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Aharonov-Bohm effect and broken valley-degeneracy in graphene rings PATRIK RECHER, U. Leiden, BJOERN TRAUZETTEL, U. Wuerzburg, ADAM RYCERZ, U. Jagiellonian, YAROSLAV BLANTER, TU Delft, CARLO BEENAKKER, U. Leiden, ALBERTO MORPURGO, TU Delft — We analyze theoretically the electronic properties of Aharonov-Bohm rings made of graphene. We show that the combined effect of the ring confinement and applied magnetic flux offers a controllable way to lift the orbital degeneracy originating from the two valleys, even in the absence of intervalley scattering. The phenomenon has observable consequences on the persistent current circulating around the closed graphene ring, as well as on the ring conductance. We explicitly confirm this prediction analytically for a circular ring with a smooth boundary modelled by a space-dependent mass term in the Dirac equation. This model describes rings with zero or weak intervalley scattering so that the valley isospin is a good quantum number. The tunable breaking of the valley degeneracy by the flux allows for the controlled manipulation of valley isospins. We compare our analytical model to another type of ring with strong intervalley scattering. For the latter case, we study a ring of hexagonal form with lattice-terminated zigzag edges numerically. We find for the hexagonal ring that the orbital degeneracy can still be controlled via the flux, similar to the ring with the mass confinement.

Patrik Recher
Universiteit Leiden

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