CRIRES Science Verification Proposal

Is NIR spectroscopy the new breakthrough for the study of pulsating stars?

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Abstract:

Asteroseismology is based on the difficult task of identifying some of the modes in a pulsating star – situation that can be greatly improved by extending the wavelength range used. With this proposal we intend to carry out an investigation not attemptxed before on the potentiallity of this wavelength range to study the pulsational content of this type of stars. We will also test the repeatibility of the wavelength settings of CRIRES during continuous changing for 3.5 hours (for airmasses from 2.00 to 1.05)

Scientific Case:

Asteroseismology is the tool used for getting information on the interior of stars through the observations of pulsation modes and the measuring of their frequencies as they emerge at the stellar surface. Having traveled through the star, these modes carry information about interior physical conditions, depending on how far and in which parts of the star the modes traveled. This is the only way of obtaining information on the interior of stars. The modes are completely described by three quantum numbers: radial order n, spherical degree, ℓ, and the azimuthal order, m. Unfortunately, the difficulty lies in determining these quantum numbers for each frequency observed, which is known as the long-standing problem of mode identification. White light photometry has proved insufficient, while the use of multi-colour photometry and/or optical spectroscopy is giving, with great difficulty though, its first results. It is known that the use of a large wavelength baseline when applying the mode-identification techniques greatly improves the significance of the mode identification. Therefore, using near infrared spectroscopic observations together with optical photometry or spectroscopy should greatly improve the mode identification techniques. However no investigation in this region of the spectrum towards this aim has been conducted so far.

We propose to obtain time series of NIR spectra in the H-band region of a pulsating star to analize the hydrogen and metal lines with the aim of setting strong constraints for the identification of the modes. The diagnostic potential of using these techniques at these wavelengths comes mainly from the description of the pulsation when limb darkening effects are included, which are very different for optical and NIR wavelengths, or for the very different sensitivity of these lines to temperature and gravity changes with respect to the optical ones.

What do we want to achieve with these observations?:

* We want to check that the pulsations are detectable in the HI (Brackett series lines from Br6 onwards, H band) and metal lines in the near infrared at this resolution for a moderate pulsator. This has been done before for δ Sct stars in the optical but never in the NIR. To this aim, a coverage of a large range in wavelength is important.

* We want to get a quantitative idea of the relation between the amplitude of the photometric pulsations and their effect in the profiles at this resolution in this part of the spectrum.

* Finally we want to check the potentiallity of this part of the spectrum for determining the physical parameters of the stars.

1 Mon is the ideal candidate because of its relatively large photometric amplitude (~ 0.1 in Strömgren v), its determined radial and non-radial pulsations, its relatively high brightness, the pulsation period and its visibility during this epoch. Large spectral covarage is needed since there does not exist any a priory information on the lines expected to show Line Profile Variations (LPV) in this region of the spectrum. With these observations we also expect to help in testing the precision of the wavelength positioning of CRIRES by continuously changing the wavelength setting during the whole length of the observations.

These observations are ideal for CRIRES SV time because: (1) they may have a great impact on pulsating star research, providing a true breakthrough in the field, (2) the science case is simple, time investment is low, and analysis straightforward. (3) validating the method means a lot of renewed activity in the field, and huge interest in CRIRES and its capabilities. Furthermore, the type of research we have described above was proposed first for ISAAC but the OPC recommended that it should be tried directly with the higher resolution of CRIRES during this SV mode.

Required observing time

Target	**RA**	**DEC**	**Wavelength Band**	**Magnitude**	**DIT**	**NDIT**
1 Mon	05 59 01.1	-09 22 56	1.525-1.765	H=5.35	10	1

We would like to observe the HADS 1 Mon (F2IV, H-band mag $H = 5.35$) during 3.5 hours continuously to cover at least one pulsation cycle. Please, take into account that the object is visible for only those 3.5 hours at the beginning of the night between 00:45h and 04:15h UT.

Acquisition with AO takes 5 min. Readout overheads for 30s (DIT) $\times$ 2 (NDIT) (which gives approx. S/N=100 at 1650nm; ETC 3.1.1) exposures are 15s. In total an AB nodding will take $2 \times (30 \times 2 + 15) + 0.25 + 0.20$, i.e. around 150s. Adding the exposure of a wavelength calibration of 5 min leads to a wavelength setting AB nodding of 7.5 min. This sequence repeated for three different wavelength setting gives a total of 22.5 min. With this time resolution we get 9 measurements during one pulsation cycle of the star, which should be enough to see the pulsations in the spectra.

Wavelength settings: 35/-1/n, 34/-1/n and 33/-1/n

Slit=0.4"

AO: Target=guide star, V=6.16, B-V=0.29