Femtosecond dynamics of spin-polarized electrons in topological insulators

H. Hedayat[1], D. Bugini[1], H. Yi[2], C. Chen[2], X. Zhou[2], G. Cerullo[1], C. Dallera[1], E. Carpene[3]
[1]Dipartimento di Fisica, Politecnico di Milano, 20133 Milan, Italy
[2]National Lab for Superconductivity, Institute of Physics, Chinese Academy of Science, Beijing 100190, China
[3]CNR-IFN, Dipartimento di Fisica, Politecnico di Milano, 20133 Milan, Italy

A faster control of spins is a major request for the new generation of computing and spintronic systems. In this framework, since many years, ultrashort light pulses have been utilized to trigger and detect the spin dynamics of electrons in magnetic materials and multilayers. Recently, three-dimensional topological insulators (TIs) have aroused keen interest to be utilized in the field of spintronics due to their spectacular features, in particular, the existence, within the insulating gap of bulk states, of spin-polarized surface states (Dirac-cone) that are protected from backscattering by time-reversal symmetry [1-4]. We have studied the femtosecond dynamics in the spin-polarized unoccupied electronic structure in $Sb_xBi_{(2-x)}Se_yTe_{(3-y)}$ TIs family, employing circular-polarized light in time and angle resolved photoemission spectroscopy (trARPES). Our results reveal the time-domain scheme of all main excitation and decay channels of spin-polarized and un-polarized electrons upon ultrashort laser pulses perturbation.

References:

[1] X.L. Qi and S.C. Zhang, Rev. Mod. Phys. **83**, 1057 (2011).
[2] H. Zhang, C.X. Liu, X.L. Qi, X. Dai, Z. Fang and S.C. Zhang, Nat. Phys. **5**, 438 (2009).
[3] Z.H. Zhu, C.N. Veenstra, S. Zhdanovich, M.P. Schneider, T. Okuda, K. Miyamoto, S.Y. Zhu, H. Namatame, M. Taniguchi, M.W. Haverkort, I.S. Elfimov and A. Damascelli, Phys. Rev. Lett. **112**, 076802 (2014).
[4] C. Jozwiak, J. A. Sobota, K. Gotlieb, Alexander F. Kemper, C. R. Rotundu, R. J. Birgeneau, Z. Hussain, D. Lee, Z. Shen, A. Lanzara Nat. Commun. **7**, 13143 (2016).