Spatial optical solitons in graphene

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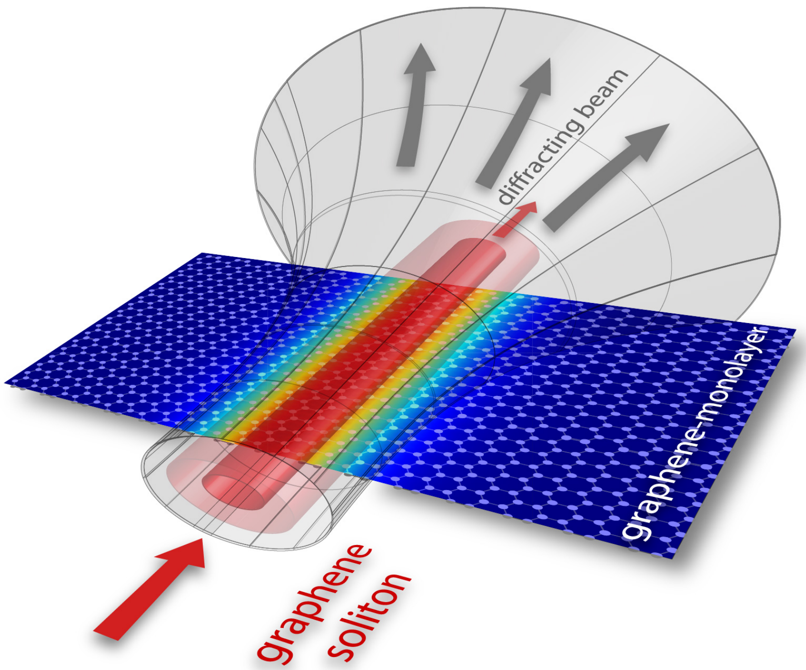
Recently, a very high nonlinear response has been theoretically predicted [1, 2] and experimentally verified [3] in monolayer graphene. In this work we show that the large intrinsic nonlinearity of graphene at optical frequencies enables the formation of quasi one-dimensional self-guided beams (spatial solitons) featuring subwavelength widths at moderate electric-field peak intensities [4]. This capability is illustrated by analyzing two arrangements leading to solitons with different polarizations: a graphene monolayer embedded into a conventional dielectric waveguide and a graphene sheet placed on top of a metal-dielectric structure. We also demonstrate a novel class of nonlinear self-confined modes resulting from the hybridization of surface plasmon polaritons with graphene optical solitons. We analyze the formation of spatial solitons and the relation between soliton width and input power, showing that the subwavelength scale can be reached by using values for the beam peak intensity below the laser-induced damage threshold of graphene. Finally, we also develop a quasi-analytical model that is able to capture the basic ingredients of the numerical results.



Schematic representation of the soliton formation by the intrinsic nonlinearity of the graphene monolayer (red cylinders). The gray surface displays the diffracting beam in the low power regime.

References

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