Imaging the build-up of a quantum interference pattern of massive molecules

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New experiments allow us for the first time to visualize the gradual emergence of a deterministic far-field matter-wave diffraction pattern from stochastically arriving single molecules. A slow molecular beam is created via laser evaporation of the molecules from a glass window. The molecules traverse an ultra-thin nanomachined grating at which they are diffracted and quantum delocalized to more than 100 μm before they are captured on a quartz plate at the interface between the vacuum chamber and a self-built fluorescence microscope. Fluorescence imaging provides us with single molecule sensitivity and we can determine the position of each molecule with an accuracy of 10 nm. This new setup is a textbook demonstration but it also enables quantitative explorations of the van der Waals forces between molecules and material gratings. An extrapolation of our present experiments to even thinner gratings is expected to also enlarge the range of nanoparticles that are accessible to advanced quantum experiments.

[1] Juffmann et al., “Real-time single-molecule imaging of quantum interference”, Nature Nanotechnology 7, 297-300 (2012).