ESO observing programme 106.211Z

X-Shooting ULLYSES (XShootU): The physics of massive stars at low metallicity. DR1

Abstract

The X-Shooting ULLYSES project (XShootU, 106.211Z) aims to provide near-UV to near-IR spectra for the massive stars targeted by the HST Director's Discretionary programme ULLYSES (https://ullyses.stsci.edu/). This first public data release (DR1) contains UVB and VIS X-Shooter spectra of 232 massive stars in the Large and Small Magellanic Clouds (LMC, SMC). All stars were observed in STARE Mode, using 0.8" and 0.7" slits for the UVB and VIS, respectively, resulting in a resolving power of ~6700 in the UVB and ~11400 in the VIS. Both individual and co-added spectra are included in the release. Future data releases will include NIR data products (DR2), and extension of the sample with sub-SMC metallicity stars (DR2), ULLYSES stars with archival XShooter data that were excluded from the large programme (DR2), and ULLYSES+ stars[1] (DR2 and DR3).

Overview of Observations

The observations were spread on 102 different nights from October 2020 to Juli 2021 and include 129 LMC and 113 SMC stars. In total, 358 UVB and 357 VIS individual exposures were obtained. 73 objects have multi-epoch observations (i.e., two or more exposures), of which 34 have these observations spread over different nights. The main reasons for these repeated observations over two nights or more are due to operators declaring that the weather conditions were below requirements or because part of the spectrum was saturated. These repeated observations provide a limited insight into the variability of these objects.
The spatial distribution of the targets in both LMC and SMC are shown in Fig. 1.

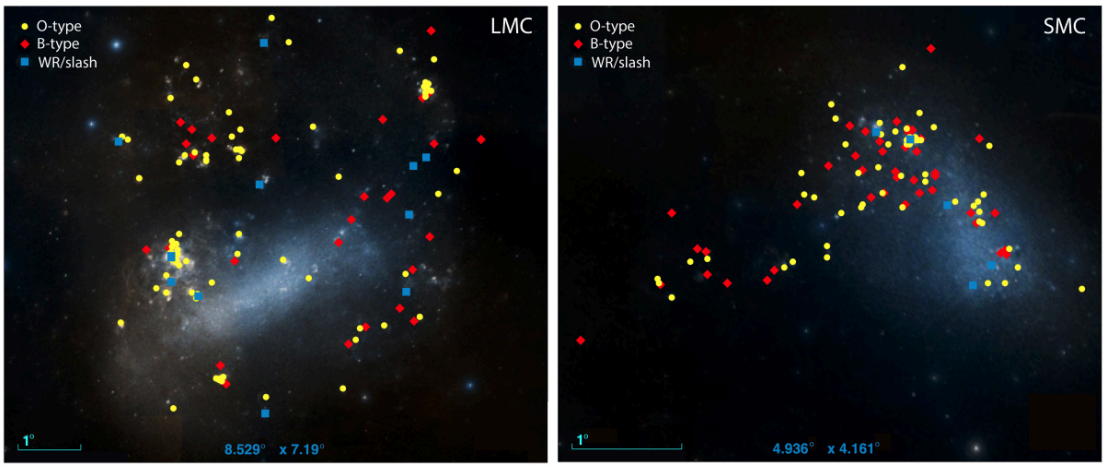

Fig. 1: Positions of the ULLYSES/XShootU sources in the LMC (left) and SMC (right). Yellow dots are O-type stars, red diamonds are B-type stars, and blue squares are WR and WR-like Of/WR 'slash' stars. Note that the two images have different spatial scales. This figure was made with the Aladin Sky Atlas (Bonnarel et al. 2000); the background consists of DSS2 colour images.

[1] Several stars with archival HST data were added to the ULLYSES program after the acceptance of the XShooter proposal. XShooter data for these stars is currently being obtained.

Release Content

The data release contains data for 232 ULLYSES stars in the LMC and SMC. It has a total of 260 science products and 610 ancillary files. Generally, individual exposures (INDIV1D) are available as ancillary files, and co-added spectra with UVB and VIS merged (COADD1D) as the main science spectra, with the exception of some of the binaries (see below). The data cover the UVB and VIS arms of XSHOOTER, i.e. a wavelength coverage of 300-1020 nm. The total size of the dataset is 0.85 GB.

Binaries: Several stars in the sample have been identified as spectroscopic binaries (see Crowther et al., subm, table A3). If these stars have multiple exposures taken on different nights, no COADD1D spectra are provided, and the INDIV1D are provided as the science spectra. This concerns the following stars: 2DFS-3689, AV-16, AV-332, VFTS-542, NGC346-ELS-007, LMCX-4, SK-71D21, BI-272.

Oe Stars: Some Oe stars in the sample have multiple exposures taken on different nights. While we provide both COADD1D and INDIV1D products for these stars, we advise caution with the use of the COADD1D files, as the emission lines may be variable. This concerns AV-61 and BI189.

Release Notes

All data were reduced using the XSHOOTER pipeline v3.5.0. Some alterations were made to the standard setup, in particular for the flatfielding and flux calibration. For the flatfielding, the same flatfields were used for both the science and flux standard stars (i.e. the 5" slit flatfields), which results in a better determination of the blaze function. New flux standard models were determined for the standard stars used in the program to improve the determination of the instrument response function, in particular near the Balmer lines.
The wavelength calibration was performed using the provided calibration files, and corresponds to wavelengths measured in standard (dry) air. All wavelengths have been corrected for the barycentric motion.

High-level data products are provided, which include a slit-loss correction, telluric absorption correction, absolute flux calibration (by scaling to optical Jonhson magnitudes), and rectification to the continuum.

All details of the data reduction and HLDPs are given in XShootU Paper II.

Data Quality

All data products have undergone extensive quality checks. These include the identification of multiple objects in the slit (in which case a manual extraction has been performed), and the assessment of the quality of the telluric correction and the rectification to the continuum. Various quality control plots and tailored static calibration files are available on the full release of the data on Zenodo (https://zenodo.org/records/12743023).

Known issues

Some issues can appear in the normalized version of the spectra:

- The bluest region (< 350 nm) displays only a pseudo continuum due to the high density of spectral lines. This prevents us from retaining continuum points so that the adopted continuum is an interpolation of the quadratic function used in the 324.6 − 364.0 nm region.
- There is a tendency to underestimate the continuum just below 410 nm (i.e. bluer of Hδ), while overestimating the continuum just redwards of Hδ (by ~0.5%)
- Small (~0.5%) dips in continuum bluewards of the Balmer lines are often present.

- Broad bumps (~1%) in flux around 570 nm caused by the O2 model of the telluric absorption correction (see Section 4.2).
- Broad bump in flux from 900−960 nm. This is a result of the inaccurate telluric absorption correction as the telluric lines are (close to) saturated in this region

Data Format

Files Types

The data release contains 1D spectra of both individual (INDIV1D) and co-added (COADD1D) exposures.

Naming convention for the INDIV1D files:
XSH-U_DR1_<OBJECT>_INDIV1D_<ARM>_<DATE>.fits
Naming convention for the COADD1D files:
XSH-U_DR1_<OBJECT>_COADD1D_<ARM>.fits
Here, <OBJECT> refers to the ULLYSES target name, <ARM> the X-Shooter arm (UVB or VIS), and <DATE> the date and time of the observation.

The BINTABLEs contain the following columns:

- WAVE: Wavelengths corresponding to standard (dry) air, corrected for barycentric motion
- FLUX: Relative flux-calibrated spectrum
- ERR: Errors on FLUX
- FLUX_SLC: Slit-loss corrected version of FLUX
- ERR_SLC: Errors on FLUX_SLC
- FLUX_TELLURIC: Telluric corrected version of FLUX_SLC (VIS arm only, for UVB this is identical to FLUX_SLC)
- ERR_TELLURIC: Eros on FLUX_TELLURIC
- FLUX_TELLURIC_ABS: Absolute flux calibrated version of FLUX_TELLURIC
- ERR_TELLURIC_ABS: Errors on FLUX_TELLURIC_ABS
- FLUX_TELLURIC_NORM: Normalized version of FLUX_TELLURIC_ABS
- ERR_TELLURIC_NORM: Errors on FLUX_TELLURIC_NORM

Acknowledgements

Publications that make use of this data are requested to cite *X-Shooting ULLYSES* Paper I (DOI: 10.1051/0004-6361/202245650) and Paper II (DOI: 10.1051/0004-6361/202347479).

According to the Data Access Policy for ESO data held in the ESO Science Archive Facility, all users are required to acknowledge the source of the data with appropriate citation in their publications.

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