Acoustically induced nonlocal magnetic domain dynamics in ferromagnet thin film revealed by ultrafast transmission electron microscopy

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Acousto-magnetic coupling plays very important roles for the formation of complex magnetic domain structures and their dynamics in various systems including rare earth garnets. In particular, guided acoustic waves, such as surface-acoustic wave, have been used to drive diverse magnetic dynamics such as magnetization switching, domain wall motion, and vortex core precession. However, understanding such acousto-magnetic dynamics is difficult particularly when there is complex magnetic domain structure. This is partly because both acoustic and magnetic should be simultaneously investigated in the same sample.

In this talk, we will introduce the recent experimental result on Yttrium Iron Garnet (YIG) revealed by ultrafast transmission electron microscopy, which enables us to detect both acoustic and magnetic dynamics in the same sample with nm × ps spatiotemporal resolutions [1,2]. We injected the photogenerated acoustic wave to a flux-closure magnetic domain pattern in YIG thin flake [Fig. 1(a-c)] and observed the dynamics of the magnetic domains. Simultaneous observation of both magnetic and acoustic dynamics in the same sample further reveals that such magnetic domain dynamics is nonlocally induced when the acoustic wave reaches the magnetic vortex core [Fig. 1(d,e)]. As the injected acoustic wave is mainly composed of rotational atomic motion, the present result suggests the possibility of an unusual coupling between the vortex core and the mechanical rotation.

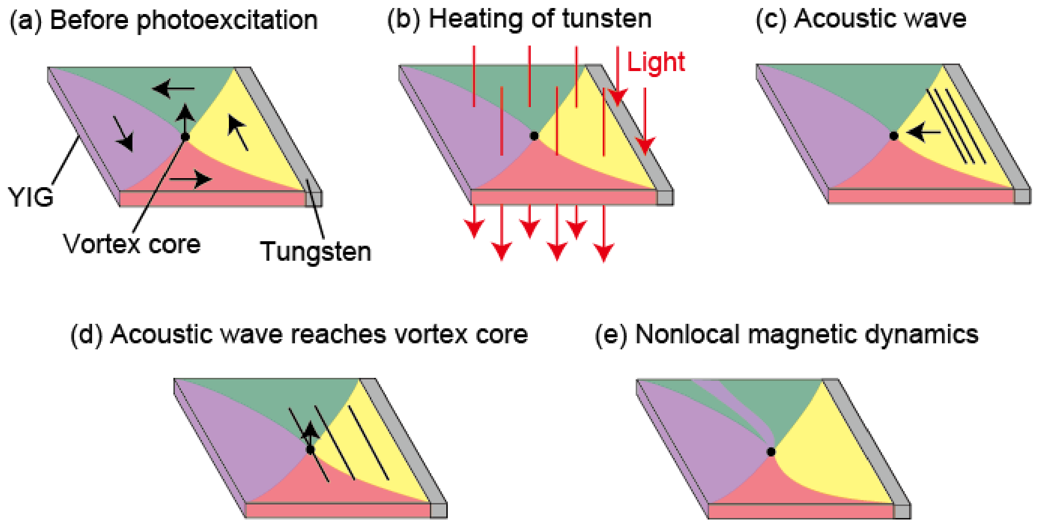

Fig.1 (a-e) Schematics of the experimental setup and results.

[1] **A. Nakamura**, T. Shimojima, K. Ishizaka, *Nano Lett.* **23**, 2490 (2023).

[2] T. Shimojima, **A. Nakamura**, K. Ishizaka, *Rev. of Sci. Instrum.* **94**, 023705 (2023).