Optical spectroscopy of Fe-based ladder compounds

Kenya Ohgushi
Department of Physics, Tohoku University, Japan

All the Fe-based superconductors identified so far share a square lattice composed of iron atoms as a common feature. In copper-based high-$T_c$ materials, the superconducting phase emerges not only in square-lattice structures but also in ladder structures, which give nice hints for elucidating the microscopic mechanism of the superconductivity. It is therefore expected to find a novel superconducting phase in Fe-based materials without a square lattice.

We have reported the discovery of the pressure-induced superconductivity in the iron-based ladder material BaFe$_2$S$_3$ [1,2]. The material is a Mott insulator with the striped-type magnetic ordering below 120 K. On the application of pressure, this compound exhibits a metal–insulator transition at about 11 GPa, followed by the appearance of superconductivity below $T_c = 24$ K. Stimulated by our discovery, the pressure-induced superconductivity is also found in an isostructural material BaFe$_2$Se$_3$ [3].

We here show results of reflectivity spectra for a solid-solution BaFe$_2$(Se$_{1-x}$S$_x$)$_3$ in a wide temperature range. We also report on detailed reflectivity measurements under pressure for BaFe$_2$S$_3$, revealing the pressure-induced dimensional crossover in electronic structure. Our systematic study deepens an understanding on what is the key for the appearance of superconductivity in Fe-based materials.

If time permits, I will briefly discuss future directions of optical spectroscopy under high-magnetic field with a special focus on the possible detection of exotic quasiparticles in magnets.

This study is performed in collaboration with Y. Hirata, H. Okamura, Y. Ikemoto, T. Moriwaki, T. Mizokawa, R. Kimura, K. Sasaki, S. Imaizumi, T. Aoyama, and Y. Imai.