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Parametric X-ray methods use 2D heterostructures to generate compact, tunable X-ray sources FREE

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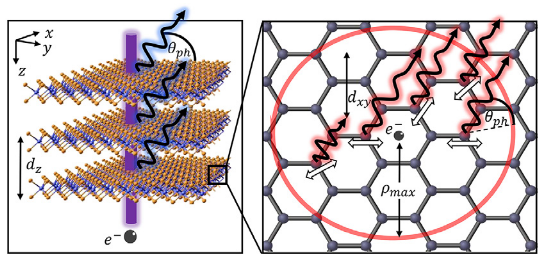
Previously unknown capabilities of parametric X-ray radiation via van der Waals materials enable control over intense, ultrashort X-ray pulses.



Tunable X-ray technology is vital to a broad range of applications, including spectroscopy, medical imaging and archaeology. However, current methods of tunable X-ray radiation are typically cost and space intensive. Balanov et al. recently reported on novel mechanisms that allow for tunable radiation at table-top scales.

Their method made use of parametric X-ray radiation (PXR), which generates radiation via the interaction of charged particles and crystals. The project was inspired by a previous experiment between free electrons and van der Waals materials, where crystalline, 2D heterostructures are present. The experiment yielded X-rays that were "more intense than originally expected," as described by author Ido Kaminer.

"In this new paper led by Amnon Balanov, we discover special properties and characteristics of the X-ray generation effect that we did not originally anticipate," Kaminer said.

Those properties include the ability to produce attosecond-scale X-ray pulses and delta-pulse trains, suggesting imaging capabilities more precise than current technology. Additionally, this method produces X-rays whose shape and polarization can be controlled by manipulating incident electron energy, material thickness, emission angle and emission frequency.

To reach these conclusions, the researchers formulated a general theory utilizing the PXR effect's electric field and Poynting vector to identify resonant angles. They then applied their theory to the case of the 2D hexagonal lattice – a structure inherent to van der Waals materials.

The researchers cite several exciting applications for their work, from reading ancient scrolls that are too delicate to unravel, to detailing ultrafast dynamics on nature's shortest timescales.

Source: "Temporal and spatial design of x-ray pulses based on free-electron-crystal interaction," by Amnon Balanov, Alexey Gorlach, and Ido Kaminer, *APL Photonics* (2021). The article can be accessed at https://doi.org/10.1063/5.0041809.

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