Three ways to levitate a magic carpet

15:38 06 August 2007 by **Zeeya Merali**
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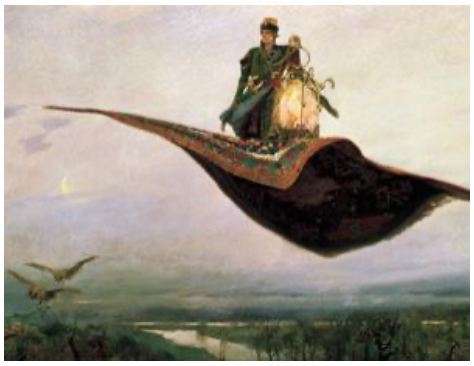
It sounds like a science fiction joke, but it isn't. What do you get when you turn an invisibility cloak on its side? A mini flying carpet.

So say physicists who believe the same exotic materials used to make cloaking devices could also be used to levitate tiny objects. In a further breakthrough, two other research groups have come a step closer to cracking the mysteries of levitation.

Scientists have levitated objects before, most famously using powerful magnetic fields to levitate a frog. But that technique, using the repulsive force of a giant magnet, requires large amounts of energy. In contrast, the latest theories exploit the natural smaller amounts of energy produced by the quantum fluctuations of empty space.

Force reversal

In May 2006, two research teams led by Ulf Leonhardt at St Andrew's University, UK, and John Pendry at Imperial College, London independently proposed that an invisibility cloak could be created from exotic materials with abnormal optical properties. Such a cloaking device - working in the microwave region - was manufactured later that year



The Flying Carpet by Viktor Vasnetsov (1880) (Image: Wikimedia Commons)

manufactured later that year.

The device was formed from so-called "metamaterials", exotic materials made from complex arrays of metal units and wires. The metal units are smaller than the wavelength of light and so the materials can be engineered to precisely control how electromagnetic light waves travel around them. "They can transform space, tricking electromagnetic waves into moving along directions they otherwise wouldn't," says Leonhardt.

Leonhardt and his colleague Thomas Philbin, also at St Andrew's University, realised that this property could also be exploited to levitate extremely small objects.

They propose inserting a metamaterial between two so-called Casimir plates. When two such plates are brought very close together, the vacuum between them becomes filled with quantum fluctuations of the electromagnetic field. As two plates are brought closer together, fewer fluctuations can occur within the gap between them, but on the outer sides of the plates, the fluctuations are unconstrained. This causes a pressure difference on either side of the plates, forcing the plates to stick together, in a phenomenon called the Casimir effect.

Leonhardt and Philbin believe that inserting a section of metamaterial between the plates will disrupt the quantum fluctuations of the electromagnetic field. In particular, metamaterials have a negative refractive index, so that electromagnetic light waves entering a metamaterial bend in the opposite way than expected, say Leonhardt. That will cause the Casimir force to act in the opposite direction -- forcing the upper plate to levitate. The work will appear in the *New Journal of Physics*.

Federico Capasso, an expert on the Casimir effect at Harvard University in Boston is impressed. "Using metamaterials to reverse the Casimir effect is a very clever idea," he says. However, he points out that because metamaterials are difficult to engineer, it's unlikely that they could be used to levitate objects in the near future.

Floating golden ball

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be achieved much sooner, by other methods. Umar Mohideen at the University of California Riverside and his colleagues have successfully manipulated the strength of the Casimir force by increasing the reflectivity of one of the plates, so that it reflects virtual particles more efficiently. Modifying the strength of the Casimir force is the first step towards reversing it, says team member Galina Klimchitskaya at North-West

Technical University in St Petersburg, Russia.

Capasso and his colleagues have also been working on an alternative scheme to harness a repulsive Casimir effect. Their calculations show that a repulsive Casimir force could be set up between a 42.7 micrometre-wide gold-coated polystyrene sphere and a silicon dioxide plate, if the two are immersed in ethanol. "Although the Casimir force between any two substances - the ethanol and gold, the gold and the silicon dioxide, or the silicon dioxide and the ethanol - is positive, the relative strengths of attraction are different, and when you combine the materials, you should see the gold sphere levitate," he says.

Capasso's early experiments suggest that such repulsion could occur, and that in turn could be used to levitate one object above another. "It's very early work, and we still need to make certain this is really happening, but we are slowly building up experimental evidence for quantum levitation," says Capasso, who presented his results at a conference on Coherence and Quantum Optics in Rochester, New York, in June.

"This is a very exciting experimental result because it is the first demonstration that we can engineer a repulsive Casimir force," says Leonhardt.

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Thu May 01 17:06:03 BST 2008 by **Mr. Yuen**

Is it possible to make further improvement on the casimir effect with much higher efficiecy so that it would be more useful and can levitate bigger things and may ultimately increasing our human living standards such as innovation on current mass transportation vehicle etc. Since I am interesting on this and do not know what is matamaterial/ negative refractive matamaterial /casmir plates and I would

be much appreciated if you can you send me more information on this (see my email below).

Many Thanks

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Meta Material For Gravity Waves

Mon Jan 12 23:18:14 GMT 2009 by **Jim Miller**

I'll be really impressed when someone invents a meta-material for manipulating gravity waves.

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Tue Jan 13 00:34:46 GMT 2009 by **Amy**

Its a bit hard to manipulate something that does NOT exist! No gravity waves detected but not for the lack of trying.

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Tue Jan 13 00:37:59 GMT 2009 by

Amy

Unless you are a mathematician - then you can manipulate totally imaginary constructs, like um ... Virtual particles.

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Tue Jan 13 00:58:03 GMT 2009 by

Does Not Exist?

Then why wikipedia goes in so much details, citing nasa? Unless i do not unerstand what was meant by gravity wave.

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Meta Material For Gravity Waves

Tue Jan 13 11:03:08 GMT 2009 by **Amy**

"Though the Hulse-Taylor observations were very important, they were only INDIRECT evidence for gravitational waves ...."

IE: ... The effects concerned have not been proven to be associated with gravity waves.

The wikipedia article then goes on to explain several complex and sensitive detection systems - NONE of which have

EVER detected even the slightest hint of a gravity wave.

Why? As far as we know they simply DO NOT EXIST.

Gotta love the mathematics though. Its neat being able to manipulate something NEVER DETECTED.

(... Same as the Virtual Particles mentioned in the Magic Carpet article. Virtual Particles are a mathematical construct only, have never been detected and AS FAR AS WE KNOW - do not exist, thereby making the explanation of the levitation effect invalid in reality.)

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