Valley filtering and splitting using nanobubbles in graphene

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Abstract
Inhomogeneous deformations of a graphene lattice give rise to pseudomagnetic fields with a profound effect on the electronic and transport properties [1-3]. The pseudomagnetic fields act differently on electrons in the K and K' valleys and thereby open the possibility of generating valley-dependent effects [4-5]. In this work, we consider local deformations in form of nanobubbles, and show that the associated pseudomagnetic field leads to different real space trajectories for K and K' electrons. In one example one of the valleys is effectively backscattered, whereas the other valley is transmitted and focused after passing through the strained region. In another example the pseudomagnetic field causes the valley resolved current to split upon passing the local strain field [6].

The Patched Green's function technique [7] is used to calculate the local response of a current incident on a locally strained region embedded in an extended graphene sheet. We treat the atomistic structure through a standard tight binding model including the strain effects. In this way, we demonstrate that inhomogeneous strain fields and their associated pseudomagnetic fields can be used to manipulate the valley degree of freedom in graphene in the *absence* of either spin-orbit coupling, external magnetic fields and spatially or temporal varying gate potentials. These valley dependent effects offer new perspectives on how to utilize experimentally feasible nanobubbles in strain engineering and valleytronics applications.

References
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Figures

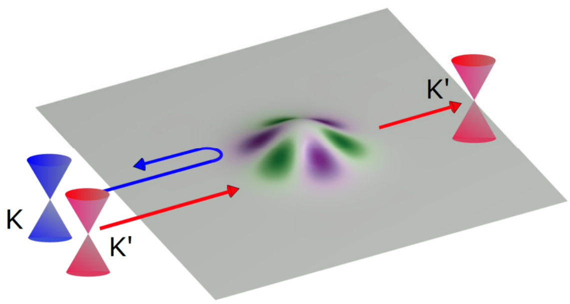

Figure 1: *Electrons in K and K' valley impinging on a graphene nanobubble with a strain induced pseudomagnetic field, as indicated by the green and purple colormap. Electrons in valley K are backscattered by the pseudomagnetic field distribution while the electrons in valley K' are transmitted.*

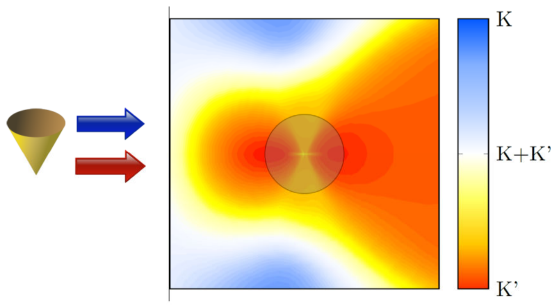

Figure 2: V*alley occupation of electrons incident from the left. The shaded area shows the bubble position. Incident current has equal components of K and K' electrons (blue and read). The current is filtered by the nanobubble such that only the K' electrons (red color) are present after passing the bubble*.