Scientists discover phenomenon of ultra-long spin relaxation in 2D van der Waals magnetic materials

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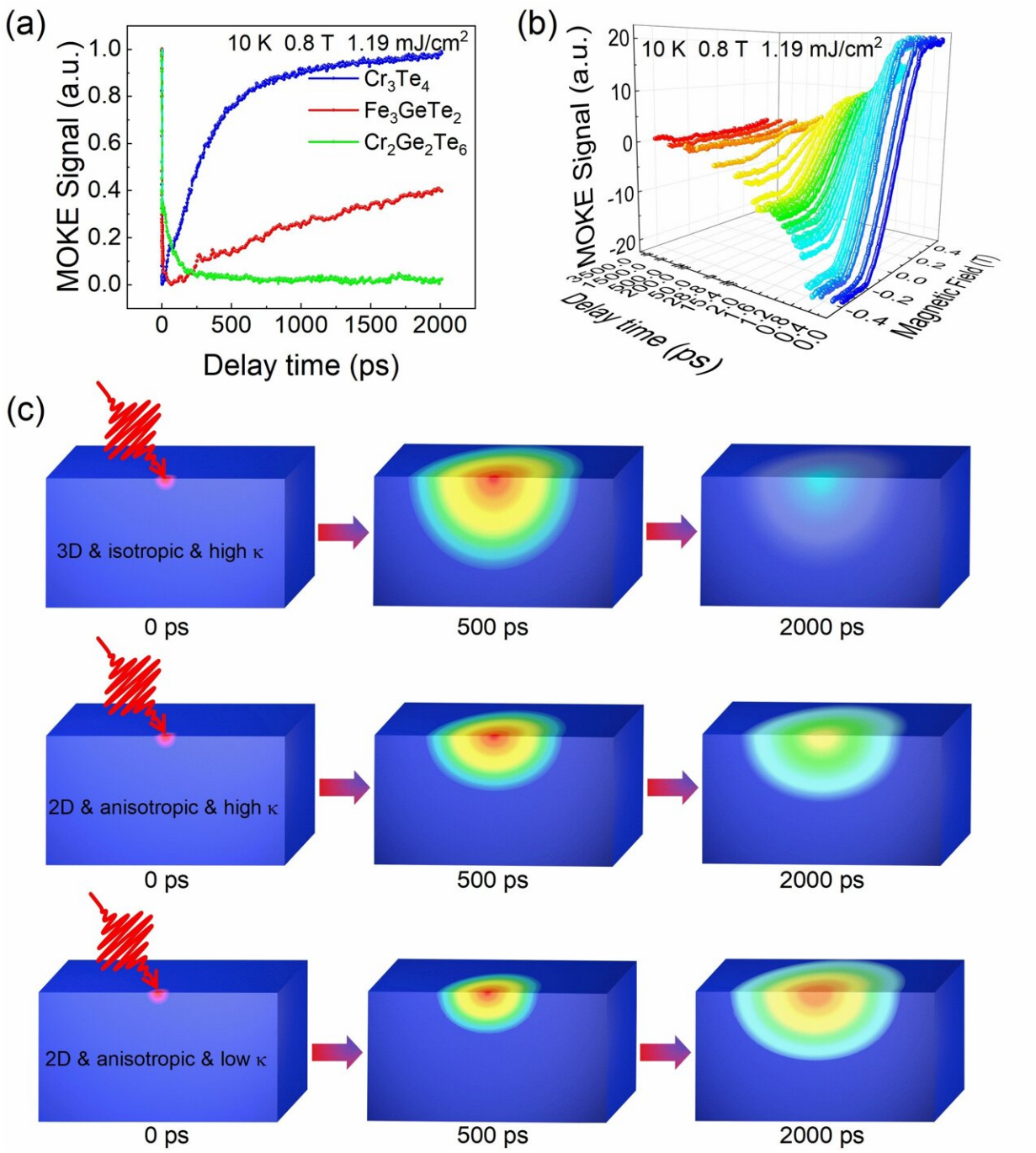

Compared with the other two materials, $Cr_2Ge_2Te_6$ exhibits ultra-long spin relaxation behavior after complete demagnetization. Credit: SUN Tao

Groups of scientists found in 2017 that long-range magnetic order can stably existence at atomic layer thickness in two-dimensional (2D) van der Waals (vdW) materials. This significant discovery provides ideal materials platform for the realization of two-dimensional vdW spintronic devices. In order to construct new high-speed spintronics devices, it is necessary to study the ultrafast spin dynamics of vdW magnetic system.

Recently, Prof. Sheng Zhigao and Luo Xuan from the Hefei Institutes of Physical Science (HFIPS) of the Chinese Academy of Sciences (CAS), collaborating with Dr. Xiao Ruichun from Anhui University, discovered the ultra-long spin relaxation behavior in 2D van der Waals magnetic materials by an all-optical time-resolved magneto-optical Kerr effect technique under high magnetic fields.

At the same time, based on the modified three-temperature model, they revealed the key role of dimensionality and thermal diffusion anisotropy in the spin dynamics of 2D vdW magnets. Relevant results were published in *2D Materials*.

Aiming at the frontier field of spin dynamics of 2D magnetic materials, the researchers utilized the ultrafast magneto-optical technology under high magnetic fields to conduct a detailed comparative study on the laser-induced spin dynamics of 2D vdW semiconductor $Cr_2Ge_2Te_6$, 2D vdW metal Fe_3GeTe_2, and 3D metal Cr_3Te_4. They found that the regenerative magnetization rates of 2D vdW magnetic materials were significantly slower than that of 3D materials after excited by femtosecond lasers.

"We found, for the first time, that $Cr_2Ge_2Te_6$ has ultra-long spin relaxation behavior, that is, there is no obvious recovery of magnetism in the time scale of 3500 ps (1 ps=10^{-12} s) after ultrafast demagnetization," said Prof. Sheng. "This is the most attracting part of this experiment."

Based on the model analysis and experimental research results, the

researchers revealed that the lattice dimension and thermal diffusion anisotropy play a key role in the spin dynamics of 2D magnetic materials.

The ultrafast dynamics study not only effectively expands the research field of 2D magnetism, but also further reveals the dimensional specificity of 2D vdW magnetics, which provides a research basis for their application in the high frequency devices.

More information: Tao Sun et al, Ultra-long spin relaxation in two-dimensional ferromagnet $Cr_2Ge_2Te_6$ flake, *2D Materials* (2021). DOI: 10.1088/2053-1583/ac2ab3

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