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An On/Off Berry Phase Switch in Circular Graphene Resonators

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Berry phase is an example of anholonomy, where the phase of a quantum state may not return to its original value after its parameters cycle around a closed path; instead the quantum system's wavefunction may acquire a real measurable phase difference, referred to as a Berry phase. Berry phase is connected with the geometry of the quantum system, providing a measurable signature of system topology. In this talk, I will present the spectroscopic measurements of the quasi-bound resonances, originating from Klein scattering, in circular graphene resonators comprised of $p-n$ junction rings in the presence of a perpendicular magnetic field. Our results show the sudden appearance of new resonances which is manifested by a giant energy splitting of time-reversed angular momentum states, orders of magnitude larger than orbital and Zeeman shifts, when a small critical magnetic field is reached. This behavior results from turning on a π-Berry phase associated with the topological singularities at the Dirac points in graphene. The electronic states can be switched on and off with small magnetic field changes on the order of 5 mT, producing strong modulation of quantum state energies. The ability to modulate a Berry phase in graphene resonators with energy scales in the meV range may prove useful for electro-optical applications operating at THz frequencies