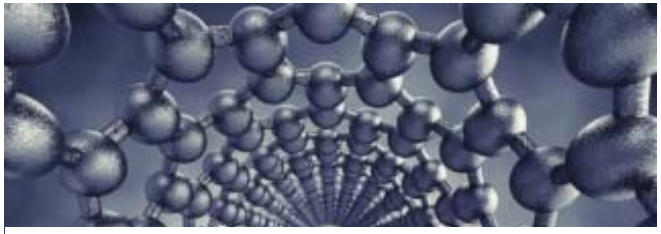

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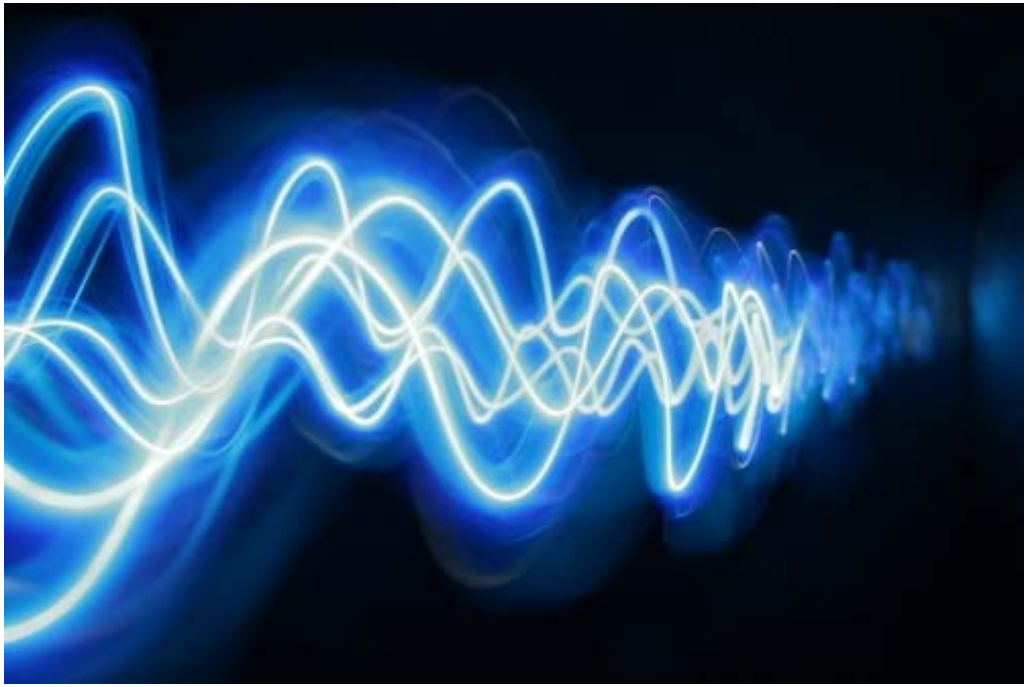
Evanescent Light Waves Show Extraordinary Spin And Momentum

By Shweta Iyer on March 10, 2014 12:40 PM EDT

A team of scientists from Japan has discovered unique dynamic properties of evanescent waves, a type of light wave. These findings are astonishing since they are completely different from previously held hypothesis of light and its spin and momentum, said a press release Thursday. The study carried out in the Quantum Condensed Matter Research Group (CEMS, RIKEN, Japan) led by Dr. Franco Nori is published today in the journal *Nature Communications*.



A team of scientists from Japan has discovered unique dynamic properties of evanescent waves (Photo: Photo courtesy of Shutterstock)

A photon is a particle representing a quantum of light or other electromagnetic radiation and momentum and spin are its intrinsic dynamic properties. A photon carries momentum along the direction of the wave's propagation and this momentum is independent of polarization, which means it cannot oscillate with more than one orientation. In addition, light can also have a dynamic rotation called angular momentum or spin. The spin is proportional to the degree of circular polarization (polarization in which the electric field of the wave rotates but does not change strength, also called helicity), and aligned with the propagation direction.

The Riken Scientists analyzed the momentum and spin of evanescent waves. Evanescent Waves are a type of light waves that travel close to the surface of material objects and whose intensity decreases exponentially, rather than varying sinusoidally (varying like a sine curve), from the interface

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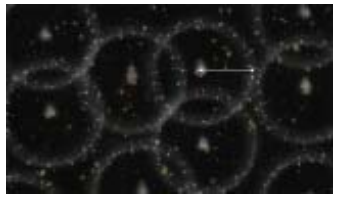

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where they were formed. In other words, their intensity decreases as the distance from the originating point increases.

Surprisingly, the scientists saw that the evanescent wave is exactly opposite of optical waves (photons) in terms of its spin and momentum. Evanescent waves carry a spin momentum that is independent of the polarization and helicity and is orthogonal to the direction of the wave propagation. Moreover, the momentum of the wave is proportional to the wave helicity and is also orthogonal to the wave vector.

"Such extraordinary properties, revealed in very basic objects, offer a unique opportunity to investigate and observe fundamental physical features, which were previously hidden in usual propagating light and were considered impossible," says Dr. Konstantin Bliokh, first author of the study. "In addition to a detailed theoretical analysis, we propose and simulate numerically four novel experiments for the detection of the unusual momentum and spin properties of evanescent waves via their interaction with small probe particles," he adds.

These findings about the characters of evanescent waves throw new light on the fundamentals of spin and momentum elements in quantum physics and can be used in varied fields that involve light-matter interaction.

Source: Konstantin Y. Bliokh, Aleksandr Y. Bekshaev, Franco Nori. Extraordinary momentum and spin in evanescent waves. *Nature Communications*. 2014.