MECHANICAL ENGINEERING SEMINAR

Monday, June 5, 2023 at 14:30, D. Dan and Betty Kahn Building, Auditorium 1

Dynamic Gravity: From a crazy idea to high precision measurements

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With the planning of new ambitious gravitational wave (GW) observatories, fully controlled laboratory experiments on dynamic gravitation become more and more important. Such new experiments can provide new insights into potential dynamic effects such as gravitational shielding or energy flow and might contribute to bringing light into the mystery still surrounding gravity. Here we present a laboratory-based transmitter-detector experiment using a vibrating beam as transmitter and a 42 Hz, high-Q bending beam resonator as detector. Then we will focus on two rotating bars as transmitter. Using a highly precise phase control to synchronize the rotating bars, a dynamic gravitational field emerges that excites the bending motion with amplitudes up to 100 nm/s or 370 pm, which is a factor of 500 above the thermal noise. The two-transmitter design enables the investigation of different setup configurations. The detector movement is measured optically, using three commercial interferometers, individually calibrated. Acoustical, mechanical, and electrical isolation, a temperature-stable environment, and lock-in detection are central elements of the setup. The periodic moving load response of the detector is numerically calculated based on Newton's law of gravitation using three methods showing excellent agreement with measurements. We can currently determine G with an accuracy of about 10^{-3}. The near field gravitational energy transfer is 10^{25} times higher than what is expected from GW analysis.

[1] Brack, T., et al. (2022). Dynamic measurement of gravitational coupling between resonating beams in the hertz regime. Nature Physics, 18(8), 952–957. doi:10.1038/s41567-022-01642-8

[2] Brack, T., et al. (2023). Dynamic gravitational excitation of structural resonances in the hertz regime using two rotating bars. arXiv. Retrieved from https://arxiv.org/abs/2301.01644 doi: 10.48550/ARXIV.2301.01644, in review with Communications in Physics, 2023

Seminars Coordinator: Assoc. Prof. Matthew Suss.