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Weighing quantum vacuum with Archimedes experiment

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The Archimedes experiment aims at measuring the interaction between vacuum fluctuations and gravity. Archimedes will measure the force exerted by the gravitational field on a Casimir cavity whose vacuum energy is modulated with a superconductive transition, by using a balance as a small force detector. If the vacuum energy does interact with gravity, a force directed upwards acts on the cavity and can be interpreted as the lack of weight of the expelled EM modes, in similarity with the Archimedes buoyancy of fluid. The expected torque generated with this modulation is of the order of $10^{-13}\ Nm/\sqrt{Hz}$. To detect such a small force, a very sensitive beam-balance has been suitably designed. A first prototype has been installed and tested in the SarGrav Laboratories at the Sos-Enattos site (Lula, Nuoro) which is seismically very quiet. In the region of tens of mHz, at which the Archimedes modulation will take place, the torque sensitivity has been recently measured to be around $5 \times 10^{-12} Nm/\sqrt{Hz}$. At present, the final setup is being installed at the SarGrav surface Laboratories in view of the final measurement of the quantum vacuum weight, which is expected to be performed in 2024.

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