Dissecting GAs Stripping Phenomena in galaxies with MUSE (GASP)

Abstract

GASP (Gas Stripping Phenomena in galaxies) is an ESO Large Program (196.B-0578) using MUSE in wide-field mode with natural seeing to study galaxies at z=0.04-0.07 in different environments. This second and last data release comprises the second half of the sample (57/114 galaxies). We release the reduced data cubes and fits images with maps of Hα and Hβ emission-line fluxes, Hα radial velocity, average star formation rate in four age bins, luminosity-weighted stellar age and stellar mass density, as well as the integrated 1D spectrum of each galaxy.

Overview of Observations

GASP observations were carried out in service mode with the MUSE spectrograph located at the Nasmyth B focus of the Yepun (Unit Telescope 4) VLT. The constraints demanded for the observations were clear conditions, moon illumination <30%, moon distance >30°, and image quality <0.9arcsec, corresponding to <1arcsec seeing at zenith.

The majority of GASP galaxies were observed with four exposures of 675 s each, each rotated by 90° and slightly offset with respect to the previous one to minimize the cosmetics. The minimum time on target is therefore 2700 s per galaxy. Some targets, however, show long tails in the optical images and require two offset pointings to cover the galaxy body and the length of the tails. Each of these pointings is covered with 2700 s split into four exposures, as above.
The great majority of pointings have a significant fraction of sky coverage, while for a few galaxies it was necessary to do a 120 s sky offset after each 675 s exposure because the galaxy fills the MUSE field-of-view (~1x1 arcmin).
The observations of this second data release were taken between February 2017 and April 2018.

Details on the survey observations and strategy can be found in Poggianti et al. 2017 ApJ, 844, 48.

Release Content

We release here data for the last 57 galaxies observed by GASP. For each galaxy we release one MUSE reduced datacube and 11 fits files with ancillary data, for a total of 684 files.

For all galaxies, the data characteristics and quality are very homogeneous. The spectral range between 4800 and 9400 A is sampled with a resolution FHWM~2.6 A (R=1770 at 48900 A and 3590 at 9300 A), and a sampling of 1.25 A pixel^{-1}.

In the table below, we list the target name, coordinates, date of observations, exposure time per pointing, number of pointings.

target	RA	DEC	DATE-OBS	EXPTIME	N
JW105	00:03:00.49	-36:06:39.733	2017-06-20T07:56:47.000	2700	1
JO10	00:57:41.61	-01:18:43.994	2017-12-16T01:18:43.000	2700	1
JO24	01:08:08.00	-15:10:54.770	2017-10-16T02:01:01.000	2700	1
JO23	01:08:08.10	-15:30:41.841	2017-09-23T03:05:33.000	2700	1
JO17	01:08:35.33	+01:56:37.043	2017-08-18T07:55:48.000	2700	1
JO20	01:08:55.06	+02:14:20.786	2017-07-31T09:09:45.000	2700	1
JO45	01:13:16.58	+00:12:05.839	2017-11-15T01:46:15.000	2700	1

A500_22_184	04:38:46.41	-22:13:22.368	2017-10-28T07:29:56.000	2700	1
P954	10:02:03.33	-00:12:49.836	2017-02-21T04:19:12.461	2700	1
P5055	10:18:08.54	-00:05:03.141	2017-12-13T06:51:06.000	2700	1
P4946	10:18:30.81	+00:05:05.001	2017-12-15T07:27:58.000	2700	1
P12823	10:52:24.04	-00:06:09.882	2018-01-22T05:13:25.000	2700	1
P13384	10:53:03.15	-00:13:30.932	2018-02-18T06:05:00.000	2700	1
P14672	11:01:55.10	+00:11:41.095	2018-01-24T05:22:25.000	2700	1
P15703	11:06:33.28	+00:16:48.192	2017-12-25T07:19:00.000	2700	1
P16762	11:10:19.63	-00:08:34.364	2018-01-22T06:11:29.000	2700	1
P18060	11:14:59.28	-00:00:43.199	2018-01-22T07:08:55.000	2700	1
P19482	11:22:31.25	-00:01:01.601	2017-05-01T01:08:39.000	2700	1
P20159	11:24:22.26	-00:16:34.268	2018-02-19T04:21:35.000	2700	1
P20769	11:27:17.60	+00:11:24.388	2018-02-21T05:11:54.000	2700	1
P20883	11:27:45.41	-00:07:16.580	2018-02-21T04:13:37.000	2700	1
P21734	11:31:07.90	-00:08:07.914	2017-05-28T01:43:43.000	2700	1
P25500	11:51:36.28	+00:00:01.929	2017-04-29T00:51:29.000	2700	1
P96949	11:54:09.95	+00:08:18.080	2017-02-21T05:18:48.213	2700	1
JW115	12:00:47.95	-31:13:41.635	2017-06-21T22:58:13.000	2700	1
JO41	12:53:54.79	-15:47:20.096	2018-01-24T06:20:55.000	2700	1
JO128	12:54:56.84	-29:50:11.184	2018-01-23T07:20:44.000	2700	1
JW36	12:56:44.22	-17:39:48.557	2018-04-15T05:38:51.000	2700	1
JO138	12:56:58.51	-30:06:06.284	2018-01-23T06:22:41.000	2700	1
JO141	12:58:38.38	-30:47:32.200	2017-06-19T23:42:13.000	2700	1
JW39	13:04:07.71	+19:12:38.486	2017-05-01T02:06:36.000	2700	2
P42932	13:10:44.71	+00:01:55.540	2018-02-20T06:31:31.000	2700	1
P95080	13:12:08.75	-00:14:20.334	2017-02-04T06:46:16.481	2700	1
P45479	13:23:34.73	-00:07:51.673	2017-07-26T23:42:37.000	2700	1
JO144	13:24:32.43	-31:06:59.036	2017-04-28T04:45:22.000	2700	1
JO159	13:26:35.70	-30:59:36.920	2017-06-20T00:41:22.000	2700	1
JO147	13:26:49.73	-31:23:45.511	2017-06-25T00:52:02.000	2700	1
JW56	13:27:03.03	-27:12:58.205	2018-04-12T06:15:13.000	2700	1
JO149	13:28:10.53	-31:09:50.200	2018-04-15T06:36:30.000	2700	1
JO153	13:28:15.15	-31:01:57.859	2017-06-23T02:43:06.000	2700	1
JO160	13:29:28.62	-31:39:25.288	2017-05-29T01:33:54.000	2700	1
JO162	13:31:29.92	-33:03:19.576	2018-02-20T05:31:13.000	2700	1
P48157	13:36:01.59	+00:15:44.696	2018-02-20T07:32:30.000	2700	1
P57486	14:11:34.45	+00:09:58.293	2018-03-12T08:38:55.000	2700	1
P59597	14:17:41.13	-00:08:39.351	2018-04-13T07:34:21.000	2700	1
P96244	14:18:35.47	+00:09:27.828	2018-02-18T07:03:11.000	2700	1
P63947	14:31:01.82	-00:10:56.943	2018-04-13T05:37:23.000	2700	1
P63692	14:31:59.98	+00:05:03.272	2018-04-13T06:35:58.000	2700	1
P63661	14:32:21.78	+00:10:41.428	2017-05-01T06:35:01.000	2700	1
JO60	14:53:51.57	+18:39:06.364	2017-05-01T04:04:54.000	2700	2
JO205	21:13:46.12	+02:14:20.355	2017-06-02T06:55:57.000	2700	1
JO180	21:45:15.00	-44:00:31.188	2017-05-01T08:51:13.000	2700	1
JO70	21:56:04.07	-07:19:38.020	2017-06-02T08:59:33.000	2700	1
JO68	21:56:22.00	-07:54:28.971	2017-06-20T05:58:34.000	2700	1
JO73	22:04:25.99	-05:14:47.041	2017-06-20T06:58:38.000	2700	1
JO181	22:28:03.80	-30:18:03.812	2017-05-28T08:42:32.000	2700	1
JO89	23:26:00.60	+14:18:26.291	2017-06-20T08:54:25.000	2700	1

Release Notes

The spectral reference system of our 3D cube spectra is barycentric. The wavelength axis refers to wavelength measured in air.

Data Reduction and Calibration

The data are reduced with the most recent version of the MUSE pipeline at any time (Bacon et al. 2010 SPIE, 7735, 8; https://www.eso.org/sci/software/pipelines/muse/). This was version 1.6 for the first data taken and version 2.0.3 for the last galaxies included in this release. The procedures and philosophy of the data reduction closely follow those set out in the ESO Pipeline Manual. To speed up and automate the process, raw data are organized and prepared with custom scripts, then fed to ESOREX recipes version 3.12. For our observations, the pipeline can be run in a semi-automated fashion, since the observations are mostly identical in execution and calibration. Briefly, the pipeline was run with mainly default parameters. The data and the standard star frames were flat-fielded, wavelength-calibrated, and corrected for differential atmospheric refraction. Typical wavelength calibration has ~0.025 A rms in the fit, and the mean resolution R measured from the arcs is about 3000.
Most of the exposures had sufficient sky coverage within the MUSE field of view, leaving > 50% area for sky measurements. The sky is modeled directly from the individual frames using the 20% pixels with the lowest counts, thus there is no risk of accidentally subtracting any faint diffuse Hα within the FOV. For spatially extended galaxies, the offset sky exposures of 120 s allow the sky to be modeled adequately.
The standard star observation closest in time to the science observations was used for the flux calibration. After flux calibration and telluric correction (performed using the spectrophotometric standard star observed each night), the final flux-calibrated data cube is generated by lining up the individual frames using sources in the white-light images to calculate the (small) offsets. Galaxies with multiple pointings use sources in the overlaps for alignment. In a few cases, we found no sources in the overlap; we therefore computed the offsets using custom scripts and OMEGAWINGS point source catalogs as reference.

Data Quality

We applied a correction to the astrometric calibration provided by the ESO pipeline by registering the position of point-like sources in the MUSE white-light image. WINGS/OmegaWINGS catalogues (Varela et al. 2009 A&A, 497, 667, Gullieuszik et al. 2015 A&A, 581, 41) were used as a reference.
The accuracy of the absolute astrometric calibration is limited by the low number of bright OmegaWINGS bright point-like sources in the ~1x1arcmin MUSE field-of-view (in most cases just one or two). As fairly conservative estimate of the accuracy of the absolute astrometric precision we can therefore use half of the FWHM of the MUSE PSF. Considering that all the observations were carried out with sub-arcsec seeing, we can safely assume that the astrometry accuracy is better than ~0.5 arcsec.

The data generally reach a surface brightness detection limit of V∼27 mag $arcsec^{-2}$ and log Hα ~ -17.6 erg s^{-1} cm^{-2} $arcsec^{-2}$ at the 3σ confidence level.

Known issues
None.

Previous Releases
This is the second and last data release for GASP.
The first data release was issues on 26 October 2017.

Data Format

Files Types

When more than one pointing per galaxy was obtained, we release the aligned and combined datacube.

The emission-line flux maps we release have been: a) corrected for dust extinction internal to our own Galaxy; b) subtracted of the stellar component using the SINOPSIS code (Fritz et al. 2017 ApJ, 848m 132). The details of these procedures are described in Poggianti et al. 2017 ApJ 844, 48.

The Hα and Hβ emission-line maps and Hα velocity map are obtained with the IDL publicly available software KUBEVIZ (Fossati et al. 2016 MNRAS, 455, 2028), written by Matteo Fossati and David Wilman. Starting from an initial redshift, KUBEVIZ uses the MPFit (Markwardt 2009, ASP Conf. Ser. 411, 251*)* package to fit Gaussian line profiles. All the fluxes provided in this release refer to single component fits.
KUBEVIZ uses " linesets", defined as groups of lines that are fitted simultaneously. Each lineset (e.g., Hα and [N II]6548, 6583) is considered a combination of 1D Gaussian functions keeping the velocity separation of the lines fixed according to the line wavelengths. KUBEVIZ imposes a prior on the velocity and intrinsic line width of each lineset, which is fixed to that obtained by the fit of the Hα and [N II] lines. Moreover, the flux ratios of the two [N II] and [O III] lines are kept constant in the fit assuming the ratios given in Storey & Zeippen (2000, MNRAS, 312, 813) .
Before carrying out the fits, the datacube was average filtered in the spatial direction with a 5x5 pixel kernel, corresponding to 1arcsec = 0.7–1.3 kpc depending on the galaxy redshift.
Moreover, as recommended by Fossati et al. (2016), the errors on the line fluxes are scaled to achieve a reduced $\chi^2=1$. The continuum was calculated between 80 and 200 A redward and blueward of each line, omitting regions with other emission lines and using only values between the 40th and 60th percentiles.

To obtain the measurements of total emission-line fluxes corrected for underlying stellar absorption and for deriving the spatially resolved stellar population properties that we release, we used our spectrophotometric model SINOPSIS (Fritz et al. 2017 ApJ, 848, 132) . This code searches the combination of SSP spectra that best fits the equivalent widths of the main lines in absorption and emission and the continuum at various wavelengths, minimizing the $\chi^2 = 1$ using an adaptive simulated annealing algorithm. The star formation history is let free with no analytic priors.
The version of the code used for this data release uses the latest SSP models from S. Charlot & G. Bruzual (2019, in preparation) which have a higher spectral and age resolution than previous versions, and the latest evolutionary tracks from Bressan et al. (2012 MNRAS, 427, 127). Please, refer to Fritz et al. (2017) for details on the spectrophotometric fitting procedures.
We provide as fits files the SINOPSIS maps of a) average star formation rate in 4 age bins, b) luminosity-weighted age; c) stellar mass (mass in living stars+remnants).
All the quantities contained in this release refer to a Chabrier (2003 PASP, 115, 763) Initial Mass Function.

The 1D integrated spectrum we provide is integrated over the region enclosed by the most external stellar continuum isophote (at the Hα wavelength), as described in sec.6.5 of Poggianti et al. (2017).

In the following we use the galaxy named JW39 as an example to illustrate the data products and file naming conventions:

`GASP_JW39_datacube.fits (PRODCATG=SCIENCE.CUBE.IFS)`
This is the reduced datacube obtained from the MUSE pipeline. It is a fits file with two extensions for data values (EXTNAME=DATA) and data variance (EXTNAME=STAT).

The ancillary data released with the datacubes are:

- `GASP_JW39_IMAGE_FOV_0001.fits (PRODCATG=ANCILLARY.IMAGE)`
  White-light image obtained by integrating the datacube over the whole spectral range.

- `GASP_JW39_map_Halpha.fits (PRODCATG=ANCILLARY.IMAGE)`
  Emission map of Hα. Data were masked out if the SNR on the emission flux measurements is less than 5 or the error on the measured velocity and velocity dispersion is larger than 50 km/s.

- `GASP_JW39_map_Hbeta.fits (PRODCATG=ANCILLARY.IMAGE)`
  Emission map of Hβ. The selection criteria is the same as for the Hα emission map.

- `GASP_JW39_map_vgas.fits (PRODCATG=ANCILLARY.IMAGE)`
  Radial velocity of the gas component in km/s. The keyword ZREF in the file header is the redshift value that set the zero-point of the velocity values. The data selection criteria are the same used for the Hα emission map.

- `GASP_JW39_map_SFR1.fits (PRODCATG=ANCILLARY.IMAGE)`
  Map of the star formation rate in the 1st age bin (t<2.0e07 yr).

- `GASP_JW39_map_SFR2.fits (PRODCATG=ANCILLARY.IMAGE)`
  Map of the star formation rate in the 2nd age bin (2.0e07 yr < t < 2.7e08 yr).

- `GASP_JW39_map_SFR3.fits (PRODCATG=ANCILLARY.IMAGE)`
  Map of the star formation rate in the 3rd age bin (5.7e08 yr < t < 5.7e09 yr).

- `GASP_JW39_map_SFR4.fits (PRODCATG=ANCILLARY.IMAGE)`
  Map of the star formation rate in the 4th age bin (t> 5.7e09 yr).

- `GASP_JW39_map_lwage.fits (PRODCATG=ANCILLARY.IMAGE)`
  Map of the luminosity-weighted age.

- `GASP_JW39_map_TotMass2.fits (PRODCATG=ANCILLARY.IMAGE)`
  Map of the stellar mass.

- `GASP_JW39_spec.fits (PRODCATG=ANCILLARY.SPECTRUM)`
  Integrated 1D spectrum of the galaxy.

The files:

*****map_vgas.fits
*map_Halpha.fits
*map_Hbeta.fits

are multi extension fits files: data are stored in the first extension (EXTNAME=DATA), and the associated measurement uncertainty (1sigma) is stored in the second one (EXTNAME=STATS).

Catalogue Columns
No catalogues are released.

Acknowledgements

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

- “This paper uses data from the GASP survey (Poggianti et al. 2017 ApJ, 844, 48).”

- "Based on data products created from observations collected at the European Organisation for Astronomical Research in the Southern Hemisphere under ESO programme(s) 196.B-0578"

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- "This research has made use of the services of the ESO Science Archive Facility."