Physicists scale up invisibility cloaks using natural crystals

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(PhysOrg.com) -- Physicists from the University of Birmingham, with colleagues at Imperial College, London, and Technical University of Denmark, have demonstrated an 'invisibility cloak' that can hide a three-dimensional object, centimetres in dimension, large enough for the cloaking area to be visible to the human eye, according to research published today in the journal *Nature Communications*.

The scientists have shown that they are able to hide an object that is much bigger than those cloaked by other research groups. Previous studies have demonstrated cloaking by using a metamaterial - a fabricated composite with optical properties not found in nature - which limits the size of the cloaking region, while the team from UK and Denmark have used a natural crystal called calcite, which has enabled them to hide a larger object.

Calcite is a transparent mineral with birefringent or double-refraction properties, which means that light enters the calcite and splits into two rays of different polarizations travelling at different speeds and in different directions.

The team has been able to cloak larger objects because it has employed a cloaking design that did not require inhomogeneous material properties, as all the previous works did. This demonstration was performed, both in the air and in a container of liquid, by using two triangular pieces of calcite glued together, placed on a mirror. The size of the cloaking area is not limited by the technology available, only by the size of the calcite crystal.

Dr Shuang Zhang, lead investigator from the University of Birmingham's School of Physics and Astronomy, said: "This is a huge step forward as, for the first time, the cloaking area is rendered at a size that is big enough for the observer to 'see' the invisible object with the naked eye.

'By using natural crystals for the first time, rather than artificial meta-materials, we have been able to scale up the size of the cloak and can hide larger objects, thousands of times bigger than the wavelength of the light.'

He continues: 'Previous cloaks have succeeded at the micron level (much smaller than the thickness of a human hair) using a nano- or micro-fabricated artificial composite material. It is a very slow process to make these structures and they also restrict the size of the cloaking area. We believe that by using calcite, we can start to develop a cloak of significant size that will open avenues for future applications of cloaking devices.'

More information: This research has been published in the journal *Nature Communications* in a paper titled "Macroscopic Invisibility Cloak of Visible Light".

Provided by University of Birmingham