X-shooter Science Verification Proposal

Towards the first spectral features seen in Ultra-cool White Dwarfs

Investigators	Institute	EMAIL
Wolf, C.	Oxford Physics, UK	cwolf@astro.ox.ac
Podsiadlowski, Ph.	Oxford Physics, UK	podsi@astro.ox.ac
Justham, S.	Kavli Beijing, China	sjustham@kiaa.pku.edu.cn

Scientific Case:

Ultra-cool White Dwarfs (UCWDs) are a class of unexplained objects, about which very little is known. The first of its kind, LHS 3250, was identified by Harris et al. (1999), and its V-band luminosity (15.7 mag) derived from a parallax measurement is the only certain physical information we have of any UCWD. Only eight objects are confirmed UCWDs, mostly found in the SDSS (Gates et al. 2004). The faintest one was discovered in the COMBO-17 survey with WFI at the ESO-2.2m-telescope (Wolf 2005).

UCWD SEDs deviate strongly from black bodies; they peak in the V-band and drop off by 10x in flux to the u-band or 1μ. No spectral features have ever been observed. It is assumed that the blue edge is the Wien tail of the Planck function while the red decline is due to collisionally-induced absorption in a pure H+He-atmosphere at $T < 3500$ K, although theoretical spectra provide no acceptable fit (Bergeron & Leggett 2002). The luminosity of LHS 3250 suggests a star that is large for a WD and hence of low mass (1/4-1/3 $M_\odot$) and low surface gravity. They could be very old objects but without masses their cooling curves are not constrained. Justham, Wolf, Podsiadlowski & Han 2008 suggested that UCWDs could be pure He cores left over from SNe Ia, whose explosions stripped the envelopes of giant donor stars. This is consistent with estimated UCWD space densities and kinematic estimates from UCWD proper motions.

Progress is expected in two areas: clues on atmospheric properties and on possible binarity from their spectra, and more parallaxes. We propose to obtain the best-quality spectrum of LHS 1402, the coolest and second-brightest known UCWD, and furthermore in the Southern sky at -28 deg declination. The current UCWD spectra are of SDSS-type quality. The spectral slope seems change monotonically with λ and no deviation from this has been observed. The best known spectrum of LHS 1402 is by Oppenheimer et al. 2001, Science 292, 698: there, all visible features are believed to be noise. It is presently unclear how subtle the atmospheric features of UCWDs might be, but we intend to push the limits much further.

We aim to see atmospheric features of any plausible width, or slight local depressions in the continuum due to weak broadened features or binarity. Our hope for progress rests on (i) vastly improved signal-to-noise that also allows for smoothing in wide windows to search for wide depressions with only a few per cent depth; (ii) covering the full λ range over which thermal emission is expected, in particular the little studied regime at $> 1\mu$. It would be extremely interesting to find spectral slope variations in the NIR.

Calibration strategy:

In order to define the shape of the SED as accurately as possible, we include two spectrophotometric standards near the target (μ Col, GD50). We need the ADCs to avoid λ-dependent slit losses.

Targets and number of visibility measurements

Target	**RA**	**DEC**	**V** mag	**Mode** (slit/IFU)	**Remarks**
LHS 1402	2 24 32	-28 55	18	slit	grey nights ok; August start of night best for low airmass

Time Justification:

Generically, improvement in S/N over existing data must be a factor of several to justify the exercise; a 30-minute expsoure on LHS 1402 would give S/N ratios per spectral bin of 40 in the B-band ($B = 18.4$), 15 at 800 nm ($I = 18.6$) and perhaps 10 in the J-band (depending on NIR SED), probably far less than 1 in the K-band, though this is TBD. We have used the ETC with airmass 1.2, seeing 0.8 arcsec, slit width 1 arcsec.