CRIRES Science Verification Proposal

NaI and CaII in a z∼2 Damped Lyman-α System

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Abstract: We propose to carry out the first search for NaID and/or CaII H-K lines in a z∼2 Damped Ly-α System for which we have UVES spectra. This will allow us to better constrain the physical conditions in the ISM of the damped Ly-alpha absorbers. In particular, the NaI/CaII ratio allows to constrain the clumpiness of the gas. Using the empirical N(NaID)/N(HI) relation, we can estimate N(HI) in the individual components of the DLA. We can determine the true metallicity variation across the velocity profile of this system and estimate the fraction of ionised gas in every component by means of a photoionisation model.

Scientific Case:

The NaI and CaII absorption lines are common features in the ISM of our Galaxy. So far they have never been observed in the ISM of objects with redshift larger than about 1. NaID and CaII H-K absorption lines have been detected at z=1.18 and z=1.06 toward APM08279+5255 using the near-IR spectrograph IRCS mounted on the Subaru telescope (Kondo et al. 2006, astroph/0603290). Although the SNR is high, the spectral resolution of IRCS is not high enough to deconvolve the numerous components.

CRIRES offers the possibility to extend the study of the ISM by means of these important lines for proto-galaxies at z>2 as flagged by damped Lyman-α systems. These lines provide important information regarding the velocity structure of the gas. NaI can be compared with the low-ionisation lines seen in the UVES spectrum to better constrain the ionisation conditions. At low redshift, CaII is often seen in turbulent material such as the one seen in the merging galaxies. Comparison between NaI and CaII is also a very good indicator of the clumpiness of the gas.

Detection of the NaID doublet redshifted to the IR window offers the possibility to deduce the N(HI) of individual components using the empirical relation between N(NaI) and N(HI) observed in Galactic interstellar absorption clouds (Sembach et al. 1993, AAS, 100, 107; Bowen et al. 1995, ApJ, 448, 634). Such data will then allow us to study the true metallicity variation from component to component across the velocity absorption profile and, for the first time, to model the ionised gas with the CLOUDY package in individual components.

We have selected a QSO which shows a damped Ly-α line in its spectrum as revealed by the H/ESO survey for Damped Ly-alpha systems (Smette et al.). We aim at better characterizing the ISM of this absorber to better understand the physical conditions within the gas. In case of success of these observations, further CRIRES observations will be requested to complete the survey and will help elucidate the origin of the magnitude-dependent bias seen in the H/ESO survey for DLAs.

As a comparison, at z=1.18 and z=1.06 toward APM08279+5255, both NaID and CaII lines have optical depths of the order of 0.1 and 0.3, respectively, at a resolution of about R=6000 and 4500, respectively.

We expect to achieve at least $R \approx 40000$ and, as the lines are not resolved in the IRCS spectrum, we could expect optical depths of about 0.2 in the same conditions.

This project will test the ability of CRIRES to detect faint absorption lines in relatively faint QSO spectra. It will take full advantage of the resolution of CRIRES to discriminate absorption lines caused by the absorber from telluric ones.

We need SNR of at least 20 to be able to detect the lines. If detected, the profiles of the NaI, CaII will be compared with the ones detected with UVES; they will provide important information regarding the ionization and clumpiness of the gas.

Required observing time

Target	**RA**	**DEC**	**Wavelength Band**	**Magnitude**	**DIT**	**NDIT**
HE 0251-5550	02 52 40.1	-55 38 32	29/1/i	H=14.6	300	12
...	...	...	43/1/n	...	300	48
...	...	...	43/1/i	...	300	48

Guiding with object on slit should be feasible. Otherwise suggested guide star:
02 52 37.24 -55 40 43.0 (R=11.5)
A minimum S/N of 20 lead to the minimum time request given above. Note that this S/N assumes optimal sensitivity of CRIRES, and therefore push CRIRES to the limit. If optimal sensitivity is not yet achieved during comm. III, this program will not be executed.

HE 0251-5550:
DLA redshift: 2.340.
NaI lines expected at 1967.5 and 1969.5 nm (taking into account Earth's motion).
Many tell. lines: NaI lines should appear on their red wing.
CaII lines expected at 1314.0 and 1325.7 nm (taking into account Earth's motion).
Exp time for this target: 5h

ETC estimates were based assuming no AO, as the object are at the limiting magnitude for AO. If AO can be used, the S/N will be improved by a factor of 2.
HE 0251-5550: R = 16.3 (but variable), V-R = 0.1

References

Kondo et al. astro-ph/0603290
Smette et al. astro-ph/0504657