Electron's 1-D metallic surface state observed

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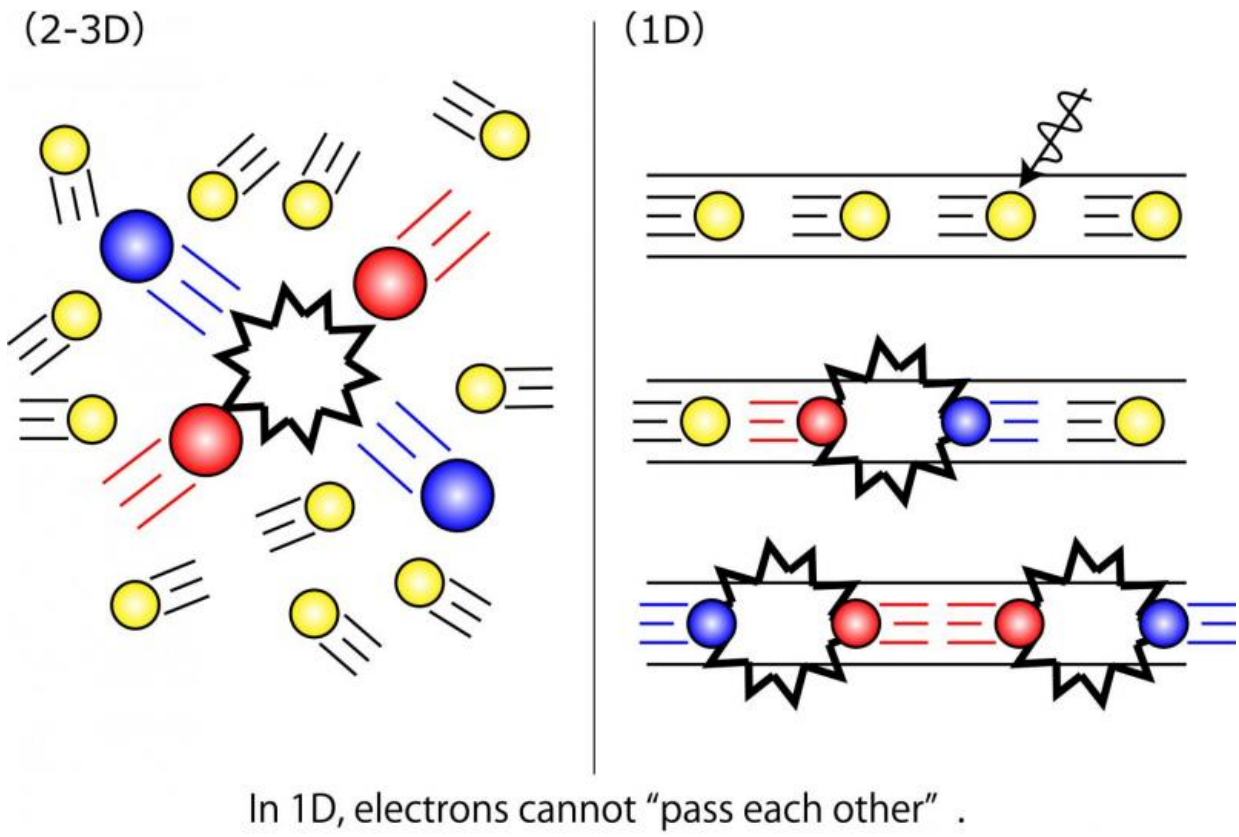

In 1-D, electrons cannot "pass each other". Credit: Osaka University

In the one-dimensional (1D), various exotic phenomena are predicted that are totally different from those in the 3D world in which we live. One of the reasons of this is that particles cannot pass each other in 1D. (Fig. 1, in other words, correlation between electrons plays much more important role than those in 3D)

Researchers in Japan and France artificially created such unique 1D nano electronic systems on the surface of a solid, and observed the 1D electronic state (energy and kinetic momentum of electrons) by analyzing photo-emitted electrons from the sample, and verified the electronic structure. This group's research will help elucidate the mystery of unique electronic properties of 1D nano metals and provide, for example, information helpful for the prediction of electrons confined in extremely fine metal nanowires used in next-generation semiconductor devices.

A group of researchers led by Yoshiyuki Ohtsubo (Assistant Professor) and Shin-ichi Kimura (Professor) at Osaka University, Kiyohisa Tanaka (Associate Professor) of the Institute for Molecular Science, and Amina Taleb (Research Director/UR1-CNRS) of Synchrotron SOLEIL, France, artificially created Tomonaga-Luttinger liquid (TLL) on the surface of a semiconductor crystal. TLL is a typical exotic state in 1D in which electrons move not as individual paticles, but as a group, and the movements of spin and charge appear separately. This state is totally different from the normal state of electrons in metal.

Using angule-resolved photoemission spectroscopy, a method for observing kinetic momentum and binding energy of electrons in solid by shedding light on solid and observing the angle and energy of emitted electrons, this group elucidated the electrons' state and movement in a wide scope of energy for the first time.

The 1D surface nanostructure discovered by this group, through the determination of detailed atomic structure and comparison with theoretical computation, will develop research on 1D nano-metallic electronic state, which had not been well known to this point due to shortage of experimental data.

As the understanding of the uniqueness of 1D nano metals is essential

for predicting electronic properties of extremely fine metal nanowires in next-generation semiconductor devices, further development of research is highly anticipated.

This research was published in *Physical Review Letters* on Dec. 17th, 2015 (EST).

More information: Yoshiyuki Ohtsubo et al. Surface Tomonaga-Luttinger-Liquid State on , *Physical Review Letters* (2015). DOI: 10.1103/PhysRevLett.115.256404

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