Nitrogen line spectroscopy in O-stars -- II. Surface nitrogen abundances for O-stars in the Large Magellanic Cloud

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Context. Nitrogen is a key element to test the impact of rotational mixing on evolutionary models of massive stars. Recent studies of the nitrogen surface abundance in B-type stars within the VLT-FLAMES survey of massive stars have challenged part of the corresponding predictions. To obtain a more complete picture of massive star evolution, and to allow for further constraints, these studies need to be extended to O-stars.

Aims. This is the second paper in a series aiming at the analysis of nitrogen abundances in O-type stars, to enable further constraints on the early evolution of massive stars. In this paper, we investigate the NIV lambda4058 emission line formation, provide nitrogen abundances for a substantial O-star sample in the Large Magellanic Cloud, and compare our (preliminary) findings with recent predictions from stellar evolutionary models.

Methods. Stellar and wind parameters of our sample stars are determined by line profile fitting of hydrogen, helium and nitrogen lines, exploiting the corresponding ionization equilibria. Synthetic spectra are calculated by means of the NLTE atmosphere/spectrum synthesis code FASTWIND, using a new nitrogen model atom. We derive nitrogen abundances for 20 O- and 5 B-stars, by analyzing all nitrogen lines (from different ionization stages) present in the available optical spectra.

Results. The dominating process responsible for emission at NIV lambda 4058 in O-stars is the strong depopulation of the lower level of the transition, which increases as a function of Mdot. Unlike the NIII triplet emission, resonance lines do not play a role for typical mass-loss rates and below. We find (almost) no problem in fitting the nitrogen lines, in particular the `f' features. Only for some objects, where lines from NIII/NIV/NV are visible in parallel, we need to opt for a compromise solution.

For five objects in the early B-/late O-star domain which have been previously analyzed by different methods and model atmospheres, we derive consistent nitrogen abundances. The bulk of our sample O-stars seems to be strongly nitrogen-enriched, and a clear correlation of nitrogen and helium enrichment is found. By comparing the nitrogen abundances as a function of vsini ('Hunter-plot') with tailored evolutionary calculations, we identify a considerable number of highly enriched objects at low rotation.

Conclusions. Our findings seem to support the basic outcome of previous B-star studies within the VLT-FLAMES survey. Due to the low initial abundance, the detection of strong Nitrogen enrichment in the bulk of O-stars indicates that efficient mixing takes place already during the very early phases of stellar evolution of LMC O-stars. For tighter constraints, however, upcoming results from the VLT-FLAMES Tarantula survey need to be waited for, comprising a much larger number of O-stars that will be analyzed based on similar methods as presented here.

Reference: Astronomy & Astrophysics
Status: Manuscript has been accepted

Weblink: http://www.usm.uni-muenchen.de/people/puls/electronic_prints.html

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