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Physicists discover new physical effect

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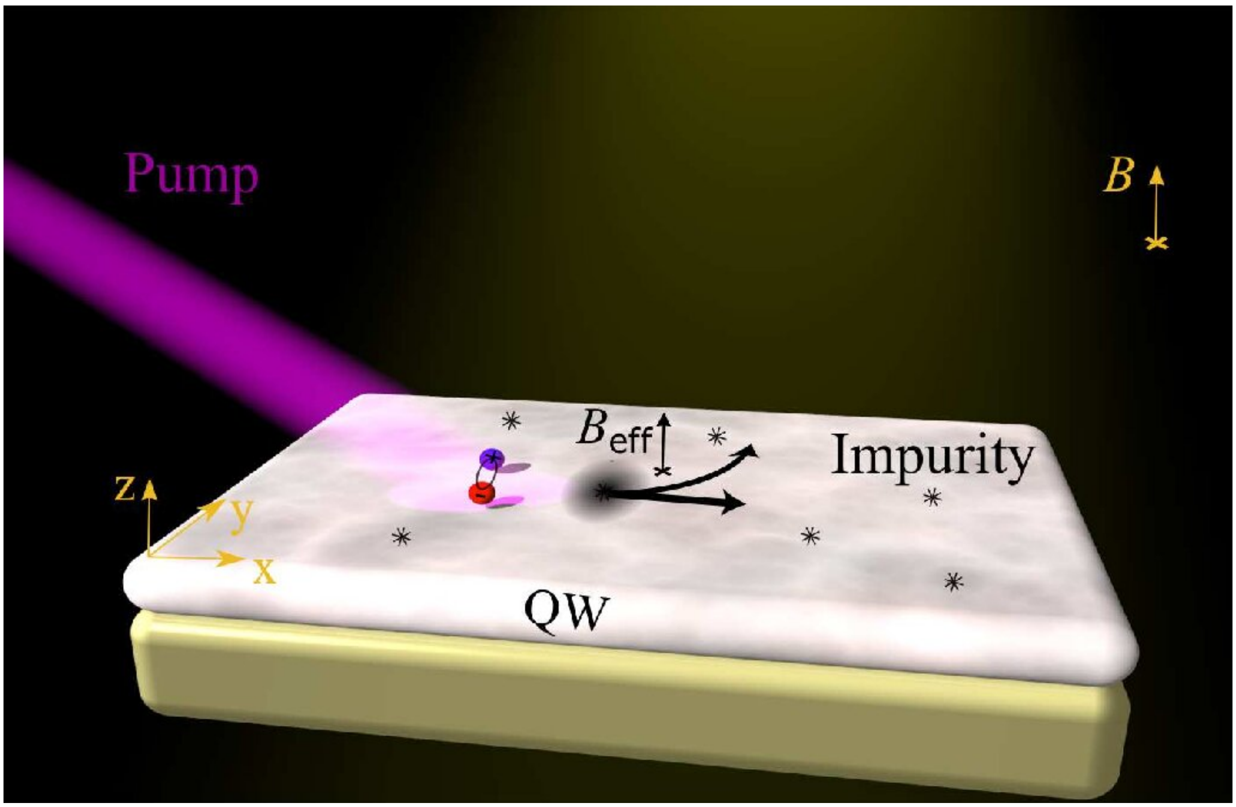

If you take a thin stripe of a semiconductor material and put it under a laser beam at the right angle, you'll create a directed flow of exciton gas. Credit: ITMO University

Scientists have found that a perpendicular magnetic field makes electrically neutral quasiparticles (excitons) in semiconductors behave like electrons in the Hall effect. This discovery will help researchers to study the physics of excitons and Bose-Einstein condensates.

The Hall effect can be achieved by applying a magnetic field in a direction perpendicular to the current flow of a semiconductor or a metal plate. In this case, all the electrons will deflect to one side, which will accumulate a negative charge, while the other side has a positive charge. This results in voltage between the right and left end faces of the plate.

ITMO physicists have recently discovered a similar effect but for excitons, composite neutral quasiparticles. It occurs when a laser affects a semiconductor plate of gallium arsenide, for example, in the presence of a magnetic field. The new phenomenon was called the anomalous exciton Hall effect.

"If you take a thin stripe of a semiconductor material and put it under a laser beam at the right angle, you'll create a directed flow of exciton gas. By applying a perpendicular magnetic field to this film, you will make the exciton cloud deflect to one side. And this is a complete analog of the Hall effect—but for neutrally charged composite quasiparticles," explains Valerii Kozin, a Ph.D. student at ITMO's Faculty of Physics and Engineering.

This effect will help researchers separate bright and dark excitons. When exciton gas is formed, some excitons are able to emit light once the electron returns to its place. Such quasiparticles are called bright excitons. Other excitons disappear without light emission—these are dark excitons. Although it is especially difficult to study and obtain them because both types of quasiparticles are created simultaneously, the proposed method for separating bright excitons from dark ones will successfully resolve this issue.

Valerii Kozin admits that the discovered effect is unlikely to be as widely applied Hall effect technologies used in smartphones, but it may be highly valuable for scientists who study excitons. In particular, it will greatly simplify the study of such mind-blowing and complex states of matter as Bose-Einstein condensates.

More information: V. K. Kozin et al. Anomalous Exciton Hall Effect, *Physical Review Letters* (2021). DOI: 10.1103/PhysRevLett.126.036801

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