Optical 'watermills' control spinning light

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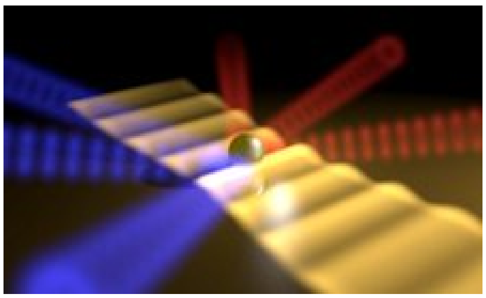

Scientists at King's have built on research they conducted last year to achieve previously unseen levels of control over the travelling direction of electromagnetic wave in waveguides and proved that the process works equally well in reverse, opening up the way for the development of technologies that could revolutionise secure communications as well as high speed computing.

In a paper published today in *Nature Communications* the team demonstrates that light waves propagating along a surface will induce the spinning of electrons in a nearby nanoparticle.

When speaking of spin in optics, one can think of the spinning wheel of a watermill as an illustration of the rotating 'motion' of the electric field vector representing the light field. Assuming the 'water wheel' analogy, the team's discovery is equivalent to demonstrating that a flow of water in the canal will cause the 'water wheel' to spin, thus acting as a 'water mill'. The team showed that the direction of propagation of the original wave determined the spinning sense of the electrons. This is only possible thanks to a very specific property of light waves guided along a surface which does not generally exist in free space, paving the way to a new understanding and new applications of spin on these guided light waves.

Dr Francisco Rodríguez-Fortuño, from the Department of Physics and one of the study's authors, said: 'It has been very encouraging for us to experimentally confirm that this optical 'watermill' was working just as we expected. This reinforces our determination to search for new insights and novel applications of spin in guided light.'

In the experiment, the team first generated a light wave propagating along the surface of a thin gold film. This wave, called a surface plasmon, was then directed at a gold nanoparticle placed on the same surface. The interaction between them resulted in a fast spinning motion of the electrons inside the nanoparticle, in synchrony with the light's frequency. The radiation from the circular motion of the electrons in the particle was subsequently detected, and its polarization analysed, confirming experimentally the reversibility of spin conservation.

By selecting the direction of propagation of the surface wave in such a miniaturized setup, the researchers have at their disposal a flexible and integrated way to control light spin, opening new avenues for all kinds of spinoptical devices. Last year, in a paper published in *Science*, they demonstrated that the direction of spinning electrons inside a nanoparticle determine the propagation direction of light along a nearby surface.

Provided by King's College London