GR 13: Relativity and Data Analysis

Time: Thursday 16:00–17:20 Location: ZEU/0260

GR 13.1 Thu 16:00 ZEU/0260

bajes-mma: Joint Bayesian Inference Framework for Multi-Messenger Astronomy with Binary Neutron Star Coalescences — •Ssohrab Borhanian[1], Matteo Breschi[1], Gregorio Carullo[2], Giacomo Ricigliano[3], Lukas Lippold[1], Albino Perego[4], and Sebastiano Bernuzzi[1] — [1]Friedrich-Schiller-University Jena, Jena, Germany — [2]Niels-Bohr-Institute, Copenhagen, Denmark — [3]Technical University of Darmstadt, Darmstadt, Germany — [4]University of Trento, Trento, Italy

The coincident observation of three events GW170817, GRB170817A, and AT2017gfo—a gravitational-wave signal with associated electromagnetic counterpart observed via a short gamma-ray burst, kilonova, and successive long-term afterglow emission—marked the onset of multi-messenger astronomy using gravitational and electromagnetic waves. In expectation of further multi-messenger events during upcoming observing runs by the LIGO, Virgo, and KAGRA observatories we developed a data analysis pipeline to jointly examine the observational data associated with a multi-messenger event. The pipeline is built on the Bayesian inference framework `bajes` and leverages its strength to incorporate any data channel, i.e. for binary neutron star mergers the gravitational waves signal and associated electromagnetic transients—including klionovae, short gamma-ray bursts, and synchrotron from the fast-tail of the ejecta. Using this pipeline we analyzed the events associated to GW170817 simultaneously to perform kilonova model selection, improve the parameter constraints of prior studies, and constrain the neutron star equation of state.

GR 13.2 Thu 16:20 ZEU/0260

Noise transients in machine-learning based gravitational-wave searches — •Ondřej Zelenka[1,2], Bernd Brügmann[1,2], and Frank Ohme[3,4] — [1]Friedrich-Schiller-Universität Jena, D-07743 Jena, Germany — [2]Michael Stifel Center Jena, D-07743 Jena, Germany — [3]Max-Planck-Institut für Gravitationsphysik, Albert-Einstein-Institut, D-30167 Hannover, Germany — [4]Leibniz Universität Hannover, D-30167 Hannover, Germany

In the recent past, machine-learning based approaches have been proposed as a solution to some problems in gravitational-wave data analysis. One of these are noise transients, which significantly complicate detection of gravitational waves. Contemporary matched-filtering based searches as well as unmodeled searches employ systems which flag likely noise transients and reject potential false alarms. It is possible that machine-learning based algorithms can learn to distinguish noise transients from signals with astrophysical sources.

In this contribution, we present a machine-learning based gravitational-wave detection algorithm focused on binary black holes, which has been submitted to the MLGWSC-1 mock data challenge. Furthermore, we describe an issue which arose when the model encountered non-Gaussian background noise, and present its solution. In doing so, we demonstrate that a machine-learning based algorithm with a suitable training method is capable of distinguishing false alarms due to transients from binary black hole injections.

GR 13.3 Thu 16:40 ZEU/0260

Finding Universal Relations using Statistical Data Analysis — •Praveen Manoharan and Kostas D. Kokkotas — IAAT, University of Tübingen, 72076 Tübingen, Germany

We present applications of statistical data analysis methods from both bi- and multivariate statistics to find suitable sets of neutron star features that can be leveraged for accurate and EoS independent - or universal - relations. To this end, we investigate the ability of various correlation measures such as Distance Correlation and Mutual Information in identifying universally related pairs of neutron star features. We also evaluate relations produced by methods of multivariate statistics such as Principal Component Analysis to assess their suitability for producing universal relations with multiple independent variables.

As part of our analyses, we are able to put forward multiple entirely novel relations, including multivariate relations for the f-mode frequency of neutron stars with reduced error when compared to existing, bivariate relations.

GR 13.4 Thu 17:00 ZEU/0260

Ranging and Clock Synchronization in LISA Data Processing — •Jan Niklas Reinhardt — Albert Einstein Institut, Hannover

The Laser Interferometer Space Antenna (LISA) is an ESA-led mission for gravitaional wave detection in space aiming for the frequency band between 1 mHz and 1 Hz after its launch in 2035. In order to extract the gravitational wave signals from the LISA data, various instrumental noise sources must be suppressed. The dominating noise source is by far the laser frequency noise, which must be reduced by more than 8 orders of magnitude to meet the LISA requirement of 1 pm. This can be achieved by time delay interferometry (TDI), which combines the various data streams with the correct delays to virtually form equal arm Michelson interferometers, in which laser frequency noise naturally cancels. This algorithm, as its name fortells, relies on knowledge about the delays (corresponding to the inter spacecraft distances), its classical execution additionally requires nano second synchronization of the three LISA timers. The estimation of the delays and the clock synchronization are the topic of this presentation.