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Chirality and Kinetomagnetism

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Chirality, which results from mirror symmetry breaking combined with spatial rotation, plays a ubiquitous role in many phenomena, from the functionality of DNA and climbing vines to the piezoelectricity of quartz crystals. It is important to note that chirality does not necessarily imply screw-like twisting and that magnetic chirality refers to chirality in spin-ordered states or mesoscopic spin textures. Although the term “chirality” is mathematically well-defined, it has been used widely in recent years, often in a confusing manner. In steady states, chirality (C) does not change under the time reversal operation. In contrast, the chirality prime (C') denotes time-reversal symmetry breaking in addition to mirror symmetry breaking in combination with spatial rotations. Various examples of magnetic chirality and chirality prime and the phenomena arising from them, such as self-induction, directional nonreciprocity in magnetic fields, current-induced magnetization, chiral-selective spin-polarized current, Schwinger scattering, magneto-optical Kerr effect, linear magnetoelectricity, and chiral tunneling will be discussed. Many of these phenomena can be understood using one hypothesis, “kinetomagnetism in chiral systems,” which I will introduce. Some of these exotic phenomena have been observed recently, and many others require experimental confirmation in the future.

Bio: Dr. Sang-Wook Cheong is the Henry Rutgers Professor and the Board of Governors Professor at Rutgers University and serves as the Director of the Keck Center for Quantum Magnetism, the Center for Quantum Materials Synthesis, and the Rutgers Center for Emerging Materials. He is a distinguished visiting professor at Postech in South Korea and Nanjing University in China and editor-in-chief of npj Quantum Materials.

Prof. Cheong has made pioneering contributions to the field of enhanced physical functionalities of quantum materials and has also conducted key research on topological self-organization in quantum solids, including nanoscale charge stripe formation, mesoscopic electronic phase separation in mixed-valence transition metal oxides, and the formation of topological vortex domains in multiferroics. He has published over 960 scientific papers, cited more than 64,000 times; h-index 114. His work has received various awards, including the 2007 Hoam Prize, the 2009 KBS Global Korean Prize, and the 2010 James K. McGroddy Award for New Materials.

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