The dance of quantum tornadoes

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Tornado-like vortexes can be produced in bizarre fluids which are controlled by quantum mechanics, completely unlike normal liquids. New research published today in the journal *Nature Communications* demonstrates how massed ranks of these quantum twisters line up in rows, and paves the way for engineering quantum circuits and chips measuring motion ultra-precisely.

The destructive power of rampaging tornadoes defeats the human ability to control them. A Cambridge team has managed to create and control hundreds of tiny twisters on a semiconductor chip. By controlling where electrons move and how they interact with light the team created a marriage of electrons and photons that form a new quantum particle called a 'polariton'.

The results come from a collaboration between the experimental team in the NanoPhotonics Centre led by Professor Jeremy Baumberg and the theoretical quantum fluids group of Natalia Berloff.

Dr Berloff says: "Being half-light and half-matter these particles are feather-light and move quickly around, sloshing and cascading much like water in a mountain river."

Most excitingly, the team says, these quantum systems are actually large, the width of a human hair, and the effects can be seen though a normal optical microscope.

Using ultra-high quality samples produced by a team from Crete the

researchers exerted unprecedented control on possible flows they can arouse within this liquid: forcing it to flow down a hill, over a mountainous terrain, forming quiet lakes and wildly raging quantum oceans.

By creating polaritons at the top of several hills and letting them flow downhill the group was able to form regular arrays of hundreds of tornadoes spiralling in alternating directions along well-defined canyons. By changing the number of hills, the distance between them and the rate of polariton creation the researchers could vary the separation, the size, and number of the twister cores, achieving a long held dream of creating and controlling macroscopic quantum states.

But quantum mechanics responsible for creating such fluids makes quantum tornadoes act even more intriguingly than their classical counterparts. Quantum vortices can only swirl around in fixed 'quantised' amounts and the liquids at the top of the various hills synchronize as soon as they mix down in the valleys - just two examples of quantum mechanics that can now be seen directly.

Quantum tornadoes can be reconfigured on the fly and pave the way to widespread applications in the control of quantum fluid circuits. Creating arbitrary configurations of polariton liquids leads to even more complicated quantum superpositions and lays groundwork for polariton interferometers (devices which measure small movements and surface irregularities) that respond extremely sensitively to even the slightest changes in the environment.

More information: The paper 'Geometrically locked vortex lattices in semiconductor quantum fluids' will be published in the 4 December edition of *Nature Communications*. doi: 10.1038/ncomms2255

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