The linear potential and the cubic phase

In 1927 Kennard [1] showed that the wave function of a particle being exposed to a linear potential, which induces an acceleration a for the time T, accumulates a position-independent phase proportional to a^2T^3. Only recently [2], this cubic phase has been observed directly in an experiment utilizing surface gravity water wave packets moving in an accelerating water flow. These water wave packets evolve analogous to quantum mechanical waves.

Additionally, by exploiting the Kennard phase, we have proposed an atom interferometer [3] probing a linear potential and having a phase shift that scales as T^3, in contrast to conventional atom interferometers with a phase scaling as T^2. Here we apply two different accelerations a_1 and a_2, depending on the internal state $|1\rangle$ and $|2\rangle$ of the atom, respectively. Based on this scheme a Stern-Gerlach interferometer [4] has been constructed which reveals the pure cubic phase scaling and represents the first atom optics observation of the Kennard phase. As the accumulated phase is very sensitive to magnetic fields, this device may serve as a unique probe for magnetic surface properties.

[1] E.H. Kennard, *Z. Phys.* **44**, 326 (1927); E.H. Kennard, *J. Frank. Inst.* **207**, 47 (1929)

[2] G. Rozenman et al., *Phys. Rev. Lett.* **122**, 124302 (2019)

[3] M. Zimmermann et al., *Appl. Phys. B* **123**, 102 (2017)

[4] O. Amit et al., submitted to *Phys. Rev. Lett.* (2019)