The A-Star Puzzle
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Panel discussion section H

CHAIR: **S.J. Adelman**

SECTION ORGANIZER & KEY-NOTE SPEAKER: M. Parthasarathy
INVITED SPEAKERS: S. Möhler, G.W. Preston, N. Przybilla

Discussion

DWORETSKY: In the blue metal poor stars shown by you (from C. Sneden) you had a lot of Pb. Were there any signs of Hg, Mn, or Y, typical signatures of diffusion? Or is nuclear processing a sufficient explanation without diffusion?

PRESTON: Yttrium is enhanced, but is, along with Strontium and Zirconium, one of the "light" s-process elements, no Hg is seen and Mn is typically deficient, a common feature of metal poor halo stars. The abundnce signature of the BMP binaries is unabigously that of the AGB helium shell-burning phase of stellar evolution.

MICHAUD: It has been suggested that the integrated light of all objects is dominated by HHB stars spectra. It was also suggested that the spectra of some galaxies were dominated by A supergiants. Could you reconcile the two?

MOEHLER: By "old" I understand older than 10 Gigayears. In such objects the ultraviolet flux is dominated by hot Horizontal Branch stars with a minor contribution from hot post-AGB stars (minor due to their short life times).

PRZYBILLA: Massive stars spend only a short fraction - of the order of a few 10^4 years - of their life time as A-type supergiants during later evolution stages. It is therefore implausible to assume that the integrated light properties of galaxies can be dominated by these objects.

TANRIVERDI: To calculate systematic errors, the effect of $T_{\rm eff}$, $\log g$, etc. are independent of each other? What is the reason for that? If it is considered dependent, what causes in result?

PRZYBILLA: The practice for estimating systematic uncertainties in stellar studies is changing parameters one at a time and in investigating the effect of this on the analysis. A formal (mean square) error may be calculated from the individual uncertainties. However, one has to bear in mind that many of the parameters are NOT independent, such that this formal systematic error has to be viewed as an estimate of the real uncertainties only. Thorough error analysis is VERY time-consuming: Monte Carlo simulations for error propagation require many hundred model runs, and with a single NLTE computation taking several CPU hours, like in the case of our Fe II model ion, we would rather perish than publish ...

GREVESSE: Comment on Non LTE - results. Your failure, when using data from the literature, and then success, when you recomputed yourself more accurate cross-sections, in the NLTE computations on Hydrogen, are a very good lessons and should be kept in mind by all the users of NLTE codes!

Cowley: In the case of the H alpha profile of Arcturus were you able to make your nonLTE fit with reasonable value of the microturbulence? I could never fit the H depth in LTE, but one could fit the width. However, to fit the width an uncomfortably large microturbulence was required. Can you now feel confident of the non-LTE fits for stars like Arcturus so H alpha could be used as a temperature diagnostic?

Przybilla: Note: This aims at the finding from a spin-off paper of results presented here (Przybilla & Butler, 2004, ApJ 610, L61).) Increasing the microturbulence velocity to supersonic values can improve the fit quality of the H line width in Arcturus. This however, stands in contrast to the results from the standard microturbulence indicators and, more serious, is hard to justify on physical grounds. The synopsis from that work is that the observed Balmer lines of K-giants cannot be reproduced by present-day standard model atmospheres. The failure to model the spectral lines of the most abundant and most basic (in terms of atomic physics) element indicates that all future conclusions from the analysis of such objects have to be viewed with caution.

Yuce: Did you look at the evolutions of your supergiants with LTE calculations? How was differences between LTE and NLTE calculations?

Przybilla: NLTE & LTE stellar parameter determinations will give similar values for luminosity classes Ib to Iab, thus resulting in similar positions in the HRD. Proper NLTE calculations however, help to reduce the uncertainties. At higher luminosities NLTE computations become mandatory, if the same degree of accuracy in the parameter determination is aspired. More drastic are the effects on abundance determinations for the elements He, C, N and O as tracers for mixing of nuclear processed matter into the stellar atmosphere. Here, the differences between NLTE an LTE abundances can amount to a factor of 2 in weak lines to a factor of 100 in strong line analyses.

Piskunov: Are you familiar with the work by Paul Barklem of Hydrogen line profiles and broadening? There are several issues which are relevant to the previous discussion, for example for solar type stars there is broadening which changes the wings quite much in particular in lower members of Balmer series and also Paschen series?

Przybilla: We have reproduced the solar Balmer and Paschen lines using the Stehle tables for Stark broadening and the Barklem formalism for the resonance broadening plus a model atmosphere by the Avrett group, and have studied also several other commonly used model atmospheres. Using this one arrives at the conclusion that one needs a chromosphere plus NLTE calculations to derive the physical run of the Hydrogen populations in the Sun. One can also reproduce the observed Balmer and Paschen lines rather accurately by LTE model atmospheres and NLTE line formation, but the physical solution is different: the line-formation depths in the latter case do not match the observation.

Piskunov: What Paul Olsson did rather recently for A stars he demonstrated that occupational probability algorythms were very important for correctly reproducing Balmer jump do you do that?

Przybilla: We do not account for it explicitly, but we introduce an empirical correction for this by restricting the model atoms to the number of levels actually observed, i.e. the classical Inglis-Teller limit. This is important.

ADELMAN: You mentioned that the depth dependent microturbulence is necessary?

PRZYBILLA: No depth dependent microturbulence.

ADELMAN: So why the people get different micturbulence in different atomic species?

PRZYBILLA: We derive a single value for the microturbulent velocity from all the species in A-type supergiants. In the previous discussion on Arcturus this point did arise as a possibility to bring the hydrogen lines and the metal lines simultaneously into match, using microturbulence as a fudge factor to a greater extent than usual. To my knowledge the only use of different microturbulences for different species in A-type supergiants occurred in the seventies when quantitative analyses of supergiants were accomplished for the first time, due to less-accurate atomic data. I am not aware that modern studies still derive this. But I would suggest that this is because of unaccounted NLTE effects. The weak and strong lines of the typical microturbulence indicators (e.g. Ti and Fe) show different sensitivities to NLTE departures, such that the NLTE analysis may result in a single value while in LTE discrepancies are found.

SKODA: You have shown us mostly the IR spectra of A supergiants. How do they look like in UV and (if is there any activity observed) in X-ray or radio bands?

PRZYBILLA: The UV spectra of A type supergiants are dominated by symmetric absorption lines, like in the visual. Only the resonance lines of the most abundant species indicate a presence of a stellar wind (in the more luminous objects), in form of saturated "black" absorption troughs. P Cygni profiles are not observed. A radio excess is observed in some stars. I am not aware of any X-ray observations of A-type stars.

SKODA: You have stressed the influence of winds in spectra (of blue supergiants). Did you try to incorporate a model of stellar wind (even a simple one) into your calculations?

PRZYBILLA: We have used NLTE unified model atmospheres for successfully modelling the wind affected Hα - Hγ lines in A type supergiants (Kudritzki *et al.* 1999, A&A 350, 970). Our present calculations for the photospheric absorption line spectra do not account for mass outflow. These lines appear to be basically unaffected by the stellar wind as indicated by preliminary results from a comparison with Hillier's CMFGEN code for β Ori.

BALEGA: Do you have any ideas about origin of fast rotators below 11000 K in globular clusters?

MÖHLER: Sills & Pinnsanneault (2000) suggest that red giants with rapidly rotating cores and differentially rotating envelopes could explain the fast rotators, if angular momentum is transported from the core to the surface on the horizontal branch. It is however, unclear, whether such fast rotating cores are possible. Soker and collaborators suggested a spin-up of the red giants precursor by a stellar companion or a planet entering the red giant's envelope as possible explanation for fast rotators. There are no observations so far to verify this hypothesis.

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