Scientists reverse Doppler Effect

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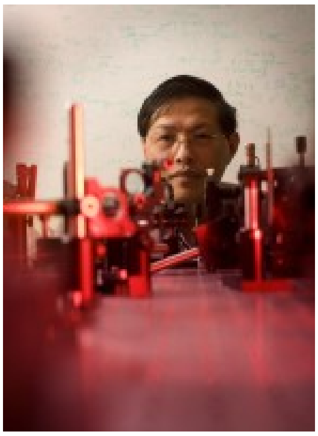

Professor Min Gu. Image credit: Paul Jones

(PhysOrg.com) -- Researchers from Swinburne University and the University of Shanghai for Science and Technology have for the first time ever demonstrated a reversal of the optical 'Doppler Effect' - an advance that could one day lead to the development of 'invisibility cloak' technology.

In physics, the Doppler Effect describes the change in frequency of light or sound waves whenever there is a relative movement between an observer and a wave's source.

Most people would have experienced the Doppler Effect in relation to sound - when you have a train coming towards you the sound frequency increases, and when it moves away the frequency decreases.

The situation is similar for light - when an object and an observer move closer together, light frequency increases from red wavelengths to blue ones. When they move further apart, light frequency decreases from blue to red.

In a paper published today in the Nature Photonics journal, Swinburne researchers Dr Baohua Jia, Dr Xiangping Li and Professor Min Gu and their collaborators from Shanghai, have demonstrated the reversal of this effect, which does not occur naturally. That is, when an object and a light wave detector moved closer together, they were able to decrease the light frequency from blue wavelengths to red ones, and vice versa.

"This is the first time in the world that the inverse Doppler Effect has been demonstrated in the optical region," Professor Min Gu, Director of Swinburne's Centre for Micro-Photonics said.

The researchers were able to achieve this by creating an artificial nanostructured crystal - known as a 'photonic crystal' - out of silicon.

By projecting a laser beam onto the unique photonic crystal 'super prism' and changing the distance between it and the detector, the researchers were able to create an inverse Doppler Effect phenomenon.

"In our super prism the dispersion of light was twice the magnitude of a standard Newton Prism. This large angle makes the prism's refractive index - a property that determines how fast light travels through it - change to negative," Professor Gu said.

All materials that occur in nature have a refractive index greater than one. This means whenever they move in respect to an observer, they will exhibit the standard Doppler Effect.

"By creating this artificial material, with a negative refractive index, we were able to reverse this natural phenomenon," he said.

Being able to reverse the Doppler Effect is a promising sign for the future development of science-fiction inspired technology such as invisibility cloaks. According to Professor Gu this technology, which has already been demonstrated on a micro-scale by US researchers, may be closer to becoming a reality than most people think.

Having a greater understanding of this phenomenon may also lead to a number of more immediate applications. Measuring the Doppler Effect currently allows astronomers to detect the speed at which stars approach or recede from Earth, enables radars to measure the velocity of objects and is used in medical imaging technology to measure blood flow in the human body.

Provided by Swinburne University of Technology

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