Micromagnetic simulations: nano-magnetism best friends

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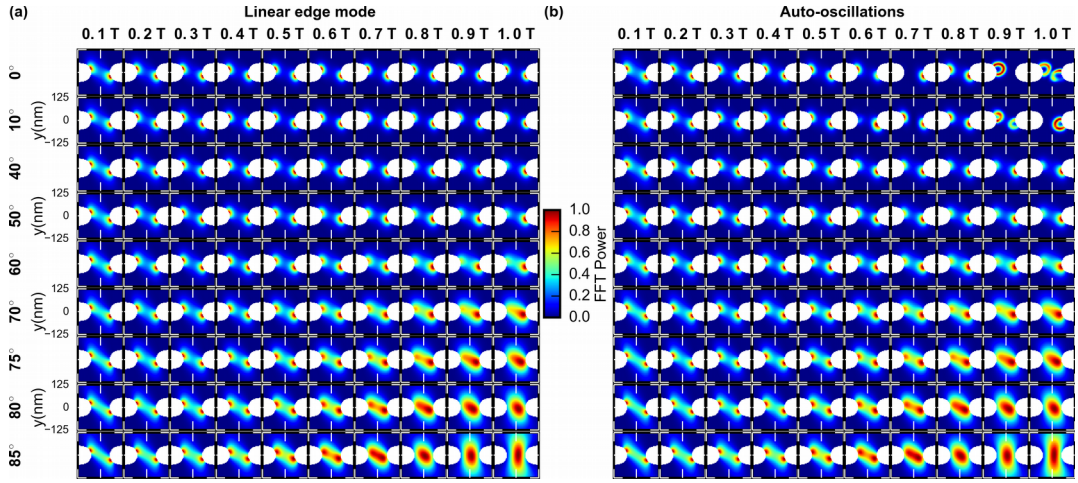
Nano-scale magnetization dynamics enables next generation storage[1], computing[2], and microwave technologies[3]. However, its intrinsic nonlinearity, non-uniformity, and presence of long-range magnetic interactions significantly complicate any analytical treatment of the technology-relevant problems, such as collective and self-sustained magnetization dynamics. So their properties are best revealed by micromagnetic simulations. In fact, for about two decades they are accompanying and frequently drive high impact research in the fields of magnonics and spintronics. The emergence of the GPU-accelerating computing allowed for large-scale micromagnetic simulations on commodity hardware and made computational magnetism accessible for virtually any research group in the world.

In my lecture, I will talk about the history of micromagnetic simulations and the most prominent problems they allowed to solve. Then, with the emphasize on the emerging problems of spintronics, I will demonstrate how to get started with systematic micromagnetic simulations, efficiently use the mumax3 code[4], perform spectral analysis of massive datasets and bridge the gap between the full-scale simulations and analytical theories.



Spatial profiles of (a) linear and (b) self-sustained magnetization dynamics of constriction-based spin Hall nano-oscillator simulated using the mumax3 code on the in-house built 110 TFLOPS cluster.[5]

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