



### Seminar

## Prof. A. Einstein meets Spintronics

### Sadamichi Maekawa

*Advanced Science Research Center,  
Japan Atomic Energy Agency, Tokai, 319-1195 Japan.*



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**Venue: Room W563, Physics Building, Peking University**

**地点: 北京大学物理学院, 西楼563会议室**

### Abstract

A. Einstein and W.J. de Haas discovered experimentally the equivalence of magnetic moment and mechanical rotation in 1915 [1]. In the same year, S.J. Barnett showed that the mechanical rotation can generate a magnetic field, i.e., the so-called Barnett field, even in a body with no electric charge [2]. These phenomena are caused by the angular momentum conservation between electron spin and mechanical rotation, which has been proved in the general relativistic quantum mechanics [3]. We introduce mechanical effects in spintronics and propose a variety of novel spintronics phenomena. In particular, the coupling between nuclear spin and mechanical rotation is demonstrated [4]. Since the Barnett field is enhanced more than three orders of magnitudes in nuclei than electron spins, the mechanical nuclear-magnetic-resonance (NMR) may provide new applications of NMR. We also observe the generation of spin current by the flow of liquid metals. Combining this effect with the spin Hall effect [5], the spin-hydrodynamic generation of electricity is obtained [6]. The mechanical generation of spin and spin current opens a door from "Spintronics" to "Spin-Mechatronics".

[1] A. Einstein and W.J. de Haas, *Verhandl. Deut. Physik. Ges.*, **17**, 154 (1915).

[2] S.J. Barnett, *Phys. Rev.* **6**, 239 (1915).

[3] M. Matuo, J. Ieda and S. Maekawa, *Phys. Rev. Lett.* **106**, 076601 (2011).

[4] H. Chudo, M. Ono, K. Harii, M. Matsuo, J. Ieda, R. Haruki, S. Okayasu, S. Maekawa, H. Yasuoka and E. Saitoh, *Appl. Phys. Express* **7**, 063004 (2014).

[5] *Spin Current*, eds. S. Maekawa *et al.* (Oxford University Press, 2012).

[6] R. Takahashi, M. Ono, K. Harii, S. Okayasu, M. Matsuo, J. Ieda, S. Takahashi, S. Maekawa and E. Saitoh, *Nature Phys.* (2015).

### About the Speaker

Prof. Sadamichi Maekawa has been a director in Advanced Science Research Center, Japan Atomic Energy Agency and an emeritus professor in Tohoku University since 2010. He was a post doctoral fellow in 1975 and 1976 in IBM Watson Research Center, New York. From 1988 to 1997, he was a professor in Department of Applied Physics, Nagoya University, and then joined in the Institute for Materials Research, Tohoku University as a professor from 1997 to 2010. He was a deputy director in Institute for Materials Research, Tohoku University from 2006 to 2008. Since 2008, he has been an associate member of the Science Council of Japan. His research experience includes a Visiting Scientist (Summer Faculty Member) in IBM Watson Research Center, a Visiting Scientist in Institute für Festkörperforschung, Jülich, a Guest Distinguished Professor in Max Planck Institute at Halle, a Guest Scientist in the Institute of Physical and Chemical Research, and a Guest Distinguished Professor in Pohang University of Science and Technology, Korea. His main research focuses on solid state theory which includes theory of electronic properties in strongly correlated electron systems and theory of transport in magnetic nanostructures.