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# Cryogenic muonium beam for the LEMING experiment

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We are developing a high intensity, low-emittance atomic muonium (Mu $= \mu^+ + e^-$) beam, which would enable improving the precision of Mu spectroscopy measurements and may be amenable to a direct measurement of the gravitational acceleration of Mu. Measuring the free fall of Mu atoms would be the first test of the weak equivalence principle using elementary antimatter of the second generation and, additionally, using a system without large contributions to the mass from the strong interaction.

We have demonstrated the working principle of a novel Mu source based on stopping a conventional muons beam in a thin layer of superfluid helium and the subsequent observation of Mu emission from the helium target. In this contribution, technical details from the first observation of Mu emitted from superfluid helium are presented. The experimental set up including detection schemes at below 0.2 K temperature will be described. An initial characterization of the novel Mu source shows sub-thermal beam dynamics with a $\sim$ 30 mrad angular divergence and a high Mu conversion efficiency of nearly $\sim$ 20 %. Implications of the newly developed Mu source on the prospective gravity experiment and the potential to improve the precision of Mu 1S-2S spectroscopy will be discussed.

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