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Direct Insight into the Electronic Band Structure and Spin Properties of Novel Topological Materials

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Photoemission with angular and spin resolution (Spin-ARPES) probes directly the electronic bands and their spin textures in solids. The development of the technique is closely related to, and stimulated by the development of novel quantum materials, often characterized by peculiar spin arrangements. We developed a highly efficient Spin-ARPES spectrometer [DOI:10.1107/S1600577517006907] hosted at the APE-LE beamline (Elettra/NFFA facilities), which became one of the reference European Spin-ARPES setups, heavily exploited in the investigation of novel candidate spintronic materials.
Here I will show how we implemented Spin-ARPES in the investigation of Dirac semimetals that attract attention due to the considerable technological potential related to their nontrivial topological states and exotic quantum transport. Especially, materials hosting type-II Dirac fermions are expected to provide functionalities enabled by anisotropic optical and magnetotransport properties. Nevertheless, any practical implementation remained elusive so far since the Dirac point lies far from the Fermi level, limiting the technological exploitation. By means of spin-ARPES we found that kitkaite NiTeSe hosts both the type-II bulk Dirac fermions and the topological spin polarized surface states in close proximity of the Fermi level and this likely plays a role in the performance of NiTeSe-based microwave detector that was subsequently demonstrated [DOI:10.1002/adfm.202106101].

Primary author: VOBORNIK, Ivana (CNR-IOM)

Presenter: VOBORNIK, Ivana (CNR-IOM)