# Optical Barnett Effect and Optical Magnon Condensation

**Kouki Nakata[1] and Shintaro Takayoshi[2]**
**[1]Advanced Science Research Center, Japan Atomic Energy Agency, Tokai, Ibaraki 319-1195, Japan**
**[2]Max Planck Institute for the Physics of Complex Systems, Dresden 01187, Germany**

Studies on the transfer of angular momentum between mechanical rotations and spin angular momentum have a long history dating back to a theoretical insight by Richardson [Phys. Rev. (Ser. I) **26**, 248 (1908)]. In 1915 Barnett observed a magnetization induced by mechanical rotations, while Einstein and de Haas (EdH) did the reciprocal phenomenon, dubbed the Barnett effect and the EdH effect, respectively. One hundred years after the discoveries, the observation of the Barnett field and the effect in nuclear spin systems was reported [H. Chudo et al., Appl. Phys. Express **7**, 063004 (2014)]. Thus the last decade has seen a rapid development of spintronics aiming at inventing a variety of methods to handle the magnetization and excitations such as magnons for a flexible and fast manipulation of magnetic systems. Another important advance in the manipulation of magnetism is the utilization of laser-matter coupling, and the reversal of magnetization was achieved experimentally [C. D. Stanciu et al., Phys. Rev. Lett. **99**, 047601 (2007)]. Thus the interdisciplinary field between optics and spintronics attracts a broad interest of both experimentalists and theorists.

In this poster, first, we [1] present a novel method to realize the Barnett effect without mechanical rotations, and its application to the dynamical phase transition as well as the magnetization control. The irradiation of circularly polarized laser to magnetic insulators gives rise to the optical Barnett field, leading to the quasiequilibrium Bose-Einstein condensates of magnons. This is the remarkable result from the combination of quantum optics and magnon spintronics, and we refer to this optical Barnett effect especially as the ``optomagnonics Barnett effect''. Second, we discuss the difference from the inverse Faraday effect [A. Kirilyuk et al. Rev. Mod. Phys. **82**, 2731 (2010)]. Last, we show a prominent application, an ultrafast Josephson spin current through optomagnonics Barnett effect in a junction of insulating antiferromagnets.

[1] KN and Takayoshi, submitted (2020).
KN and Takayoshi, in preparation (2020).
KN and Takayoshi, Phys. Rev. B **100**, 014421 (2019).
KN et al., Phys. Rev. B **90**, 144419 (2014).