Fastest rotating man-made object created

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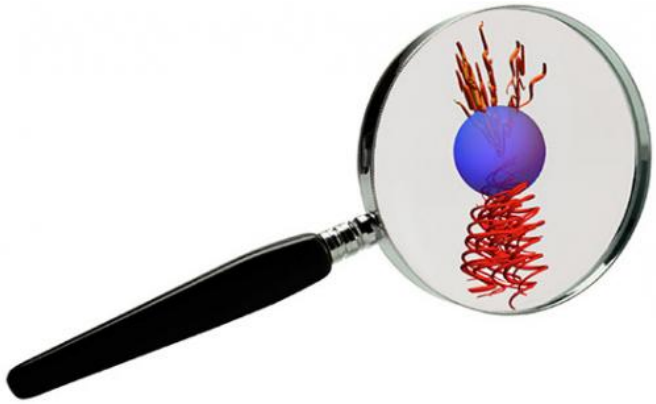

(Phys.org) —A team of researchers at the University of St Andrews has created the world's fastest spinning man-made object.

Dr Yoshihiki Arita, Dr Michael Mazilu and Professor Kishan Dholakia of the School of Physics and Astronomy at the University of St Andrews were able to levitate and spin a microscopic sphere, purely using laser light in a vacuum, briefly up to 600 million RPM before it broke apart.

This speed is half a million times faster than the spin speed of a domestic washing machine and more than a thousand times faster than a dental drill.

The work is published today in the international journal *Nature Communications*.

Although there is much international research exploring what happens at the boundary between classical physics and quantum physics, most of this experimental work uses atoms or molecules. The St Andrews team aimed to understand what happened for larger objects containing a million million atoms or more.

To do this they manufactured a microscopic sphere of calcium carbonate only 4 millionths of a metre in diameter. The team then used the miniscule forces of laser light to hold the sphere with the radiation pressure of light - rather like levitating a beach ball with a jet of water.

They exploited the property of polarisation of the laser light that changed as the light passed through the levitating sphere, exerting a small twist or torque.

Placing the sphere in vacuum largely removed the drag (friction) due to any gas environment, allowing the team to achieve the very high rotation rates.

In addition to the rotation, the team observed a "compression" of the excursions or "wobble" of the particle in all three dimensions, which can be understood as a "cooling" of the motion. Essentially the particle behaved like the world's smallest gyroscope, stabilising its motion around the axis of rotation.

Dr Yoshihiko Arita said: "This is an exciting, thought-provoking experiment that pushes the boundary of our understanding of rotating bodies.

"I am intrigued with the prospect of extending this to multiple trapped particles and rotating systems. We may even be able to shed light on the area of quantum friction – that is – does quantum mechanics put the brakes on the motion or spinning particle even though we are in a near perfect vacuum with no other apparent sources of friction?"

Dr Michael Mazilu, a newly appointed lecturer in the School of Physics and Astronomy, said: "This system poses fascinating questions with regard to thermodynamics and is a challenging system to model theoretically. The rotation rate is so fast that the angular acceleration at the sphere surface is 1 billion times that of gravity on the Earth surface– it's amazing that the centrifugal forces do not cause the sphere to disintegrate!"

Professor Kishan Dholakia said: "The team has

performed a real breakthrough piece of work that we believe will resonate with the international community. In addition to the exciting fundamental physics aspects, this experiment will allow us to probe the nature of friction in very small systems, which has relevance to the next generation of microscopic devices. And it's always good to hold a "world record" - even if for only a while!"

Provided by University of St Andrews