OPEN DATA FROM LIGO VIRGO AND KAGRA THROUGH THE FIRST PART OF THE FOURTH OBSERVING RUN

The LIGO, Virgo, and KAGRA collaborations have publicly released a new dataset from the first segment of their fourth observing run (O4a), covering Gravitational-Wave (GW) observations from May 24, 2023, to January 16, 2024. The data release currently includes strain data from the two LIGO observatories; Virgo was not observing during O4a and KAGRA data are presently less sensitive.

MAKING GW DATA PUBLICLY AVAILABLE

Public data releases enable broad participation in science. Past data releases from GW observatories have been cited in over 900 scientific publications, and are also used by teachers, students, and citizen scientists for a wide range of investigations and educational activities.

This release includes GW measurements recorded at the highest sensitivity to date. **Figure 1** shows the binary neutron star range, a standard measure of interferometer sensitivity, for the LIGO observatories during the O4a run. At peak performance, the observatories could detect binary neutron star mergers up to approximately 150 megaparsecs (Mpc) away from Earth. The data are available through the Gravitational Wave Open Science Center (GWOSC), which also hosts past data releases for public access, and other distribution channels described in the paper. **Figure 2** shows the homepage of the GWOSC website.

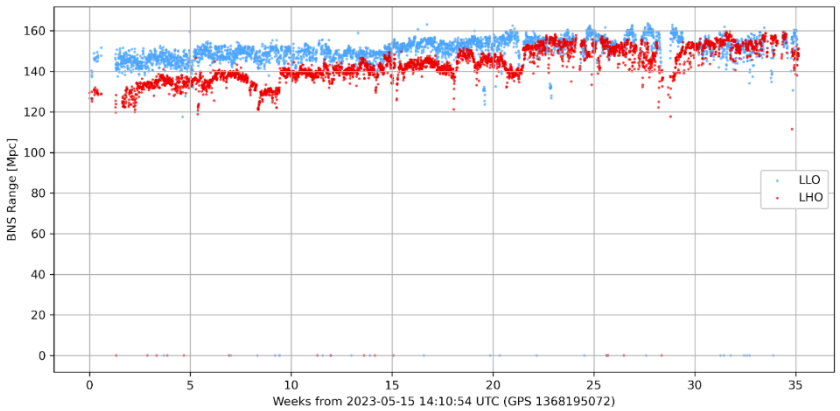

Figure 1: The sensitivity of LIGO, measured via the binary neutron star observable range (vertical axis), as a function of time during the O4a run (horizontal axis). The instruments were capable of detecting binary neutron star mergers from distances as far as 150 Mpc (500 million light-years) from Earth. Additional data segments starting from May 15, 2023, that were used in GW searches from supernova 2023ixf, are also included in this release.

WHAT'S INCLUDED IN A GW DATA RELEASE?

LIGO Key data products include two types of data files:

- *Strain* time-series data record tiny distortions in the detectors' arm lengths that are the primary data product of the observatories. They include a mix of microscopic length changes due to passing gravitational waves and noise from local sources.
- *Segment lists,* available through the GWOSC Timeline app, record times when the observatories were operating, provide information about data quality, and include flags for simulated GW signal injections (artificially generated test signals deliberately added to detector data to test the detection pipelines).

FIND OUT MORE:

Visit our websites:

www.ligo.org

www.virgo-gw.eu

gwcenter.icrr.u-tokyo.ac.jp/en/

The release includes documentation and multiple download methods, such as a web interface, an application programming interface (API), and curated Zenodo repositories.

Also included is the fourth version of the Gravitational Wave Transient Catalog (GWTC 4.0), which lists confident GW detections from O4a and earlier runs. Users can explore the catalog through the GWOSC Event Portal or programmatically via an API.

Additional datasets complement the release, such as strain data surrounding supernova 2023ixf and auxiliary channel sets used to identify periods when the data could be contaminated by spurious noise. In addition, GWOSC has recently started hosting *community catalogs*, making available discoveries of GW sources found in public data by researchers outside the LIGO/Virgo/KAGRA collaboration.

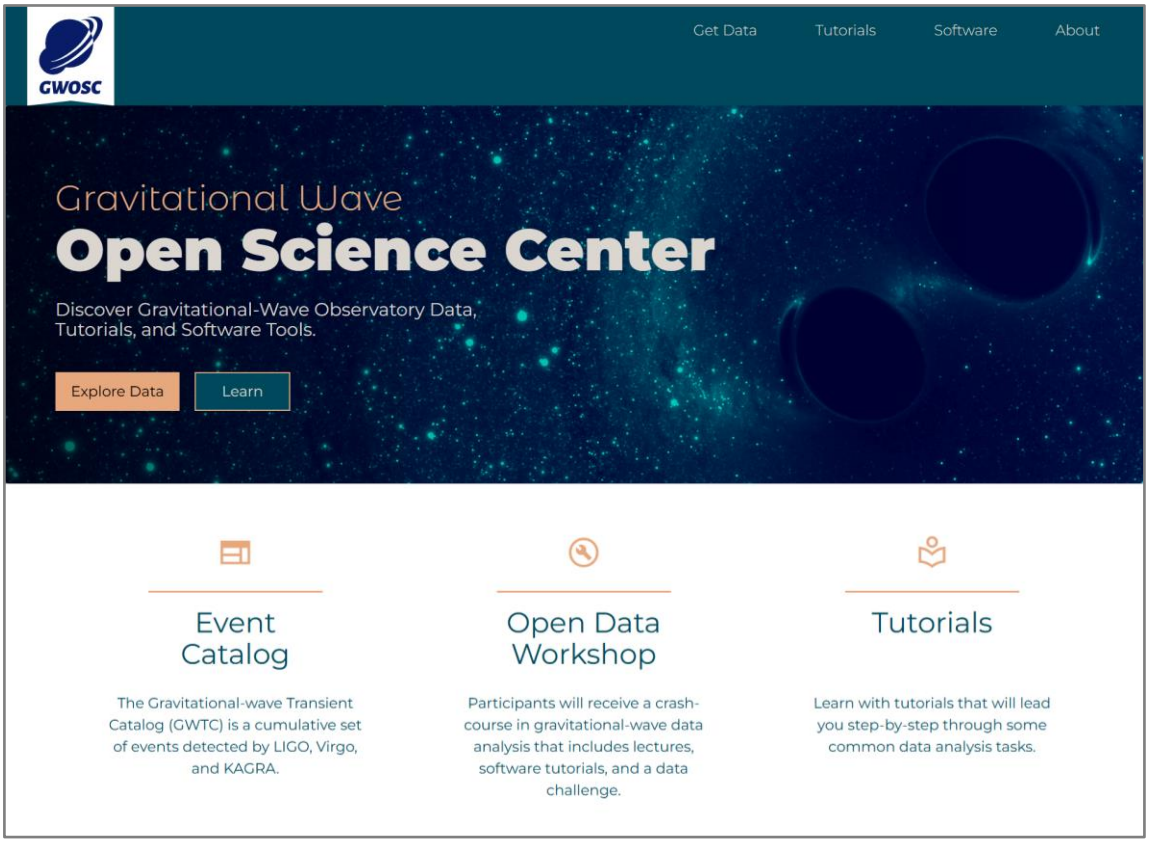

Figure 2: Homepage of the GWOSC website (https://gwosc.org/). GWOSC makes available public data along with software, tutorials, and documentation.

EXPLORING GW DATA

With this release, we intend to facilitate wide access to GW data and allow for the reproducibility of the analyses from the participating collaborations. A great way to get started is by attending an Open Data Workshop, available at learn.gwosc.org. If you make use of these data, don't forget to acknowledge their use.

FIND OUT MORE:

Visit our websites:

- http://www.ligo.org/
- http://www.virgo-gw.eu/
- https://gwcenter.icrr.u-tokyo.ac.jp/en/

Gravitational-Wave Open Science Centre: gwosc.org

The O4a Data Release: gwosc.org/O4/O4a/

Open Data Workshop: learn.gwosc.org

Read a free preprint of the full scientific article here or on arxiv.

GLOSSARY

Gravitational waves: Ripples in space-time that are generated by some of the most violent processes in the universe, such as merging neutron stars or black holes.

Interferometer: Instrument, used in many fields of science and engineering, that operates by merging two or more sources of light to create an interference pattern, which can be measured and analyzed and contains information about the object or phenomenon being studied.

LIGO, Virgo and KAGRA: Respectively located in the USA, Italy and Japan, these are the instruments that allow us to detect gravitational waves. The basic concept of the LIGO, Virgo and KAGRA detectors consists of two arms of kilometer scale forming an "L" shape, with mirrors at their end and in which a laser beam circulates. We use the laser to measure relative variations in the length of the arms caused when gravitational waves cross the Earth. The distance between the arms of each detector is constantly monitored and constitutes the data in which we search for gravitational waves signatures.

Noise: Fluctuations in the gravitational-wave measurement signal due to various instrumental and environmental effects. The sensitivity of a gravitational-wave detector is limited by noise.

Strain: The fractional change in the distance between two reference points due to the deformation of spacetime by a passing gravitational wave. The typical strain of even the strongest gravitational waves reaching Earth is very small — typically less than 10^{-21}.