ESO Phase 3 Data Release Description

AMAZE/SINFONI Data Release

01 February 2011 – Migrated to Phase 3 in August 2017

AMAZE (Assessing the Mass-Abundance redshift[-Z] Evolution) is an ESO large program aimed at determining the mass-metallicity relation and galaxy dynamics in the redshift range $3 < z < 5$. Observations have been performed with SINFONI (Eisenhauer et al. 2003), the near-IR integral field spectrometer at VLT, for a total of 180 h, distributed in three semesters under the program ID 178.B-0838 (A) (B) (C), PI: R. Maiolino. SINFONI was used in seeing-limited mode, with the 0.125"x0.25" pixel scale and the H+K grism, yielding a spectral resolution R $\sim$1500 over the spectral range 1.45 − 2.41 µm. The two-dimensional spectroscopic capabilities of SINFONI are exploited to map the emission lines. The main goal of the SINFONI observations is to determine the gas metallicities by means of a combination of strong line diagnostics based on Hβ and [OIII]5007 redshifted into the K band, as well as [OII]3727 and [NeIII]3870 redshifted into the H band for sources at $3 < z < 4$. At $4 < z > 5.2$ we only rely on the [OII]/[NeIII] ratio observed in the K band. The spectral resolution is also high enough to trace galaxy kinematics in most cases.

In this release we provide the full set of extracted 1-dimensional FITS spectra in the AMAZE/SINFONI survey and associated spectral previews for each target. Furthermore, a catalogue is also associated where we give for each target the basic information such as coordinates, redshifts, magnitudes (3.6-4.5µm IRAC and R band).

A full description of the survey can be found in the accompanying papers:

"AMAZE I. The evolution of the mass–metallicity relation at z > 3", Maiolino et al. 2008, A&A, 488, 463 (first data release),

"Dynamical properties of AMAZE and LSD galaxies from gas kinematics and the Tully-Fisher relation at z~3", Gnerucci et al. 2011, A&A, 528, A88 (results of the complete campaign).

"Metallicity evolutoin, metallicity gradients, and gas fractions at z~3.4", Troncoso et al. 2014, A&A, 563, 58 (additional results of the complete campaign).

Additional papers from the team using these data are:

"Gas accretion as the origin of chemical abundance gradients in distant galaxies", Cresci et al. 2010, Nature, 467, 811.

"A fundamental relation between mass, star formation rate and metallicity in local and high-redshift galaxies", Mannucci et al. 2010, MNRAS, 408, 2115.

"A dynamical mass estimator for high0z galaxies based on spectroastrometry", Gnerucci et al. 2011, A&A 563, 58

"LSD: Lyman-break galaxies Stellar populations and Dynamics - I. Mass, metallicity and gas at z~3.1", Mannucci et al. 2009, MNRAS 398, 1915.

"Stellar metallicity of star forming galaxies at z~3", Sommariva et al. 2012, A&A 539, 136

"AMAZE and LSD: metallicity and dynamical evolution of galaxies in the early Universe", Maiolino et al. 2010, The Messenger, 142, 36

The data were reduced and prepared for release by the AMAZE team, and specifically by F. Cocchia, G. Cresci and P. Troncoso.

Overview and field layout

The target sample consists of about 30 Lyman Break Galaxies (LBGs), most of which at $3 < z < 3.7$, and only a few of them at $4.3 < z < 5.2$. Most of the galaxies were taken from the Steidel et al. (2003) survey and from the deep spectroscopic surveys in the Chandra Deep Field South (CDFS) (Vanzella et al. 2006), but we also included some lensed galaxies (e.g. Frye et al. 2002, 2007) to better explore the low mass end.

Galaxies were selected only among those with highly reliable spectroscopic redshift (e.g. flagged as “A” in Vanzella et al. 2006). We required that the redshift is such that the emission lines of interest for the metallicity determination ([OIII], Hβ,[OII], [NeIII]) are displaced from strong sky emission lines and out of deep atmospheric absorption features. Actually, these requirement could not always be fulfilled for all of the emission lines (also because sometimes the redshift determined through optical spectra is not accurate, due to winds affecting UV-rest frame features, or IGM absorption of the Lyα). The additional requirement is that the source has been observed with at least two of the Spitzer-IRAC bands, which at these redshifts sample the rest-frame near-IR light. Finally, we excluded sources whose optical spectrum shows indications for the presence of an AGN.

Release content

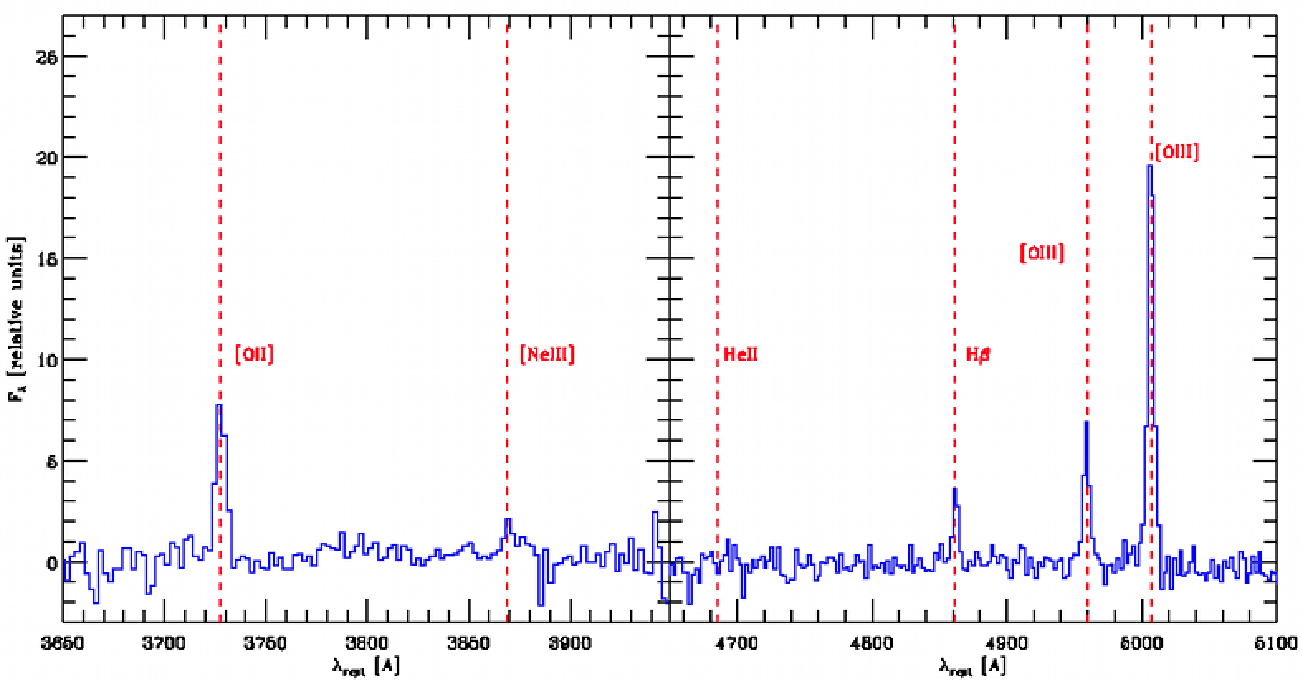
Summary of reduced SINFONI observations

A table listing the position, redshift, R band magnitude, IRAC magnitude (3.6,4.5 [μm]), extraction aperture of the spectra of the observed galaxies can be found associated to each spectra.

A total of 25 spectra could be extracted from the AMAZE observations and are provided in this release.

In three objects the lines are not detected. We also provide JPEG images of the spectra (smoothed with a 2 pixel boxcar), focusing on the main emission lines. For 21 objects the spectra were extracted within a fixed aperture of 0.75" in diameter. In three galaxies the emission lines extends significantly beyond 0.75"; in these cases an aperture of 1.25" has been used. For the detected AMAZE lensed sources “Lna1689-1”, “Lna1689-4” and “Lna1689-2”, the spectra extraction was done manually by choosing the regions with high S/N.

A composite spectrum of the 26 galaxies at z~3 is also available. It was obtained by shifting the spectra to their rest-frame, resampling them to a common wavelength scale, normalizing them by the flux of Hβ and averaging them. We excluded spectral regions strongly affected by atmospheric absorption within individual spectra.



Composite spectrum of the AMAZE galaxies showing the position of the key emission lines at each band.

Release Notes

Observations

SINFONI was used in its seeing-limited mode, with the 0.25″ pixel scale and with the H+K grism, yielding a spectral resolution R ∼1500 over the spectral range 1.45–2.41μm. Each target was acquired through a blind offset from a nearby bright star. Each observing block consisted of 10 integrations, 5 min each, obtained by nodding the position of the source within the 8″ × 8″ SINFONI field of view (generally by locating the source in two opposite corners). A minimal dithering of 0.5" was also required, so that instrumental artifacts can be minimized when the individual observations are aligned and combined together. The (K-band) seeing during the observations was generally better than 0.8″. Each source was observed with a number of observing blocks ranging from 5 to 9. Some observing block was discarded because the seeing was much worse, or the background much higher, with respect to the other observing blocks. The total, on-source integration times range from 3h to 7.5h, per source.

Data reduction method

Data were reduced by using the ESO-SINFONI pipeline (version 3.6.1). The pipeline subtracts the sky from the temporally contiguous frames, flat-fields the images, spectrally calibrates each individual slice and then reconstructs the cube. The wavelength axis refers to wavelength measured in vacuum. Residual sky emission was accounted for by removing the median of each spectral plane; this is feasible because our source occupy only a small part of the field of view. In some cases we performed an additional step in the background subtraction (which resulted imperfect with the previous method probably because of minor uncertainties in the flat-fielding) by sampling the sky in a region outside the source (either annular or another region in the field of view observed with the same effective integration) and rescaling it to optimally subtract the sky lines on the spectrum of the source. Individual cubes where aligned in the spatial direction by relying on the telescope offsets and then averaging them together by applying a 2σ clipping to remove bad pixels and cosmic rays. The atmospheric absorption and instrumental response were corrected by dividing the spectrum of the scientific target by the spectrum of a star (spectral type OV-BV or GV) taken close to the source, both in time and in elevation. The intrinsic spectrum of the star was removed by dividing the observed stellar spectrum by the appropriate template given in Pickes (1998), or by the solar spectrum in the case of GV stars (Maiolino et al. 1996).

Flux calibration

The physical flux unit of the 1-dim spectra is specified by the FITS keyword TUNIT2, which for all the sources is 10**(-17) erg cm**(-2) s**(-1) um**(-1).

Known caveats in this release

We recall that the spectral previews show only a restricted wavelength range. For access to the full wavelength range we refer to the fits spectra.

The ESO Archive Science Group migrated the products to the Phase 3 infrastructure allowing seamless publication with the Science Data Products. We want to alert the archive users that the provenance information indicated in the file headers might be incomplete/imprecise. This can affects the header keywords NCOMBINE, PROVi, OBIDi.

Data format

The data files in this release come essentially in pairs: one is the 1-dimensional spectrum in fits format, the second one is the corresponding spectral preview (.JPG) showing the position of key emission lines and the regions affected by strong sky emission lines. For the fits spectrum all relevant parameters are included in the FITS header consistent with other VO compliant releases of ESO Phase 3 Data Products.

The following file naming convention has been adopted for all individual extracted spectra:

```
AMAZE_SINFONI_xx_HK_v1.0.fits       1-d FITS file

AMAZE_SINFONI_xx_HK_v1.0.JPG        Spectrum preview
```

where <xx> is the target name. Here is an example of a full, valid name:
AMAZE_SINFONI_DSFC21_HK_v1.0.fits

In addition the following files are also part of the release:

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AMAZE_SINFONI.dat                   Redshift catalogue

AMAZE_SINFONI_COMPOSITE.dat         Composite spectrum
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Data retrieval

The entire data set (the data table, the preview products, the composite spectrum and the 1-d FITS spectra; 52 files with a total size of 6.7 MB, can be retrieved here
http://archive.eso.org/wdb/wdb/adp/phase3_spectral/form?collection_name=AMAZE

Acknowledgements

When using data products provided in this release, we request acknowledgement of the ESO/AMAZE team and referring to the publications "AMAZE I. The evolution of the mass–metallicity relation at z > 3', 2008, A&A, 488, 463 (first data release). Please also use the following statement in your articles when using these data:

Observations have been carried out using the Very Large Telescope at the ESO Paranal Observatory under Program ID(s): 178.B-0838(A), 178.B-0838(B), and 178.B-0838(C).