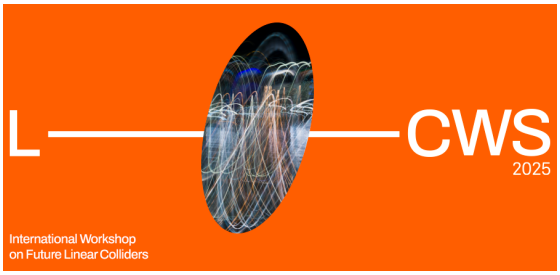

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Excitation of Wakefields in Carbon Nanotubes and Graphene Layers: Hydrodynamic Model and PIC simulations

Tuesday 21 October 2025 19:40 (1 hour)

Charged particles traveling through carbon-based nanostructures may excite electromagnetic modes (plasmonic modes) due to the collective excitation of the electron gas confined in their surfaces. This effect has recently been proposed as a potential candidate to accelerate particles with ultra-high accelerating gradients. Such plasmonic excitations can be investigated through both particle-based simulations and analytical modeling approaches. In this contribution, we firstly review the existing theory based on a linearised hydrodynamic model for a point-like charge propagating along a carbon nanotube and graphene layers. This model treats the free electron gas on the surfaces as a plasma, governed by linearized continuity and momentum equations adapted to the material's solid-state characteristics. Then, we compare the plasmonic excitations derived from the hydrodynamic model with those obtained from Particle-in-Cell (PIC) simulations. Finally, a comprehensive analysis is performed to explore the similarities, differences, and limitations of both methods. Our findings offer valuable insights into the feasibility of using carbon-based nanostructures to boost particle acceleration technologies, opening new avenues for advancements in high-energy physics and related disciplines.

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