University of Crete
**Department of Physics**

# *Physics Colloquium*

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# THZ Spintronics: Probing ultrafast spin and charge current dynamics


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## ABSTRACT


*The conversion mechanism of spin to charge currents and vice versa, with the help of the spin Hall and the inverse spin Hall effect has recently opened a novel direction in the research field of spintronics that combines magnetism with optical physics and ultrafast photonics. The target is to realize future spintronic devices operated at THz frequencies based on the ultrafast generation and conversion of charge and spin currents.*

*In this talk the field of THz spintronics will be introduced together with the most recent achievements. Experiments will be presented that are using femtosecond laser pulses to trigger ultrafast spin and charge dynamics in magnetic bilayers composed of ferromagnetic (FM) /non-magnetic (NM) layers where the NM layer features a strong spin-orbit coupling. Such heterostructures are novel sources for the generation of THz radiation based on the spin- to-charge conversion in magnetic films [1-4]. The key technological and scientific challenges of THz spintronic emitters in order to increase their intensity and frequency bandwidth will be discussed. The enhanced performance of spintronic terahertz emitters based on bulk and interface defect density will be revealed.*

*In conclusion, the presented results will define a roadmap of how to control the spin- dependent transport on THz time scales. The perspective of application of THz spintronic devices in ultrafast computing and THz technologies is large. THz spintronics opens a new paradigm in current ultrafast technologies.*



*[1] "Efficient terahertz generation using Fe/Pt spintronic emitters pumped at different wavelengths", E. T. Papaioannou et al., IEEE Transactions on Magnetics 54, 1 (2018).*
*[2] "Optimized spintronic terahertz emitters based on epitaxial grown Fe/Pt layer structures", G. Torosyan et al., Sci. Rep. 8, 1311 (2018).*
*[3] "Efficient metallic spintronic emitters of ultrabroadband terahertz radiation", T. Seifert et al., Nat. Photon. 10, 483 (2016).*
*[4] "Enhanced performance of spintronic terahertz emitters based on defect engineering", D. Nenno et al., Sci. Rep. 9, 13348 (2019) (2019).*