Invisible tool enables new quantum experiments

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Experiments on the quantum wave nature have enabled researchers to precisely measure tiny forces and displacements as well as to shed light onto the unexplored zone between the microscopic realm of quantum physics and our everyday world

Matter wave interferometry has a long standing tradition at the University of Vienna, where the first quantum interference of large molecules has already been observed in 1999. Nowadays scientists are hunting down evidence for the quantum mechanical behavior of increasingly complex constituents of matter. This is done in experiments in which the flying of each particle seems to obtain information about distinct places in space, which are inaccessible according to classical physics.

Synchronised laser flashes for quantum interferometry

The quantum nanophysics team around Markus Arndt of the University of Vienna has now established a novel way of manipulating massive particles: the researchers use nanosecond long flashes of laser light to create gratings, three of which form a closed-path interferometer. This scheme allows creating quantum mechanical superposition states, which we do not observe in our macroscopic environment.

When precisely synchronized, the fleeting light structures form a device freed from many constraints that limited the measurement precision in earlier machines. "Interferometry in the time-domain with pulsed light gratings will become a central element of quantum experiments with nanoparticles" states Philipp Haslinger who is the first author of the paper.

Viennese prototype with powerful universality

Five students from the University of Vienna have been planning and setting up the device over the past years. The developed prototype is one of a kind: for the first time it allows to investigate the quantum wave nature not only of single molecules, but also of clusters of molecules. During an experiment these particles line up for few nanoseconds in a periodic nanopattern. This structure may serve as a "nanoruler" which enables the detection of tiny external perturbations as well as the precise measurement of small forces and fields.

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