Electrical and optical nucleation of magnetic skyrmions

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The fascination of magnetic skyrmions derives in large parts from their topological properties, which are shared between all types of skyrmions regardless of the specific materials. One of these properties is the topological nucleation energy barrier of $8\pi At$ per skyrmion [1]. On the one hand, this energy barrier prevents skyrmions from being created by random thermal activation at room temperature, which is an important property to use skyrmions in applications. On the other hand, this large energy barrier makes it often difficult to access the skyrmion phase, and in particular to access it fast and efficiently. Here, I will discuss two ways of nucleating skyrmions on a sub-nanosecond time scale: electrical nucleation by spin-orbit torque pulses [2] and optical nucleation by single femtosecond laser pulses [3]. Surprisingly, both phenomena do not require skyrmions to be generated in skyrmion-antiskyrmion pairs. The theory behind these switching mechanisms will be illustrated in this talk.

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FIG: Schematic illustration of skyrmion nucleation. The talk will focus on the mechanism and speed of how such skyrmion nucleation can be induced by spin-orbit torque current pulses and femtosecond laser pulses.