# Spectromicroscopic study of the nontrivial topological phase of graphene

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Today graphene remains one of the most intensively researched materials due to its high potential for application in 2D electronics and spintronics. Even though graphene in its quasi-freestanding state is a non-magnetic material with weak spin-orbit interaction (SOC), its electronic properties can be significantly modified upon contact with the atoms of the substrate. For example, the interaction of graphene with heavy atoms can lead to an increase in SOC in graphene, which in turn makes it possible to efficiently generate spin currents based on the spin Hall effect and its quantum version [1]. On the other hand, the combination of strong spin-orbit interaction and magnetism is a necessary condition for observing the quantum anomalous Hall effect [2]. Such a combination can be realized in the magneto-spin-orbit (MSO) graphene at the Au/Co(0001) interface, which not only provides conditions for the implementation of the magnetic proximity effect and the giant Rashba effect [3], but also allows to preserve the linear nature of the dispersion of electron bands near the Fermi level and the ultrahigh mobility of charge carriers.

In this work, calculations within the framework of density functional theory (DFT) have shown the presence of ferrimagnetic order in the A and B sublattices of graphene induced by the dislocation loops in Au/Co interface [4]. Such magnetic ordering of the system along with Rashba spin–orbit coupling induced by Au, as it turned out, leads to the appearance of a band gap in the K-point of the Brillouin zone of graphene and the asymmetry of its spin texture. At the same time our tight-binding calculations indicate that graphene in such a system can exhibit non-trivial topological properties that can be used to realize the Hall effect of circular dichroism and create an infrared detector of circularly polarized radiation based on graphene [4,5].

However, it is worth noting that the MSO graphene reveal one important problem of experimental study of such systems. Due to the very small magnetic moments of carbon atoms (the presence of which, however, significantly affects the electron and spin structures of the MSO graphene), the study of the magnetic order of graphene by standard methods represents an unsolvable task. In this work by modeling the spatial and energy distribution of the electron density, it was shown that the magnetism of carbon atoms manifest itself in the data of scanning tunneling spectroscopy (STS). Modeling of STS data and its comparison with the experimental results gives us strong confidence in the induction of the ferrimagnetic state in graphene on the Au/Co(0001) substrate and makes it possible to estimate the magnitude of the energy gap in its band structure.

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