



## 复旦大学物理系物质科学报告

### **Spin Hall effect, large diamagnetism, and spin-polarization in magneto-optical conductivity of Dirac electrons**

### Physics Department Colloquium

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**Tokyo University**

Spin Hall conductivity of fully relativistic Dirac electrons in solid with strong spin-orbit interactions is studied based on the Kubo formula aiming at possible application to bismuth and bismuth-antimony alloys. It is found that there are two distinct contributions to spin Hall conductivity, one only from the states near the Fermi energy and the other from all the occupied states. The latter remains finite even in the insulating state, i.e., when the chemical potential lies in the band-gap, and turns to have the same dependences on the chemical potential as the orbital susceptibility (diamagnetism). This effect comes purely from the inter-band effect, while the usual Hall conductivity originates both from intra- (dominant) and inter-band (small) effects. This result suggests a close relationship between the spin Hall effect

and diamagnetism. The obtained magnitude of spin-Hall conductivity turns out to be about 100 times larger than that of Pt which is a standard metal used in spintronics.

In the same model for Dirac electrons in solid, we propose a mechanism based on the Kubo formula to generate a spin-polarized magneto-optical current. The ac current response functions are calculated in the isotropic Wolff model under an external magnetic field, and the selection rules for Dirac electrons are obtained. By using the circularly polarized light and tuning its frequency, one can excite electrons concentrated in the spin-polarized lowest Landau level when the chemical potential locates in the band gap, so that spin-polarization in the magneto-optical current can be achieved.

### **Professional Appointments**

1986-1993 Research Associate at Institute for Solid State Physics, University of Tokyo

1993-2000 Associate Professor at Institute of Physics (Komaba), University of Tokyo

2000-2008 Associate Professor at Department of Physics, University of Tokyo

2008-present Professor at Department of Physics, University of Tokyo

1989-1991 Postdoctoral fellow at Theoretische Physik, ETH-Honggerberg, and Interdisziplinäres Projektzentrum, Zurich Switzerland working with Professor T. M. Rice

1991-1993 Postdoctoral fellow at Joseph Henry Laboratories of Physics, Princeton University, working with Professor P. W. Anderson

**Time: 2:00pm, Tuesday, 2016.04.12**

**Location: Physics Building, Room 221B**

**(Cookies and coffee are served from 1:30 pm)**