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LEMING - Cold muonium for atomic physics and gravity

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In the LEMING experiment we aspire to carry out next generation laser spectroscopy and gravity experiments using a novel cold atomic beam of muonium (Mu = $\mu^+ + e^-$). The result of a Mu free fall measurement would reveal a clean coupling of gravity to elementary (anti)leptons from the second generation, complementary to all existing probes - normal atoms and recently antihydrogen - where composite hadronic masses dominate the interaction.

To measure the expected nanometer-scaled displacements of Mu trajectories by gravitational acceleration, phase-sensitive methods like atom interferometry is needed. However, state-of-the-art thermal muonium sources were not amenable to produce the contrast and intensity needed for such a measurement.

We recently succeeded in developing a novel cold atomic Mu beam in vacuum using muon conversion in a thin layer of superfluid helium (SFHe), amenable to atom interferometry. Muonium atoms were synthesized and thermalized to below v_t ˜ 0.06 km/s velocities in SFHe, and gained v ˜ 2.2 km/s velocity at the surface in normal direction by transforming the chemical potential to kinetic energy. We report here the synthesis of this high luminosity beam, resulting in ˜10% conversion efficiency of the stopped muons to vacuum muonium. Latest results concerning the atomic interferometer setup and the feasibility studies of the various precision experiments will be also presented.

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