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Development of a Retro-reflection Platform for the MAGIS and AION Experiments Towards Kilometre-scale Atom Interferometry

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MAGIS and AION are a pair of next-generation quantum sensors that aim to explore fundamental physics with atom interferometry. This new experimental regime is capable of probing a diverse range of physical phenomena by creating unprecedented macroscopic superpositions of matter waves, including detecting mid-band (0.1-10 Hz) gravitational waves, testing theories of wave-function collapse, searches for new fundamental forces and dark matter candidates, as well as capabilities in precision metrology to measure Newton's constant and the fine structure constant and test the Equivalence Principle. MAGIS-100 will be a strontium atom interferometer located at Fermilab with a 100-metre vertical baseline, building on previous work done over 10-metre scales, and with the intention of providing a development platform for future kilometre-scale experiments. AION is a sister consortium which is planning to build a 10-metre prototype at the University of Oxford, with plans to upgrade to a 100-metre baseline. The collaboration between MAGIS and AION will facilitate the development of the technologies required to build such an ambitious experiment, as well as providing multiple independent observatories for gravitational waves.

The University of Liverpool is developing a retro-reflection platform for both MAGIS and AION. This platform will be capable of performing phase-shear detection - a method of state detection which allows the phase and contrast of the interferometry fringes to be inferred in a single measurement - as well as compensating for the Coriolis effect which becomes significant over such large baselines. The design, development and status of this platform, as well as future plans towards kilometre-scale and spaced-based iterations, will be presented.

Author: CARROLL, Andrew (University of Liverpool)

Presenter: CARROLL, Andrew (University of Liverpool)

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