CRIRES Science Verification Observations

Topic : Towards precise effective Temperatures and Gravities of low mass stars and brown dwarfs

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We propose high-resolution observations of two low-mass stellar and substellar double systems. We intend to investigate regions in the spectra of these objects that are most sensitive to effective temperature and gravity. We will compare the observations with the most recent synthetic spectra, produced by Peter Hauschildt (University of Hamburg). We aim to characterize the parameters with a high precision. We will thus also determine the mass of these objects via measured logg and radius estimates.

Abstract:

We will concentrate this study on the most sensitive features in low-mass, substellar objects which includes features of CO and a K I doublet whose spectra are theoretically well understood.

With eps Ind B the target list comprises the closest T dwarf double (T1/T6) to the sun. GEMINI/PHOENIX spectra of this object (Smith et al. 2003) let to physical parameters for eps Ind Ba and Bb that are inconsistent with effective temperatures and gravities determined by other techniques like mid-IR photometry from VIZIR data (Sterzik et al. 2006). It is believed that this is meanly due to poor modeling and the choice of inappropriate spectral features for the PHOENIX spectra. Hence this system is a crucial benchmark test for the understanding of the physics and the spectral features of these objects.

The second system proposed here is 2MASS2200-3038, a close M0/L1 double (Burgasser et al.2006). We have observed the system in no AO/natural seeing mode during the first CRIRES commissioning in June. When observed now in closed loop mode, we can test the system performance in both modes on a faint target, that is a challenge in throughput and spatial resolution.

Both systems have separations of less then 1" and the spectral regions that shall be investigated here are contaminated by telluric features. Hence we need both, the high spatial and high spectral resolution of CRIRES.

Target List and Table

name	alfa 2000 delta 2000	lambda range / wavelength ID	Fnue or Fline	exp. time DIT, NDIT
eps Ind B	22 04 10.59 -56 46 58	CO	20 + 3 mJy	
		24/-1/n		240, 16
		CH4, KI	26 + 5 mJy	
		48/ 0/i		180, 16

112 min int time, (32x30") = 17 min readout and nodding overhead,
15 min for preset + acquisition, 2 min for setting changes = 2h 45min

2MASS2200	22 00 02.05 -30 38 33	CO	5 + 4 mJy	
		24/ -1/n		240, 12
		FeH, KI	4 + 3 mJy	
		48/ 0/i		180, 12

84 min int time, (24x30") = 12 min readout and nodding overhead,
15 min for preset + acquisition, 2 min for setting changes = 2h

Total time asked for: 4h 45min

Adaptive optics notes:

eps Ind B has to be observed in noAO / natural seeing mode
2MASS2200 has an AO guide star ~28' north

Detailed description of Suggested observations:

NOTE: Instead of the given number of NDITs use AB nodding positions and NDIT always 1 to guarantee an optimal sky background subtraction!

Use the 0.4 arcsec slit , position angle as such that both components fall into the slit. Appropriate finding charts will be prepared. Note that the AO guide star for 2MASS2200 is a galaxy core that has wrong 2MASS magnitudes and can only be seen shortwards of the H band on the slitviewer! Its magnitude in R is ~14mag.

SCIENCE GOALS:

The vast majority of brown dwarfs are field objects. Their mass is still undetermined and their classification is solely based on evolutionary models, which are insufficiently tested.

All intrinsic parameters and properties to determine the mass of these objects can be obtained by comparing high resolution infrared spectra to the latest generation of synthetic spectra. With this approach we will be able to provide distinct properties for the first M, L and T dwarfs that could not be determined on different ways.

The study of close double system offers an extra advantage in comparison to single objects. Astrometry and radial velocity studies can reveal the orbital parameters of these systems over time. Thus we will have access to the mass of the system from first principles. This allows an evaluation of the mass predictions from evolutionary models and thus the needed calibration of the models.

For data reduction we will use standard packages for long slit data in MIDAS and IRAF as well as a self-written IDL pipeline that has been successfully tested with data obtained during CRIRES commissioning run in June (AS).

The expected signal to noise of ~20 is high enough to determine the effective temperature to better than ± 100K and logg to ± 0.5 dex. This could be demonstrated with the first spectra of 2MASS2200 from commissioning I which had lower S/N.