Quantum behavior with a flash

Just as a camera flash illuminates unseen objects hidden in darkness, a sequence of laser pulses can be used to study the elusive quantum behavior of a large, 'macroscopic' object. This method provides a novel tool of unprecedented performance for current experiments that push the boundaries of the quantum world to larger and larger scales. A collaboration of scientists led by researchers from the Vienna Center for Quantum Science and Technology (VCQ) at the University of Vienna report this new scheme in the forthcoming issue of PNAS.

Overcoming the "blur"

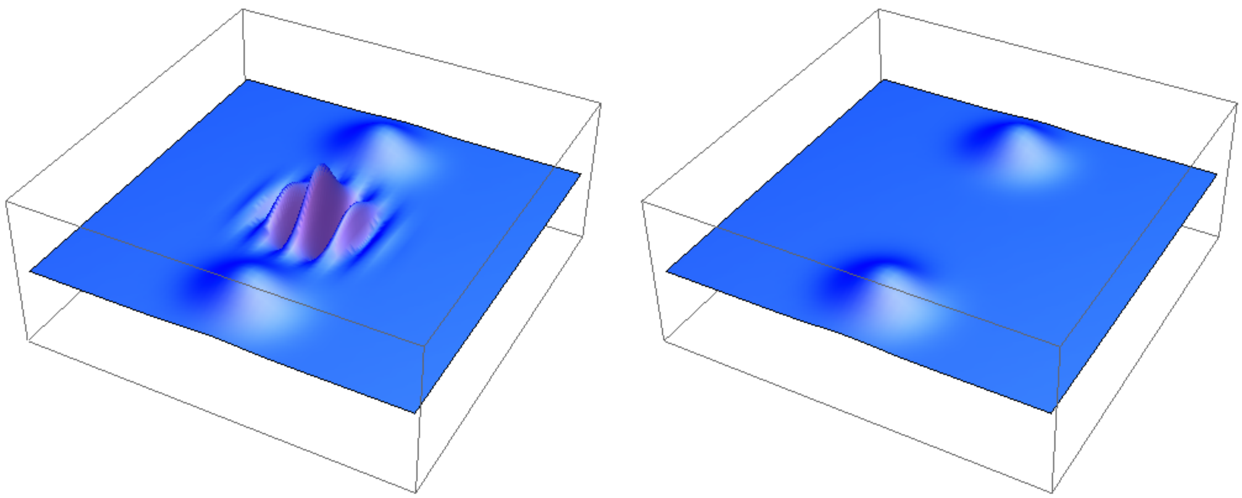
One of the most fascinating and still open questions in physics is how far quantum phenomena extend into our everyday world. To answer that, experiments need to peer into the quantum world at a completely new scale of mass and size. This is a bumpy road: it becomes increasingly difficult to detect the genuine quantum features as mass and size are increased. Publishing under the title 'Pulsed quantum optomechanics,' the team proposes a method that uses flashes of light to observe quantum features of large objects with unprecedented resolution. The main idea is based on the fact that quantum objects, in contrast to classical objects, behave differently when they are being watched. "In current approaches, objects are constantly monitored and the possible quantum features are being washed out. This is in many ways analogous to the blurring of a photograph of a fast moving object." says Michael R. Vanner the lead author of the paper and member of the Vienna Doctoral School CoQuS. "The flashes freeze the motion and create a sharp image of the quantum behavior."

How macroscopic can "quantum" be?

With this new tool, experiments will be able to peer into the quantum world at a completely new scale of mass and size. In particular, the scheme can be directly applied to the ongoing experiments that attempt to prepare quantum phenomena in micro-mechanical resonators i.e. mechanically vibrating massive objects. "By analyzing the dynamics of such behavior, *pulsed quantum optomechanics* provides a path for investigating whether macroscopic mechanical objects can be used in future quantum technologies. It will also help shed light on nature's apparent division between the quantum and the classical worlds."

This work has been undertaken as a joint effort by researchers of the Vienna Center for Quantum Science and Technology (VCQ) of the University of Vienna, Imperial College London, the Institute for

Quantum Optics and Quantum Information (IQOQI), the Albert-Einstein Institute of the University of Hannover and the University of Queensland. It was supported by the Australian Research Council, the EPSRC, the European Research Council, the European Commission, the FQXi, the Austrian Science Fund FWF and the Austrian Academy of Sciences.



Pulsed quantum optomechanics can directly probe quantum mechanical behavior (left), which is seen as the central rippling in this representation of a Schrödinger-cat state, these quantum features are otherwise washed out (right). **Image credits:** VCQ – University of Vienna.

Publication:
Pulsed quantum optomechanics
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DOI: 10.1073/pnas.1105098108

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