Contribution ID: **87** Type: **Poster**

Towards constraining short range forces by whispering gallery states of neutrons and hydrogen atoms

Thursday, 25 September 2025 16:31 (1 minute)

Whispering gallery states (WGS) of neutrons and cold atoms, as well as their interferences, are a very powerful tool to probe surface potentials in a curved wave guide. They form in slow particle beams that are confined by the quasi-centrifugal potential generated by the curvature of the wave guide, and the surface interaction exerted from the atoms of the wave guide on the particle beam. Compared to other methods relying on quantum states (such as gravitational quantum states (GQS)), WGS allow us observation of quantum states at higher beam velocities, and they also probe surface potentials at much smaller lengthscales [1, 2].
Short range interactions (SRI), mediated by unknown particles between the particle beam and the wave guide, will modify these surface potentials, and leave their imprint on the interferences of the WGS, manifesting as a small observable shift in the interference pattern of several states. WGS measurements are sensitive to SRI at typical lengthscales down to several 10s of nanometers, which is larger than the expected length scale of surface contact interactions, allowing us to eliminate false effects [3]. When placed in a gravitational field, WGS can also be used as a measurement of the gravitational acceleration.
We present results from our last beamtime of neutron WGS, as well as our newly developed analysis method, which enables us to detect small shifts in two-dimensional interference patterns, and that we have tested with very small, artificially induced magnetic shifts in polarized neutron beams at the Institut Laue-Langevin (ILL). Within the GRASIAN collaboration we prepare unprecedented WGS measurements with hydrogen atoms, to be carried out in 2026, utilizing a cryogenic hydrogen beam with slow horizontal velocities. A short overview of the preparation of this experiment will be presented.

[1] Nesvizhevsky, V. et al.: Neutron whispering gallery. Nature Physics, 6, 114–117 (2010). https://doi.org/10.1038/nphys1478
[2] V.V. Nesvizhevsky, A.Yu. Voronin, Centrifugal quantum states of neutrons, Comptes Rendus Physique, 12(8), p. 791-795 (2011), https://doi.org/10.1016/j.crhy.2011.07.001.
[3] Antoniadis, I. et al.: Short range fundamental forces. Ultra cold neutron quantum states. Comptes Rendus Physique, 12(8), p.755-778 (2011). https://doi.org/10.1016/j.crhy.2011.05.004

Presenter: SCHREINER, Katharina (Stefan Meyer Institute - Austrian Academy of Sciences)

Session Classification: Poster flash