"Investigation and Control of Ultrafast Magnetic Phenomena"

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Spintronic devices have shown a lot of promise in low power and non-volatile memory applications. However, conventional spintronic devices are limited by the speed of equilibrium magnetization reversal. For more than two decades, the field of ultrafast magnetism, wherein magnetic processes in (sub)picosecond timescales are triggered by the ultrafast non-equilibrium heating of magnetic thin films with femtosecond laser pulses, has provided us with the tantalizing prospect of controlling magnetism in unprecedentedly fast timescales. In this talk, I will speak about the research I have conducted in understanding ultrafast magnetic phenomena, and in controlling and integrating them with conventional spintronic processes to realize fast, non-volatile spintronic devices.

In the first part of my talk I will speak about our results on detecting the current induced spin accumulation due to the spin-orbit effects in heavy metals, commonly termed as the spin-Hall effect, directly on the heavy metal surface using an optical technique called the magnetization-induced second harmonic generation (MSHG). This experiment gave us insight into the dynamics and timescales of current induced spin accumulation in conventional spin-orbit torque devices. I will then talk about experiments on ultrafast helicity-independent all-optical switching (HI-AOS) in ferrimagnetic GdFeCo and GdTbCo alloys, which helped us understand the complex interplay of exchange coupling, elemental damping and other parameters in ultrafast magnetization switching events.

In the second part of my talk, I will introduce ways to integrate ultrafast magnetic phenomena into conventional spintronic devices. HI-AOS events had thus far only been reported in Gd-based ferrimagnetic films, which are not very attractive for device integration. I will discuss our results on extending the ultrafast HI-AOS capabilities of GdFeCo to Co/Pt multilayers, a conventional ferromagnet that can be easily used in spintronic devices, through exchange coupling. Finally, I will share our work on ultrafast switching of a Co/Pt ferromagnet with the spin-orbit torque effect from picosecond current pulses.

Bio: Akshay Pattabi is a graduate student in the EECS department at UC Berkeley. Since 2014, he has been working towards a PhD in ultrafast nanomagnetism and spintronics in the group of Prof Jeffrey Bokor. His research interests have mostly been focused on studying the physics of ultrafast magnetism, especially helicity-independent all optical switching in rare earth-transition metal ferrimagnets, and applying these phenomena to speed up conventional spintronic devices. Throughout his PhD, Akshay has been a part of the Center for Energy Efficient Electronics Science (E3S) at Berkeley. He was a visiting researcher at the Institut Jean Lamour at the University of Lorraine, Nancy, France during Spring 2019 as part of the France-Berkeley Fund.