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Solid-state plasma-based wakefield accelerators

The development of ultra-compact plasma-based particle accelerators is primarily beneficial from the ultra-high acceleration gradient, which is achieved through coherent plasma wave excitation driven by high-intensity beams, such as photon or charged particle beams. The acceleration field in plasma wave is dependent upon the plasma density. The current state-of-the-art gaseous plasma-based accelerators, for example, laser-driven wakefield accelerator (LWFA) or beam-driven wakefield accelerator (PWFA), practically work with the low-density classical plasma in the range from 1014 to 1018 cm-3. This density can, in principle, support an acceleration gradient of 1-100GV/m. To achieve a higher acceleration gradient, denser solid-state plasma is required, which, for example, naturally exists in metallic crystals. The density of charge carriers (conduction electrons) in these crystals ranges from 1020 to 1024 cm-3, which can support acceleration gradient in TV/m-level. In this talk, we will discuss recent scientific progress in generating extremely strong wakefields in solid-state plasmas, as well as the new opportunities and challenges presented by high-intensity lasers, high-energy beams, and novel crystal materials.

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