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JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Seminar über die Physik der kondensierten Materie (SFB/TRR173 Spin+X und SFB/TR288 Kolloquium, TopDyn-Seminar)

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Medienraum 03-431, institute of Physics

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Molecular Motor Based on Single Chiral Tripodal Molecules

There has been a longstanding interest in the realization of machines, such as motors, on the nanoscale. First described in a thought experiment by Marian Smoluchowski in 1912 and popularized by Richard Feynman in 1962, the concept of the so-called Brownian ratchet has shown the physical limits in the realization of such nanomachines. Long after the theoretical description of such nanomachines, Bernard L. Feringa was able to design and synthesize a light-driven molecular motor and was awarded the Nobel Prize in 2016.
Taking a different approach by using the electric current in a scanning tunneling microscope (STM) as the stimulus, we present our results concerning a single molecular motor. Three anchoring groups fix the molecules to a Au(111) surface. The chiral functional group is connected via a rotatable axis and is supposed to perform a rotation in a preferred direction, proposed to be driven based on the chiral-induced spin selectivity (CISS) effect. This effect causes the electron spin of an injected current to be spin-polarized after passing through a chiral electric field, exerting a torque on the functional group via spin-orbit coupling.
Indeed, when positioning the STM tip above the molecule at a fixed position, we can observe directed rotation in the follwing way : We observe three distinguishable current levels, which are interpreted as metastable rotational states of the molecule. That way, two rotation directions can be defined. Via binomial tests, we verify that the surplus of rotational switches in one direction compared to the other is statistically significant.
In voltage and current dependent measurements, two interesting trends are

observed. The rate of events decreases with increasing current and the asymmetry in the switching events varies non-monotonically with voltage. From voltage polarity dependent measurements, it is possible to extract more information on the underlying effect causing the directed rotation.

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