of CRISPR-Cas genome-editing technology has made it possible to successfully inactivate 62 PERVs in immortalized pig cells (12), and now the same group, in Niu et al., inactivated all PERVs in primary cells and used these cells to generate live, healthy, genetically modified pigs (1) (see the figure). The pig strain used for this experiment normally carries 25 copies of PERV-A and PERV-B. Using CRISPR-Cas to introduce an inactivating mutation in a highly conserved region in the pol gene that encodes reverse transcriptase, all 25 PERVs in the primary cells were inactivated and unable to produce infectious virus particles. Using nuclei from these cells, embryos were produced by somatic cell nuclear transfer and transferred into surrogate sows with no PERV-C and minimal PERV numbers. They produced 37 PERV-inactivated piglets from 17 sows—15 piglets remain alive, and the oldest healthy pigs were four months old at the time of publication. Although it remains unclear whether PERVs can actually infect humans (even though they can infect human cells in culture) and induce diseases that are typical for retroviruses, such as immunodeficiency or cancer, this new achievement will allay fears of PERV infection after xenotransplantation. This is a step forward in the clinical application of xenotransplantation; however, the other problems—immune rejection, physiological compatibility, and the elimination of other potentially zoonotic viruses—have to be solved.

There is another interesting piece of information gained from Niu et al.: In numerous species, including humans, the envelope proteins of endogenous retroviruses play an important role in the generation of the placenta (13). These proteins, known as syncytins, help generate the syncytiotrophoblast in the placenta and may have immunosuppressive properties (14). The fact that the genetically engineered pigs were born healthy indicates either that the disruption of the reverse transcriptase does not affect the function of the envelope proteins or that placentalogenesis in pigs does not, after all, require retroviral envelope proteins.

REFERENCES


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ULTRAFAST OPTICS

Angular momentum can slow down photoemission

Electrons with high angular momentum are the last to emerge from a solid

By Vladislav S. Yakovlev
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Photoemission spectroscopy, where the absorption of an energetic photon by a material results in the emission of an electron, is an invaluable source of information about electronic structure. Electrons gain their kinetic energies by interacting with both light and their surroundings. In a solid, for example, this makes it possible to measure band energies, energies and lifetimes of quasiparticles, spectral density of states, surface states, and electron-plasmon/phonon coupling.

This was the question that Siek et al. (2) asked. They considered the centrifugal barrier experienced by an electron in a solid, where electrons are exposed to a complex environment created by a crystal lattice and other electrons? This was the question that Siek et al. asked. Solids are much more complex than individual atoms, so the answer was not trivial.

To investigate this question, they performed attosecond streaking measurements on tungsten diselenide, WSe_{2} (see the figure). This van der Waals material consists of alternating sheets of W and Se, with the...
topmost layer consisting of Se. For this material, photoelectrons emitted by a 91-eV pulse belong to four easily distinguishable classes. The fastest electrons originate from the valence band, and the slower ones leave vacancies in the 4s and 3d subshells of Se, as well as in the 4f subshell of W. Thus, in a single measurement, it was possible to determine the formation of wave packets emerging from atomic orbitals with zero, two, or three quanta of angular momentum.

In the idealized picture of photoemission from atomic orbitals, the outgoing partial waves would have angular momenta up to four (photoemission with a linearly polarized field changes the angular momentum by one). Each partial wave with a nonzero angular momentum is subject to a repulsive centrifugal potential. This potential is frequently called centrifugal barrier. It is not a barrier in the way of an outgoing electron wave—this barrier keeps an electron away from the nucleus. However, in many-electron atoms with strong electron screening, another potential barrier may form through the combined action of the repulsive centrifugal force and attractive atomic forces. The elastic scattering of a wave packet from centrifugal potential modifies the timing of the wave packet’s emission.

Because the electrons originating from states with higher angular momenta see higher effective outward forces, it is counterintuitive that they are the most delayed in the atomic model of the photoemission process. Nevertheless, this idealized picture correctly predicts the order in which wave packets leave the WSe₂ sample: The larger the angular momentum of the atomic orbital that an electron vacates, the longer it takes for the wave packet to begin interacting with the laser field.

This work demonstrates that the local environment of a bound electron, which is dominated by atomic potentials, leaves measurable signatures in time-resolved photoemission. Knowing this is important for understanding the photoelectron escape time. This effect arises from the centrifugal barrier associated with the electron angular momentum on the atomic orbitals with zero, two, or three quanta of angular momentum.

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