CRIRES Science Verification Proposal

Title: FeH spectroscopy in ultracool dwarfs - CRIRES or UVES?

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Abstract:

We ask for observations of two M-dwarfs and one L-dwarf with the new high resolution facility CRIRES in the FeH band at the blue end of the wavelength range. This wavelength regions covers the most narrow and isolated spectral lines in such objects. It is used for rotation and magnetic flux investigation although its molecular parameters are not yet fully available. The region will likely become most important for future radial velocity studies in ultracool stars and brown dwarfs. The observations will allow an accurate comparison between CRIRES and UVES performance. CRIRES is expected to be at least a factor of four more efficient in this wavelength region. For planning future projects it is essential whether a significant amount of time can be saved using CRIRES instead of UVES in this wavelength region.

Scientific Case:

We want to observe two M-dwarfs and one L-dwarf around 1 micron with the CRIRES spectrograph. Our observations cover the FeH band that recently has been identified as an ideal tracer for rotation and magnetic flux investigation (Reiners & Basri, 2006, ApJ, 644, 497). It is the only known region where slow rotation can unambiguously be measured in M-dwarfs, and provides the strongest structure in ultracool dwarf spectra that will be of enormous importance in future radial velocity projects. FeH adds significantly to the overall opacity in very low mass objects. We are incorporating FeH opacities, that have recently become available, into the PHOENIX models in very cool objects, so we will be able to model FeH absorption in the near future. Furthermore, the lines are ideally suited for the measurement of magnetic flux. However, magnetic coupling constants are not available but Zeeman sensitivity of FeH absorption lines can be deduced from observations of magnetically active M-dwarfs. Thus, there is growing interest in this spectral region. Detailed line profile analysis as well as pushing radial velocity surveys towards cooler objects will make the wavelength region around 1μm most important for future science in very low mass stars and brown dwarfs. In such faint objects, it is essential to save telescope time at the VLT by choosing the most efficient instrument for such projects - UVES or CRIRES.

So far, only very few spectrographs offer access to this spectral region, which lies between the classical visual and infrared instruments. The problem is that in this region all available instruments have comparably low efficiency. CRIRES is expected to easily get ahead of all available instruments offering very high resolution and an AO system. The current estimate is that with CRIRES one could save at least a factor of 4 in exposure time compared to UVES. The proposed comparison is absolutely essential for optimizing observing efficency in future work. Such a comparison has to be performed in the targets in which the FeH band is most useful, i.e. in M- and L-dwarfs since it is the efficiency of the spectrograph in the given absorption structure and flux distribution that counts.

We ask for observations in three targets. Apart from its technical importance for future proposals, the data will be used for the following science: a) Gl 829 is one of the two early M-stars in the sample of Delfosse et al. (1998) that show no activity but for that only an upper limit in rotation velocity of around 5km/s could be measured. From the proposed observations, we will accurately measure the rotation velocity, i.e. pushing the upper limit to $\sim 2\,$km/s, to clarify wheter the star is a rapidly rotating but inactive early M-star. b) Magnetic flux should be measured in all targets following the strategy in Reiners & Basri, 2006, ApJ, 644, 497. The L-dwarf is also part of our UVES-survey (ID 077.C-0449) where we characterize ultracool dwarfs and measure rotation. This new spectrum will be used to search

for signatures of variable magnetic flux.

Required observing time

Target	RA	DEC	Wavelength Band	Magnitude	DIT	NDIT
Gl 829AB	21 29 36.8	+17 38 36	0.980-1.002	J=6.2	30	4
GJ 2005	00 24 44.2	-27 08 24	0.980-1.002	J=9.3	120	4
2MASS2057	20 57 54.1	-02 52 30	0.980-1.002	J=13.2	300	8

Total time required is about 1.5 hours.
Total integration time is 50min. CCD readout, telescope acquisition and AO will sum up to about half an hour.