The MUSE Ultra Deep Field (MUDF)

Abstract

This is the first data release (DR1) of the MUSE data obtained in the MUSE Ultra Deep Field (MUDF) as part of the Large Programme ID 1100.A-0528. The MUDF covers a 1.5 x 1.2 arcminute^2 region which contains two bright quasars at z~3.2 with a close separation of ~500kpc. The data consists of ~150 hours on source integral field optical spectroscopy. This has been reduced with the ESO/MUSE pipeline via the Esorex Recipe Execution Tool and is released jointly with the associated white-light image and exposure map.

Overview of Observations

Observations for this large programme have been obtained from the Multi-unit spectroscopic explorer (MUSE) instrument between August 2017 and June 2022 with the instrument in the Wide Field Mode with the extended wavelength coverage. The observations took advantage of the Ground Layer Adaptive Optics module (GALACSI) to correct for atmospheric turbulence and improve the image quality.

The MUDF covers a 1.5 × 1.2 arcmin^2 region which was chosen due to the presence of two quasars at z~3.22. Given the separation of the quasars is 62 arcseconds, a single Wide field mode (which is ~60 arcseconds across) is not able to fully cover both these sources. Therefore the MUDF observational strategy uses two highly overlapping pointings, one to the North-West and the other to the South-East of the field centre, creating a final elliptical-shaped field.

The final datacube presented here consists a total of 358 exposures taken over 86 different nights, centred on each of these two pointings with small dithers of ~3-4 arcsec and 10 degree rotations to reduce systematic errors resulting from the different response of the 24 spectrographs and detectors of MUSE. Each exposure is ~1450s which combined together make a total exposure time of 144.82h.

Release Content

This release contains a single datacube of the MUDF mosaic along with a white-light image and exposure map. This data is a combination of 144h of data taken between August 2017 and June 2022. The field is 1.5 × 1.2 arcmin^2 and is centred at 21h:42m:24s −44°:19m:48s , including two z~3.22 quasars at 21h:42m:25s−44°:20:m18s and 21h:42m:22s−44°:19m:29s. The data cover a spectral range from 4650Å to 9300Å and reach a limiting magnitude of 26.9 in the central regions where there is the largest number of observations (texp>80h).

Release Notes

Data Reduction and Calibration

The data provided here are reduced using a pipeline based on the recipes distributed as part of the ESO MUSE pipeline (Weilbacher et al. 2014, version 2.4.1), which reduces the calibrations (bias, flats, arcs and standard stars) and applies them to each of the individual exposures. We use the ESO MUSE pipeline for advanced flat field correction (the illumination auto-calibration) that improves the spatial uniformity of the background illumination and we sky-subtract the

individual pixel tables using models of the sky continuum and sky lines. Individual exposures are aligned using the position of point sources using the muse_exp_align recipe of the ESO MUSE pipeline. A coadd is then generated and it is lastly matched to the WCS coordinates of the two quasars from DR2 of the GAIA survey (Gaia Collaboration et al. 2018). The final reconstructed cube has 800x800 spatial pixels and 3801 spectral pixels where each of them measures 0.2 arcsec in the spatial direction and 1.25Å in the spectral direction. Wavelengths are in air with barycentric corrections applied. Readers can refer to Fossati et al. 2019 (10.1093/mnras/stz2693) for further details on the reduction.

Data Quality

To validate the photometric calibration of our cube we create an image in the HST WFPC2/F702W filter and extract magnitudes for some of the bright stars in the field. These values are compared with those from HST in the same band, after ensuring the HST images are not saturated. We find that the magnitudes show very good agreement with typically less than ten percent variation between the two instruments.

In addition, to check the wavelength calibration we compared the quasar spectra extracted from the MUSE cubes with the archival UVES finding good agreement between the two with features within the 1.25Å spectral . We also check the redshifts of sources extracted from the MUSE cube and compare them to values derived from HST spectroscopy (Revalski et al. submitted) values finding no systematic offsets in the redshifts.

Known issues

Data provided in this data release are known to have imperfections in the sky subtraction and in the illumination uniformity of the field. Also, the standard deviation computed during the standard data reduction is known to be underestimated by a factor of ~1.2 compared to the true noise. For more details on these issues, and ways to correct them, see Lofthouse et al. 2020, doi:10.1093/mnras/stz3066 and Fossati et al. 2019 doi:10.1093/mnras/stz2693 . Future data releases will deliver data products that correct these issues.

Data Format

Files Types

The cube and white-light image released follow the standard format described in the MUSE pipeline manual. The cube is named DATACUBE_FINAL_358_esocomb.fits while the associated image is IMAGE_FINAL_358_esocomb.fits. We also provide an exposure map entitled EXPOSUREMAP_FINAL_358_esocomb.fits

Acknowledgements

Publications making use of these data should acknowledge the paper accompanying the data release of this programme: Fossati et al. 2019 (10.1093/mnras/stz2693)

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To access the codes and scripts used, please visit http://www.michelefumagalli.com/codes.html.

Any publication making use of these data, whether obtained from the ESO archive or via third parties, must include the following acknowledgment:

- "Based on data products created from observations collected at the European Organisation for Astronomical Research in the Southern Hemisphere under ESO programme 1100.A-0528 "

If the access to the ESO Science Archive Facility services was helpful for you research, please include the following acknowledgment:

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