CRIRES Science Verification Proposal

Title: The abundance of sulphur in metal-poor stars

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Abstract:

We propose to observe the three sulphur lines at 1045 nm in spectra of metal-poor turnoff stars. The S abundances that can be derived from these lines will serve as an important check of whether sulphur has a similar overabundance with respect to iron ([S/Fe] $\sim +0.3$ dex) as other alpha-capture elements (Mg, Si and Ca) and hence is made by oxygen burning in Type II supernovae or whether sulphur has a large overabundance with respect to iron ([S/Fe] $\sim +0.8$ dex) suggesting that S was made by very energetic supernovae, socalled hypernovae, in the early Universe. High S/N > 150 and a resolution of R=50.000 is needed to measure the relatively weak SI lines with sufficient precision; hence, the spectra with the clean continuum in metal-poor stars will also serve as a critical test of the flat-fielding in CRIRES.

Scientific Case:

Despite of several recent works on sulphur abundances in metal-poor stars, it is still debated if S shows the same kind of overabundance with respect to iron as other typical α-elements, Mg, Si and Ca. Some studies (e.g. Nissen et al., 2004, A&A, 415, 993) suggest that this is the case; [S/Fe] is constant at about +0.3 dex for [Fe/H] ranging from -1 to -3 indicating that S has been made by classical Type II supernovae. Other studies (e.g. Israelian & Rebolo 2001, ApJ, 557, L43); Caffau et al. 2005, A&A, 441, 533) seem, however, to indicate that [S/Fe] increases to a very high value of +0.8 dex at [Fe/H] $\simeq -2.0$, which may be due to S production by hypernovae in the early Galaxy (Nakamura et al. 2001, ApJ, 555,880). A clarification of the origin of sulphur is particular important for studies of the chemical enrichment and star formation history in the distant Universe via abundances in Damped Lyman-alpha systems, because sulphur is one of the few elements that are not depleted on dust.

So far S abundances have been derived from the weak SI line at 869.5 nm and the stronger pair of SI lines at 921.2 and 923.7 nm. The Nissen et al. (2004) results were based on UVES observations of these lines. The UVES spectra in the near-IR are, however, affected by residual fringing after flat-fielding, and - in the case of the 921.2, 923.7 nm pair - by telluric water wapor lines, which limits the accuracy of the S abundances derived.

Here we suggest to observe three SI lines at 1045.54, 1045.68 and 1045.94 nm for metal-poor turnoff stars for which we already have UVES data for the other SI lines. The 1045 nm lines have a strength comparable to the lines at 921.2 and 923.7 nm, but fall in a spectral region that is not significantly affected by telluric lines. Furthermore, one may hope that fringing is not a problem at this wavelength for the CRIRES detector. Hence, the results may serve as an important test of the S abundances derived by Nissen et al. (2004). At the same time, the observations will serve as a superb test of how well the flat fielding in CRIRES can be done. A direct comparison of the efficiency of UVES and CRIRES in the 1000 nm transition region will also be possible.

Required observing time

Target	RA	DEC	Wavelength Band	Magnitude	DIT	NDIT
CD −30 18140	20 44 06.3	−30 00 08	1.031-1.056	V= 9.95	900 sec	3
HD 215801	22 48 29.4	−46 03 51	1.031-1.056	V=10.05	900 -	3
G 29-23	23 19 40.4	+03 22 17	1.031-1.056	V=10.19	900 -	3

According to the present ETC for CRIRES, 3 times 900 sec integration on a V=10 mag star will give a S/N of 160 only. This is a bit on the low side for a very precise measurement of the S abundance. Number of stars and integration time should be adjusted to reach S/N > 200. Even one star would be highly interesting.