High-Resolution near-IR spectroscopy of massive stars

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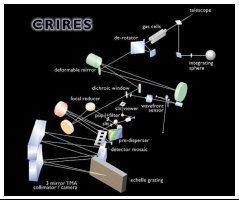
Abstract

We show preliminary results from a recent analysis of high-quality spectra of early-B dwarfs and giants in the solar neighbourhood obtained with CRIRES on the VLT. The precise quantitative spectral analysis in the visual developed in the past years is extended to the near-IR for the first time at high resolution.
The present work includes the identification and modelling of metal lines never resolved before and benchmark tests of spectrum synthesis, which is more challenging in the near-IR than in the optical because of amplification of non-LTE effects.
Stellar parameters are derived simultaneously from the near-IR hydrogen and helium lines and metal ionization equilibria. Agreement of atmospheric parameters and chemical abundances with those obtained in the visual confirms the self-consistency of the quantitative analysis.

Observations

- bright early B-type dwarfs and giants
- high signal-to-noise, high resolution spectra
- CRIRES on the VLT/UT1 (Käufl et al. 2004).
- J, H, K & L bands

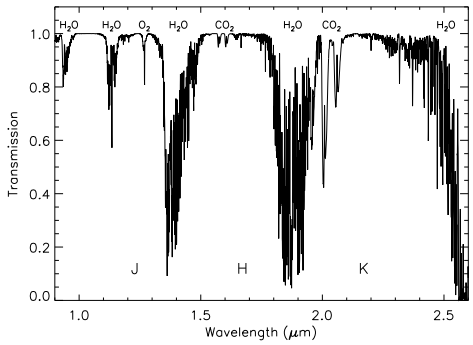


Telluric lines in near-IR

A basic data reduction step for ALL near-IR science spectra is the removal of telluric lines, as

observed spectrum = science spectrum × telluric spectrum

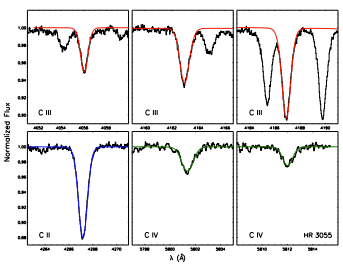
The water vapour content of the air is highly variable and reliable modelling of the telluric spectrum is challenging. The atmospheric transmission is therefore commonly monitored via telluric standards, observed close in time and position to the science target.

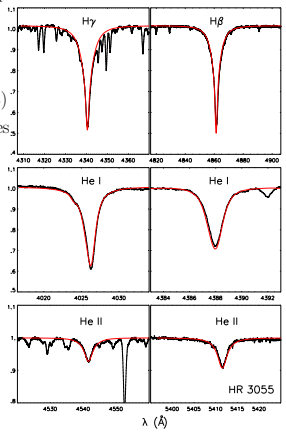


Transmission of Earth's atmosphere in the near-IR: identification of telluric line contributors.

Previous study of B stars in visual

- Stellar parameter determination from visual spectra.
- FEROS data & hybrid-non-LTE approach.
- Balmer lines & He I/II ionization balance (Nieva & Przybilla 2007)
- C II-IV ioniz. balance (Nieva & Przybilla 2008)
- Simultaneous high-quality fits to observed lines





Early-B stars as telluric standards

- B-type dwarfs and giants: telluric line correction of other science spectra.
- They are almost ideal telluric standards: only few spectral lines in the near-IR.
- Reliable modelling is challenging: sensitive to non-LTE effects & stellar parameters.

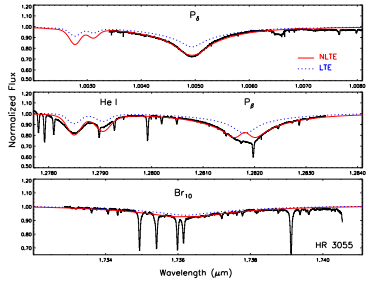
Models for hybrid non-LTE approach

- Hydrostatic metal-blanketed LTE model atmospheres (ATLAS9) in plane-parallel geometry + non-LTE line formation with DETAIL and SURFACE
- State-of-the-art model atoms (here extended to near-IR): H (Przybilla & Butler 2004); He I/II (Przybilla 2005); C II/III/IV (Nieva & Przybilla 2006, 2008)

Preliminary modelling of B stars in near-IR

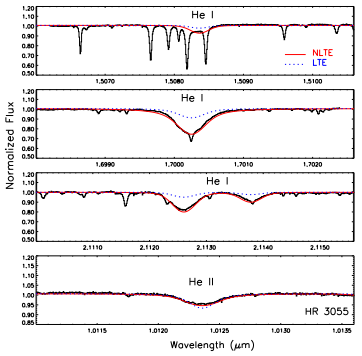
- Synthetic spectra: stellar parameters and NLTE level populations as from the optical.
- Reduction of observed spectra has to be improved.
- Non-LTE modelling requires small refinements.

Hydrogen

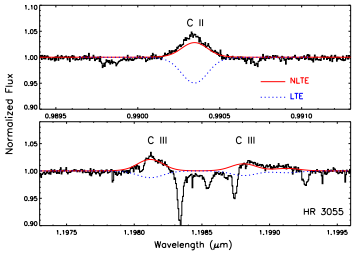


He I/II & C II/III ionization equilibrium simultaneously established in the visual & near-IR

Helium



Carbon



- Emission lines are characteristic of pure non-LTE effects.
- An LTE approach fails in reproducing the observations (even qualitatively).
- Similar C abundances as derived from optical spectra (within 1σ uncertainties).

References

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