Controlling the electron spin: Flip it quickly but carefully

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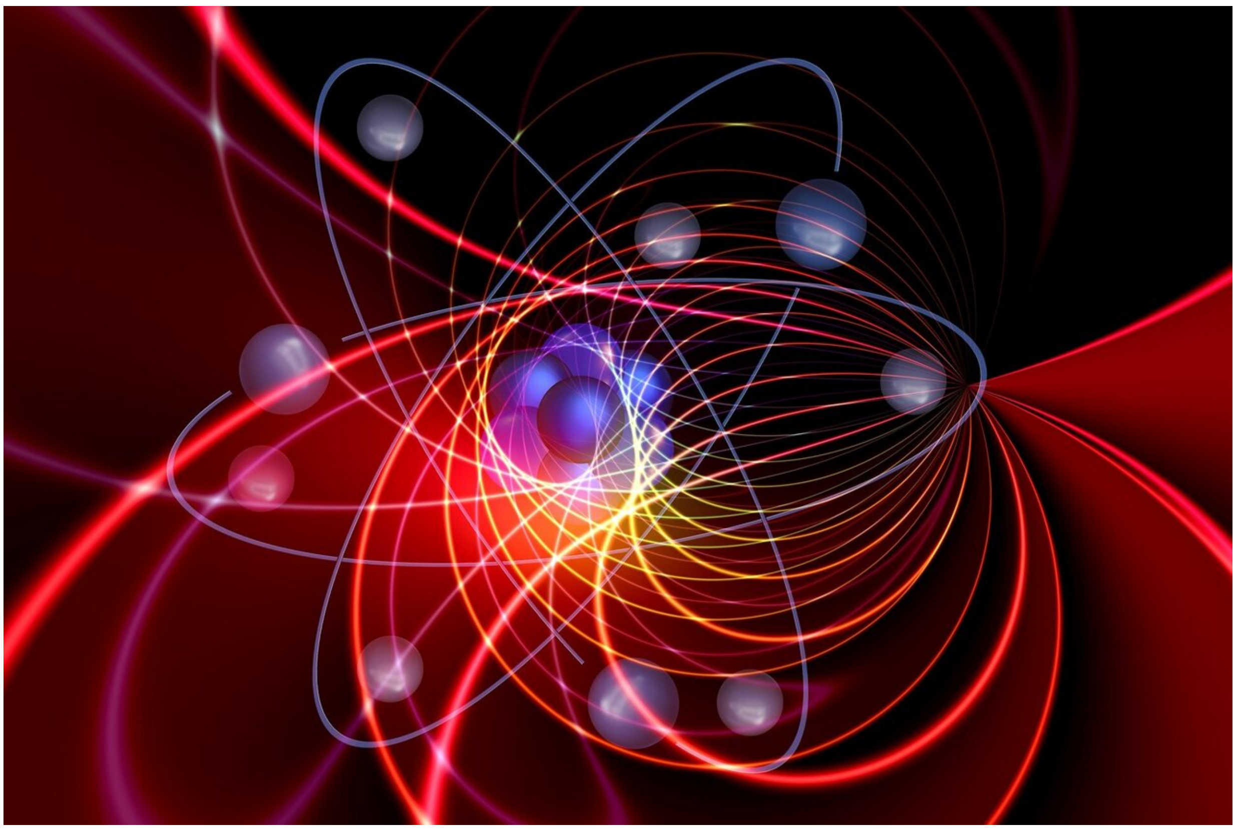

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Over the past two decades, a new area at the interface of semiconductor physics, electronics and quantum mechanics has been gaining popularity among theoretical physicists and experimenters. This new field is called spintronics, and one of its main tasks is to learn how to control the spin of charge carriers in well known semiconductor structures. Many theoretical efforts are always required before some idea finds its embodiment in an actual device, and so far theoretical work on spintronics has been outweighing experimental research.

Denis Khomitsky, Associate Professor of Theoretical Physics Department at Lobachevsky University together with postgraduate student Ekaterina Lavrukhina in collaboration with Professor Evgeny Sherman from the University of the Basque Country in Bilbao (Spain) have proposed a new model that describes electron spin behavior in a semiconductor nanowire with a deep quantum dot (an area where electron movement is confined by electrodes), where spin behavior can be controlled by means of a periodic electric field.

It is known that in materials with strong spin-orbital interactions it is possible to control the electron spin without switching the magnetic field. Instead, the control can be achieved by applying a periodic electric field at a specially selected frequency.

This phenomenon, called electric dipole spin resonance, has been known for quite some time, but its practical application is still limited and there is a need for such technology.

"In the proposed model, we have elucidated the role of the continuum states with energies 'above' the quantum dot, to which the electron will inevitably make its way or tunnel under the action of a sufficiently strong field in the process of resonance. It turns out that to accelerate the spin flip, which is very desirable in electronics and spintronics, there is no need to have very strong electric fields, because in such fields the electron tunnels into the continuum too quickly, and the projection of its spin begins to fade with time, taking away valuable information," says Denis Khomitsky who is in charge of this research project at

Lobachevsky University.

Hence, a practically important conclusion: it is necessary to choose an optimum interval of control fields in such structures, which will make it possible to flip the electron spin quickly and "carefully" enough not to lose the valuable information.

The work is published in *Physical Review Applied*.

Provided by Lobachevsky University

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