THE ADVANCED PHOTON SOURCE
RIXS and a DAC Lead to the Discovery of a Novel Confined Metal

Insulator-metal transitions (IMT), where a material changes from an insulator to a metal with substantially enhanced electrical conductivity, represent an important topic in contemporary condensed matter physics and an opening to a new field for synthesizing functional materials. Recent experiments at the Advanced Photon Source (APS) at Argonne found that strontium iridium oxide, Sr$_3$Ir$_2$O$_7$, undergoes just such an IMT and becomes a confined metal at high pressure, showing metallicity in the crystal ab-plane but insulating along the c-axis. Such unusual behavior resembles the strange metallic phase encountered in cuprate high-temperature superconductors.

Sr$_3$Ir$_2$O$_7$ is a compound belonging to the Ruddlesden-Popper perovskite iridates Sr$_{n+1}$IrO$_{3n+1}$ (where $n$ is the number of SrO$_3$ perovskite layers between extra SrO layers), and it is insulating at ambient condition. The relatively low electrical resistivity and small charge gap of Sr$_3$Ir$_2$O$_7$ suggest that the material can undergo a potential IMT upon external perturbation, such as carrier doping, magnetic field, or external pressure.

In a recent study, the research team performed electric resistance and resonant inelastic x-ray scattering (RIXS) measurements at the X-ray Science Division 27-ID-B and 30-ID-B,C x-ray beamlines at the APS on Sr$_3$Ir$_2$O$_7$ for the first time under high pressure, employing diamond anvil cell (DAC) techniques. The resistance measurements indicated an IMT occurring at around 59 GPa, and the resulting high-pressure phase exhibited a novel confinement phenomenon: metallic behavior within the ab-plane, but an insulating one along the c-axis.

The discovery of a novel high-pressure metallic phase with intriguing confinement characteristics similar to those found in overdoped cuprate superconductors suggests that superconductivity could potentially be found in doped Sr$_3$Ir$_2$O$_7$ under high pressure.


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CALL FOR APS GENERAL-USER PROPOSALS

The Advanced Photon Source is open to experimenters who can benefit from the facility’s high-brightness hard x-ray beams.

General-user proposals for beam time during Run 2017-1 are due by Friday, October 28, 2016.

Information on access to beam time at the APS is at http://www.aps.anl.gov/Users/apply_for_beamtime.html or contact Dr. Dennis Mille, DMM@aps.anl.gov, 630/252-5880.

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