GR 7: Gravitational Waves I

Time: Wednesday 14:00–15:20 Location: ZEU/0260

GR 7.1 Wed 14:00 ZEU/0260

LISA Pathfinder — •Sarah Paczkowski for the LPF collaboration — Max Planck Institute for Gravitational Physics (Albert Einstein Institute), D-30167 Hannover, Germany — Leibniz Universität Hannover, D-30167 Hannover, Germany

The Laser Interferometer Space Antenna (LISA) is a satellite mission to observe gravitational waves in the frequency range from 0.1mHz to 1Hz. In this talk, I will give an overview of its technology demonstrator mission LISA Pathfinder (2015-2017), and how it is paving the way for LISA.

Conceptually, the idea of LISA Pathfinder was to mimic one arm of the triangular LISA constellation. The LISA Pathfinder satellite, therefore, hosted two free-falling test masses and their relative positions and orientations were measured using heterodyne laser interferometry. Combined with a drag-free attitude control system and micronewton thrusters in a quiet environment, a nearly perfect free-fall was achieved. The undesired remaining differential acceleration between the two test masses was only $(1.74 \pm 0.05)\,\mathrm{fms^{-2}}/\sqrt{\mathrm{Hz}}$ above 2 mHz. This was significantly below the requirements and exceeded expectations. Accordingly, LISA Pathfinder has demonstrated the ability to realise the low-frequency science potential of the LISA mission. The interferometric readout on LISA Pathfinder also worked immediately and reliably throughout the mission with a sensing noise of only $32.0^{+2.4}_{-1.7}\,\mathrm{fm}/\sqrt{\mathrm{Hz}}$. Since it will be similar to the local LISA interferometry, LISA Pathfinder has successfully proven this concept to work in space.

GR 7.2 Wed 14:20 ZEU/0260

Potential of Gravitational Waves Detection with SCRF Cavities — •Gudrid Moortgat-Pick[1], Robin Löwenberg[1], Daniel Klein[1], Krisztian Peters[2], and Marc Wenskat[2] — [1]II. Inst. for Theoretical Physics, University of Hamburg, Luruper Chaussee 149, 22761 Bahrenfeld — [2]DESY, Notkestrasse 85, 22603 Hamburg

We study the physics potential of detecting gravitational waves via superconducting high-frequency cavities. The direct coupling of gravitational waves to electromagnetic fields is widely known as the (inverse) Gertsenshtein effect. We have described gravitational waves in the framework of linearized theory in general relativity. In this regard it is substantial to define the proper detector frame. We use a heterodyne cavity setup, extend the theoretical approach to calculate different scenarios in an unified and accurate way, including cavity perturbation theory and the effects of wall deformation.

GR 7.3 Wed 14:40 ZEU/0260

Gravitational wave induced perturbation of atomic levels — •Falk Adamietz[1,2], Friedemann Queisser[1,2], and Ralf Schützhold[1,2] — [1]Helmholz-Zentrum Dresden-Rossendorf — [2]Technische Universität Dresden

Motivated by partly controversial results in the literature and recent studies regarding the detection of gravitational waves with atoms instead of photons (as in LIGO), we study the response of atomic levels to gravitational waves. For slow gravitational waves, we may employ lowest-order stationary perturbation theory. We find that the perturbation Hamiltonian consists both of a kinetic and a potential correction term and explicitly evaluate their matrix elements.

GR 7.4 Wed 15:00 ZEU/0260

A Michelson interferometer as a demonstrator for gravitational wave detection in outreach activities — •David Koke and Alexander Kappes — Institut für Kernphysik der Westfälischen Wilhelms-Universität Münster, Deutschland

Gravitational waves are one of the most exciting phenomena in astrophysics and have given us new insights into our universe since their first direct detection in 2015. To easily demonstrate the basic principles of gravitational wave detection in outreach activities, a demonstration experiment based on a Michelson interferometer was created in the framework of a master thesis. Subject of this talk is the presentation of the results of the project with focus on the technical realization, as well as a live demonstration of the interferometer's features.