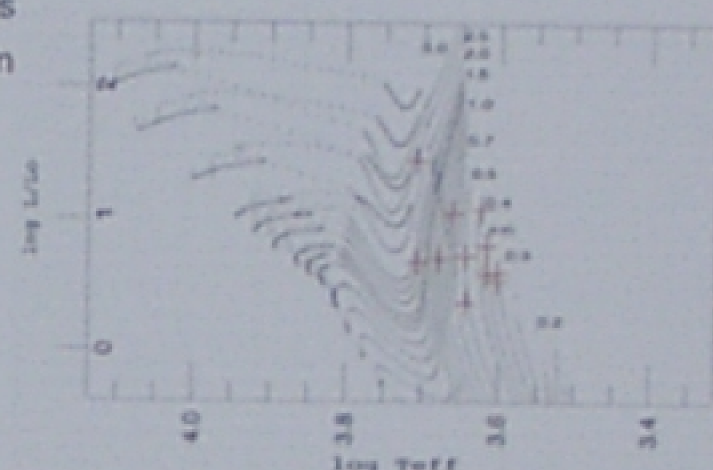
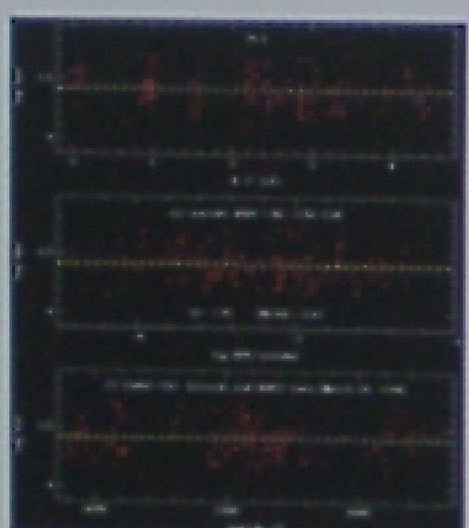


Fig. 2 - HR diagram and the D'Antona & Mazzitelli[6] evolutionary tracks for the stars in the sample. The red crosses represent the TTS studied[7]. The interpolation among the tracks enabled surface gravity estimates and subsequent comparison with results found through our own spectroscopic analysis.

Spectroscopic Analysis

The spectroscopic analysis[3] was done with a recent version of the line-abundance code MOOG[4] and using LTE atmospheric models taken from the ATLAS9 stellar grid of Kurucz[5].



The method used was based first on the measurement of the Equivalent Widths(EW) of spectral lines of six different species featuring the spectrum of the sample and second on the simulation of stellar atmospheric models able to reproduce the physical conditions underlying the EWs observed.

Fig. 3 – The abfind driver in MOOG force-fits abundances to yeld computed EWs previously measured with other software packages. In this figure an example of a final plot generated by MOOG for the FeI specie can be seen.

Star	T_{eff}	T_{eff}	log g	log g	log g
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	3.7	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	-	[illegible]	-	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	3.4	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Fig. 5 – Comparison between the parameters determined in the spectroscopic analysis and those taken from the literature. (tw) refers to values of the atmospheric parameters computed in this work. In the last column the results obtained for logg (surface gravity) by interpolation with evolutionary tracks with the Teff estimated in this spectroscopic analysis are presented. We can notice a standing discrepancy between the values obtained and those given by the literature.

Testing veiling's influence

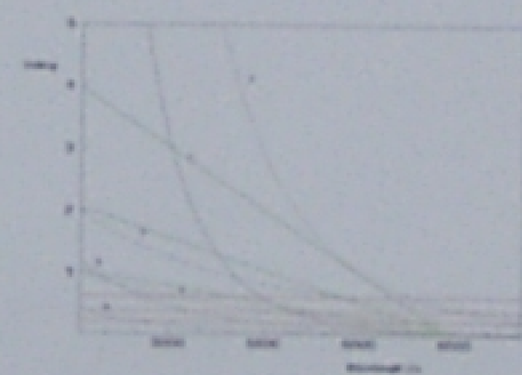


Fig. 4 - Some of the veiling functions that were superimposed to the spectra of the standard stars. The spectrum of every star was first normalized to the continuum and to unity (identified as 1 in the vertical axis).

We tried to reproduce spectrum of veiled TTS[2] by selecting several spectrum of standard template stars and superimpose on them different functions of veiling in the wavelength ranges where this phenomenon is most relevant. The aim of this proceeding would be the one of tracking changes in the parameters found, induced by the addition of the different excesses.

Fig. 6 – Original Spectra of the star K0IV star HD191026 superimposed to an hypothetical excess emission continuum which in this case is a rapidly decreasing exponential function. The actual effect of this superimposition is the one of shallowing (veiling) the spectral features of the star in certain wavelength ranges.

Final Conclusions

- Spectrum with low SNR
- Few ionized specie lines due to the later spectral types of the sample
- Higher uncertainties to later Spectral Types
- Only with less uncertainties could we individuate the veiling
- High values for the parameters can be explained in terms of the zero value of the temperature scale

Future Orientations

Other than collecting spectra with better SNR conditions we could explore more profoundly the effect of excess emission in TTS spectroscopic analysis. This could be done in several ways. We could study, for example, a robust sample of Weak-TTS or try to superimpose accurate continuous veiling functions over spectra of MS stars in order to reproduce TTS observational and physical characteristics. The study of the elemental abundances in different molecular clouds could also represent a very interesting solution for future developments in this kind of research.

References:

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