**Shining light on Spintronics: From detection of orbital currents to unlocking an elementary interaction between light and magnetism using insights from quantum optics**

The ferromagnetic resonance (FMR) experiment is pivotal for detecting spin currents in Spintronics technology. It occurs on Gigahertz timescales due the relatively slow relaxation time of the spins in ferromagnets. In contrast, optical fields oscillate much faster, at ∼ 400 − 800 THz. Therefore, it seems unlikely that such fast-oscillating fields may interact with magnetic moments. In this talk, I will start by discussing our recent report of the efficient generation of spin currents from the orbital Hall effect. I will demonstrate the technology in pure Cu and Al which are two key metals in the semiconductor industry due to their superior electrical and thermal conductivity. I will then show that by combining principles from quantum optics, the equations governing the FMR experiment are even relevant to magnetic fields that oscillate at much faster optical frequencies. Namely, the interaction between optical beams and the magnetization is made possible. We find that the strength of the interaction is determined by an elementary efficiency parameter $η=αγH/f\_{opt}$, where $H$ is the amplitude of the optical magnetic field, $α$ is the dissipation rate of spin angular momentum to the lattice, and $f\_{opt}$ and $γ$ are the optical frequency and gyromagnetic ratio. Our results can explain a variety of highly debated experimental observations on the interactions between optical fields and ferromagnets that have been reported in the last 25 years.

Short Bio

Assistant Prof. Amir Capua heads the Spintronics Lab at the Institute of Electrical Engineering and Applied Physics at the Hebrew University of Jerusalem, Israel. Amir received his Ph.D. (2013) from the Electrical Engineering Department at the Technion, Israel where he worked in the fields of semiconductor laser physics and quantum optics. In 2013 Amir joined the Spintronics research group at the IBM Almaden Research Labs in California managed by Prof. Stuart Parkin and in 2016 he joined the Max Planck Institute for Microstructure Physics, Germany. Since 2017 Amir heads the Spintronics Lab at the Hebrew University. His team explores spin transport and magnetization dynamics for novel sensing, processing, and memory applications.