ESO Science Archive Facility - Phase 3 Data Release Description
ESO programme Reduced data from programme 60.A-9392(B) - GW follow-up, Data Release DR1
provided by Andreas Kaufer, published on 2017-10-16

ESO Phase 3 Data Release Description

LIGO-VIRGO Gravitational Wave and GRB alerts: follow up observations in the mid-infrared

Abstract

VISIR imaging observations were carried out under ESO program 60.A-9392(B), PI A. Kaufer, to constrain the spectral energy distribution at 8.72 micron of the source identified by the LIGO-VIRGO GW and the gamma-ray burst GRB 170817A alerts. The data were acquired in four different nights, from late-Aug to early-Sep 2017, mostly under good conditions. The VISIR imaging was carried out with the J8.9 filter and the small field of view, with a pixel scale of 0.045 arcsec pixel^{-1}. The FWHM of the photometric standard stars observed before or after the science data acquisition indicate near diffraction-limited image quality. The images were coadded using the offset parameters from the headers. There are no unresolved sources detected in the field. The extended nearby galaxy NGC 4993 falls inside the VISIR field of view, but it also not detected. Detection limits were derived for images produces from single night observations , and for image products obtained from multiple nights combined together. The VISIR raw data were reduced by Valentin Ivanov of the Science Data Product group in the Back-Operation Department; the conversion to the ESO Science Data Product standard and Phase 3 publication process in the ESO Science Archive Facility was carried out by the Archive Science group.

Overview of Observations

The sky position of the GRB 170817A was observed with the VISIR instrument on VLT on the nights of 23-24 August , 31 August-1 September, 1-2 September and 6-7 September, 2017. The combined exposure times were 2200, 857, 600 and 2200 seconds, respectively. The detector integration time (DIT) was set to 0.0114 seconds, yielding a sky level at ~18,000 ADU on a single frame. The instrument set up included the J8.9 filter, the small field of view with a pixel scale of 0.045 arcsec pixel^{-1}. The total field of view was ~46" x 41" and it was centered at RA=13h09m48.2s DEC= -23d22m58s (J2000). A WISE image obtained at W3 filter, centered at 12.082 micron is shown in Fig. 1.

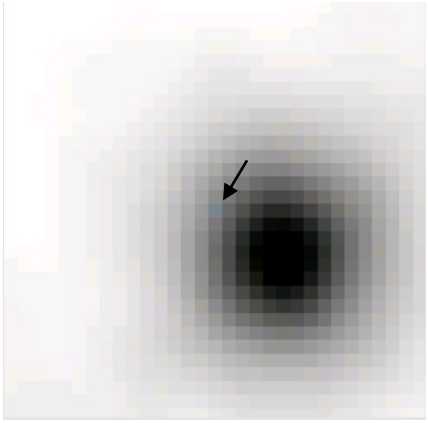

Fig. 1. WISE W3 image, ~45"x45". North is on the top, East is to the left. The position of the target is marked with a blue circle and an arrow. The extended source in the South-West is NGC 4993 .

The precipitable water vapor did vary during the observations, with average values of about 1.4, 3.8, 4.0 and 0.6 mm, respectively. The relative humidity measured at ground level was about 12, 7, 4 and 3 percent, respectively. The wind speed during the first epoch of observations was about 7 ms^{-1} and during the remaining three it was 2-3 ms^{-1}.

Release Content

The release consists of reduced images for a single pointing, at RA = 13h09m48.2s and DEC=-23d22m58s (J2000). The reduced data products cover a contiguous field of view of ~29"x32" (~0.25 sq. arcmin), imaged in the filter J8.9 at a central wavelength of 8.72 micron and a band width FWHM of 0.73 micron[1]. The release includes the reduced data from all four nights, processed independently for each night and two additional stacked image products. One stacked image includes all raw data files, the other one the raw data files from the first three nights only. This combination strategy was adopted because of the limited sensitivity of the observing run on 6-7 September, and by the possible intrinsic fading of the source.

The 5-sigma detection limits for the night-based image products are 6.9, 14.7, 16.7 and 14.1 mJy, respectively; the 5-sigma detection limit for the stacked image obtained from the first three nights is 5.0 mJy; for all four nights it is 4.6 mJy. These detection limits translate into the following limiting AB magnitudes: 14.33, 13.52, 13.38, 13.56 for the individual night images products, and 14.68 and 14.78 mag for the three and four night coadded products. These detection limits were measured as five times the standard deviation of the entire image, divided by the square root of the number of pixels in a circular aperture with a radius equal to the FWHM (6.4 pixels) measured from the photometric standard stars. The variation of the flux calibration from different photometric standards affects these limits at about 15-20 percent level.

There is no unresolved source detection within the derived sensitivity limits at the sky position of the LIGO-VIRGO GW/GRB source in the reduced VISIR images. The nearby galaxy NGC 4993, located ~10 arcsec away, is not detected either. WISE lists for it a W3 magnitude of 8.9 mag, which corresponds to ~10 mJy[2], but the galaxy is extended so it does not contradict the detection limits for point sources.

There is no catalog of sources associated with this data release The release contains 18 fits images, the total data volume is 31.8 Mb.

Release Notes

Data Reduction and Calibration

The data were processed with the ESO VISIR pipeline ver. 4.3.3[3]. The algorithms are described in the pipeline manual and include sky subtraction, alignment and combination. Flat fielding was not applied.

The lack of detectable sources, even after stacking 2-4-6 images, implied the adoption of the chopping information as it is reported in the headers, in order to align the individual chopped and nodded images. This procedure was verified on the photometric standard images – in individual images the stars would fall onto the same positions of the detector to within 3-5 pixels which is equivalent to 0.1-0.2". All reported magnitude and flux information in the headers are in the AB magnitude system.

Data Quality

Direct test of the photometric and the astrometric calibrations with sources on the science data is not possible for the lack of source detections. However, these calibrations were verified on the

1 https://www.eso.org/sci/facilities/paranal/instruments/visir/inst.html
2 http://wise2.ipac.caltech.edu/docs/release/allsky/expsup/sec4_4h.html
3 http://www.eso.org/sci/software/pipelines/

observations of photometric standard executed before and after the science observations. The photometry agrees to within 15-20 percent and the coordinates of the standard star on the processed images agree with the literature data to within 1".

Known issues
There are no known issues with the data.

Previous Releases
This is the first data release.

Data Format

Files Types
The reduced data products are two dimensional sky-subtracted and flux calibrated images, with the corresponding errors and bad pixel maps. All products are in FITS format.

Catalogue Columns
The release contains no catalogs.

Acknowledgements

Any publication making use of this 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(s) 60.A-9392(B), PI A. Kaufer"

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