Aharonov-Bohm effect on nanoholes in thin graphite and graphene

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We studied magnetoresistance of thin graphite single crystals containing nanoholes produced by irradiation with heavy ions or by etching with focused ion beam. The diameter of nanoholes was correspondingly 24nm and 35nm. Crystal thickness has been varied from 50nm down to 1nm using soft beam-plasma etching. For samples of both types we found pronounced field periodic oscillations of magnetoresistance with periodicity corresponding to flux quantum hc/e per nanohole area independently of sample thickness [1, 2]. This kind of periodicity is expected for Dirac fermions [3]. The fact that effect does not depend on sample thickness indicates that effect is very likely related with the surface layer of graphite which is often represents as a graphene layer lying on graphite substrate [4, 5].

Normally, Aharonov-Bohm effect is observed in ring geometry samples. This geometry lets fix the quantized orbits between inner and outer boundary of the ring. In our experiment Aharonov-Bohm type effect was observed on non-ring geometry and as shown is determined by the orbits located close to the hole. We consider that the restricted orbits near the hole can exiSt due to the edge states located near graphene boundary. Otherwise, the averaging contribution of all possible orbits around hole would smear out interference effect. Existence of the edge states in graphene has been recently predicted theoretically [6]. Our observations of Aharonov-Bohm effect on nanoholes (antidots) strongly support the existence of the edge states in graphene.

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