T 60: Gravitational Waves

Time: Wednesday 16:15–18:00 Location: VG 3.104

T 60.1 Wed 16:15 VG 3.104

Archival search for sub-TeV neutrino counterparts to subthreshold Gravitational Wave events with IceCube — •Tista Mukherjee for the IceCube-Collaboration — Institute for Astroparticle Physics (IAP), Karlsruhe Institute of Technology (KIT), Hermann-von-Helmholtz Platz 1, 76344 Eggenstein-Leopoldshafen, Germany

The IceCube Neutrino Observatory actively participates in multi-messenger follow-ups of gravitational wave (GW) events. With the release of the Gravitational Wave Transient Catalogue (GWTC)-2.1 and -3, sub-threshold GW event information from the third observation run of the LIGO-Virgo-KAGRA (LVK) collaboration is publicly available. This offers an opportunity to search for their corresponding neutrino counterparts. For these sub-threshold GWs, identified via template-based and minimally-modelled search pipelines, archival searches for neutrinos can enhance their astrophysical significance, and improve localization.

In this contribution, we perform a catalogue-based search for sub-TeV neutrino counterparts to some shortlisted sub-threshold GWs. This study uses archival data from IceCube's dense-infill array, DeepCore. By correlating IceCube data with sub-threshold GWs, we aim to contribute to the ongoing efforts to identify common astrophysical sources of neutrino and GW. We present the current status of this search and its role in advancing multi-messenger astronomy, paving the way for deeper exploration of transient astrophysical events.

T 60.2 Wed 16:30 VG 3.104

Seaching for high frequency gravitational waves using an external magnetic field — •Jasper Jödicke, Dieter Horns, and Marios Marouder — Institut für Experimentalphysik, Universität Hamburg

Gravitational waves interacting with external electric and magnetic fields can induce electromagnetic effects, such as displacement currents. A novel approach to detecting gravitational waves in the high-frequency regime benefits from existing axion haloscopes. In this talk the GravLC experiment is introduced, which leverages the 14 T solenoidal magnetic field of the WISPLC axion haloscope at DESY in Hamburg. By employing a suitably designed pickup loop, the experiment enables searches for transient and broadband signals, such as those expected from primordial black holes and the stochastic gravitational wave background, across the frequency range of 10 kHz - 10 MHz. This technique provides a complementary method to existing gravitational wave detection approaches.

T 60.3 Wed 16:45 VG 3.104

Quantum enhanced high frequency gravitational wave searches — •Tom Krokotsch[1], Lars Fischer[1], and Gudrid Moortgat-Pick[1,2] — [1]Universität Hamburg, Hamburg, Germany — [2]Deutsches Elektronen Synchrotron DESY, Hamburg, Germany

A promising way to probe physics beyond the Standard Model is to search for gravitational wave (GW) signals at high frequencies where known astrophysical sources can not obscure the signal. Similar to the search for dark matter, microwave cavity resonators can be used to detect faint effects from GWs. This talk will focus on the possibility to apply quantum enhancement techniques like vacuum squeezing to operate such detectors beyond the standard quantum limit. In particular, we will highlight the unique benefit this would bring to transient GW sensitivities such as those for primordial black hole mergers.

T 60.4 Wed 17:00 VG 3.104

Estimating the Detection Horizon of Gravitational Waves from Core-Collapse Supernovae for the Einstein Telescope — Markus Bachlechner, Thilo Birkenfeld, •Timo Butz, and Achim Stahl — III. Physikalisches Institut B, RWTH Aachen

Core-collapse supernovae are one of the most anticipated sources for gravitational wave detectors. A detection of such an event can provide crucial information on the processes occurring during the final stages of massive stars and open perspectives in multi-messenger astronomy. The proposed Einstein Telescope (ET), as the first of the third-generation of gravitational wave detectors, is predicted to be an order of magnitude more sensitive in the whole frequency band compared to the previous generation. Therefore, an increased event rate due to the enlarged observable volume and the ability to study details of the underlying mechanism are expected. This talk presents an analysis of ET's detection horizon for core-collapse supernovae obtained with the unmodelled search algorithm *Coherent WaveBurst* and compares it to the upper limit given by optimal matched filtering.

T 60.5 Wed 17:15 VG 3.104

Characterizing the Seismic Impact of Steel- and Wood-Based Wind Turbines on the Einstein Telescope — Marc Boxberg[2], Tom Niggemann[1], •Niklas Nippe[1], Achim Stahl[1], and Florian Wagner[2] — [1]III. Physikalisches Institut B, RWTH Aachen — [2]Geophysical Imaging and Monitoring, RWTH Aachen

Knowing the seismic impact of nearby wind turbines is crucial for future gravitational wave detectors like the Einstein Telescope. In the low frequency regime, seismic and gravity gradient noise are the dominant effects impacting the sensitivity. Vibrations of nearby wind turbines (WTs) are expected to be significant contributions. Wood as an alternative tower material is known to decrease the transfer of vibrations into the ground for existing WTs. This talk will present measurements of seismic noise and simulations of the tower vibrations of a conventional steel-based WT and compare these to measurements and simulations of a wooden tower WT.

T 60.6 Wed 17:30 VG 3.104

Cavern Geometry Effects in Newtonian Noise at the Einstein Telescope — •Valentin Tempel, Markus Bachlechner, David Bertram, and Achim Stahl — III. Physikalisches Institut B, RWTH Aachen University

The Einstein Telescope (ET) is a proposed third-generation gravitational wave detector designed to surpass the sensitivity of current interferometers like LIGO and Virgo by at least an order of magnitude. This enhanced sensitivity will enable the detection of fainter gravitational waves and provide new insights into astrophysical phenomena. One of the major challenges in achieving the desired sensitivity is Newtonian Noise (NN), which dominates the expected noise budget of ET in the frequency range of 1 Hz to 5 Hz. NN arises from density fluctuations in the rock surrounding the cavern walls, leading to fluctuating gravitational forces on the mirrors. This talk presents the impact of cavern geometry on the coupling of seismic waves to the ET mirrors. Analytical and numerical approaches are applied to demonstrate how the size and shape of the cavern influence the coupling transfer functions.

T 60.7 Wed 17:45 VG 3.104

Testing noise mitigation techniques for future gravitational wave detectors — Markus Bachlechner, •Tim Johannes Kuhlbusch, and Achim Stahl — III. Physikalisches Institut B, RWTH Aachen

Future gravitational wave (GW) detectors like the Einstein Telescope aim to decrease the detector noise to measure weaker signals and to increase the precision of measurements. To measure the minuscule length changes induced by GWs, extremely low vibration levels for the test masses are required. New noise sources become relevant in reducing the residual vibrations of the detector test masses. Gravitational couplings from surrounding vibrating material, called gravity gradient noise, can not be shielded. Therefore, predicting the coupled noise from inertial sensors is essential to reduce the impact in the 1 to 10 Hertz range.

Wiener filters are a simple and robust approach to predicting coupled noise. However, the classic Wiener filter can not adapt to variations in the amplitude of the coupled noise. As variations in the amplitude over time are expected for the ambient noise sources in GW detectors, an adaptive filter is required for optimal performance. This talk will discuss adaptive filtering options including modifications to Wiener filters and neural networks. An evaluation on data from a small-scale interferometer will be presented.