MONITORING THE OUTBURST OF THE LUMINOUS BLUE VARIABLE R71 WITH X-SHOOTER

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INTRODUCTION

The Luminous Blue Variable (LBV) R71 (= HDE 269006) in the Large Magellanic Cloud is currently undergoing an outburst that started in 2005. The star has reached unprecedented brightness, accompanied by remarkable variations in its optical spectrum [1]. LBVs and their instability may shape the upper HR diagram (Fig. 1) but the physical cause of their sporadic, violent mass-loss events is still not understood [2]. R71's current outburst therefore offers unparalleled observing opportunities.

During R71's last eruption in 1970-1977 its brightness reached V_{max}=9.9 mag. The star then faded to V_{min}~11 mag [3]. Currently, R71 has reached an unprecedented V=8.3 mag. In 2008 Feb the star displayed a spectrum similar to an early-A supergiant, in 2009 Aug that of an extreme early-F hypergiant, and in 2012 that of an early-G supergiant [1,4].

There is ambiguity in the literature if R71 is a classical LBV [5] or a less luminous LBV [2]. However, to interpret the behavior of R71 it is important to know to which of the two groups it belongs because they imply different evolutionary paths [2]. Classical LBVs have M_{bol}<-9.6 mag and have very likely not been red supergiants (RSGs). Less luminous LBVs have M_{bol}=-8...-9 mag, lower temperatures, smaller amplitudes, and lower mass-loss rates. They have probably been RSGs. R71 is below or just at the upper luminosity boundary (Fig. 1). A dust shell around R71 may have been produced in a short RSG phase [6]. This is supported by Herschel and Spitzer data; a dust component at 10-100 µm resembles RSG dust [7] and [8] found that the coolest dust around R71 was likely expelled a few 10^4 yr ago in a RSG phase.

Monitoring R71's eruption with multi-wavelength, medium-resolution X-shooter spectra will secure key data for the understanding of LBV eruptions.

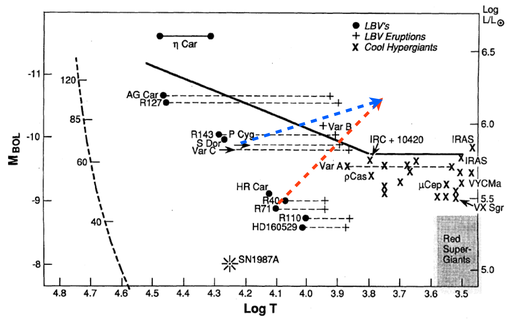

Fig. 1: Schematic upper HR diagram (source: [2]). The black dashed lines represent LBV transitions. The solid line is the upper luminosity boundary. The current outburst of R71 is indicated for the two competing luminosities found in the literature for the quiescent state (red line: less luminous LBV [2]; blue line: classical LBV [5]).

VLT X-SHOOTER OBSERVATIONS

On 2012 Aug 25 and Sep 3 we obtained the first of a series of X-shooter spectra of R71. X-shooter is a multi-wavelength medium-resolution spectrograph at the VLT [9]. It consists of 3 arms (UVB: 300-560 nm, VIS: 560-1024 nm, NIR: 1024-2480 nm). Each arm is an independent cross-dispersed echelle spectrograph. The detector pixel scales are 0.16"/pixel for the UVB and VIS arm, and 0.21"/pixel for the NIR arm.

Observations with the narrowest available slits of 0.5" (UVB), 0.4" (VIS), and 0.4" (NIR) and T_{exp}=60-120 s result in spectra with R ~10,000-18,000. Observations with slit widths of 5" and T_{exp}=10-20 s permit spectro-photometry. The spectra were reduced with the X-shooter pipeline.

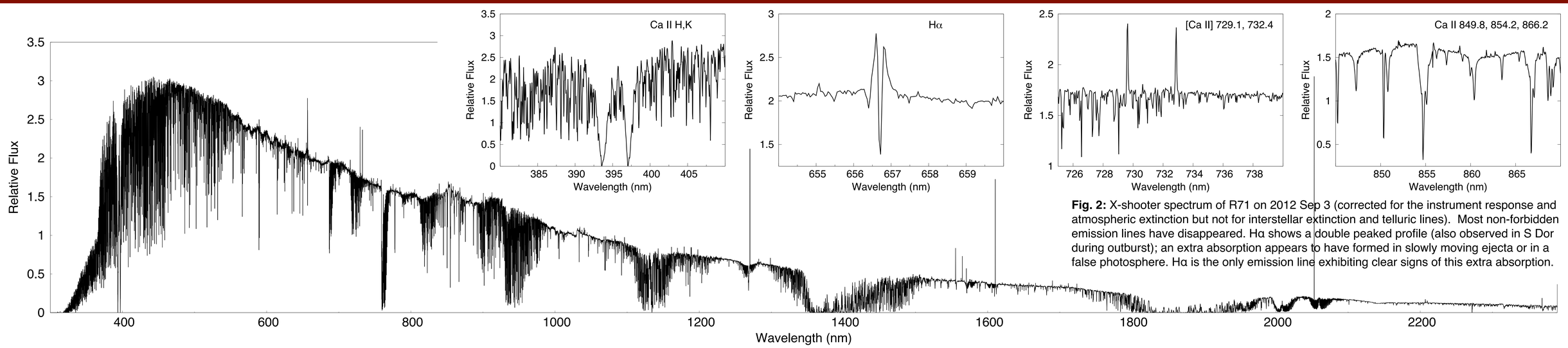

Fig. 2: X-shooter spectrum of R71 on 2012 Sep 3 (corrected for the instrument response and atmospheric extinction but not for interstellar extinction and telluric lines). Most non-forbidden emission lines have disappeared. Hα shows a double peaked profile (also observed in S Dor during outburst); an extra absorption appears to have formed in slowly moving ejecta or in a false photosphere. Hα is the only emission line exhibiting clear signs of this extra absorption.

References

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CONCLUSIONS

1. The current LBV outburst with $\Delta V > 2.5$ mag is unprecedented in R71 and the largest known V-band amplitude in the Local Group for more than a century. The star is likely having a giant eruption similar to Eta Car and P Cygni in the past. The peak of its current SED (not corrected for interstellar extinction) implies T_{eff} ~5500 K.
2. The current spectrum of R71 shows intricate spectral features, see Fig. 2. Our recent X-shooter spectra confirm the dramatic spectral changes reported in [1].
3. Assuming DM=18.5 mag, A_V=0.16...0.63 mag [3,5], and BC=0 mag, R71's current V=8.3 mag results in $M_{bol,2012}$~-10.4...-10.8 mag. In spite of the uncertainty of M_{bol} during quiescence there is strong indication of a change in M_{bol} during outburst, see Fig. 1.
4. We will continue to monitor R71 with X-shooter to better understand the nature of R71's outburst and LBV-type eruptions in general.

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