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Photonic crystals, graphene, and new effects in Cherenkov radiation

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Recent discoveries of new materials, combined with modern nanofabrication techniques, have revealed novel ways of manipulating and confining light on the nanoscale. These developments offer opportunities to control a variety of light-matter interactions, and in particular, manipulate radiation emission from charged particles. My talk will discuss novel phenomena that occur when charged particles interact with photons in such nanophotonic structures. These interactions can lead to novel physical phenomena including a new type of Compton scattering that can be used for compact x-ray sources, and new types of Čerenkov radiation that can potentially improve detectors for high-energy physics experiments.

In a conceptual breakthrough that is now more than 80 years old, Čerenkov showed how charged particles emit shockwaves of light when moving faster than the phase velocity of light in a medium. We predict new effects, occurring because of the quantum wave nature of a charged particle, that create unexpected deviations from the conventional Čerenkov theory. Despite the years that have passed since its discovery, and much interest in the Čerenkov effect, it remained inaccessible to most nanoscale electronic and photonic devices because of the relativistic velocities it requires. In a recent project, we have shown that a newly discovered material called graphene provides the means to overcome this limitation through the low phase velocity of light trapped on its surface. The interaction between the trapped light (called graphene plasmons) and the charge carriers flowing inside graphene presents a highly efficient 2D Čerenkov emission process, giving a versatile, tunable, and ultrafast conversion mechanism from electrical signal to photonic/plasmonic excitation.

[1] C. Luo, M. Ibanescu, S. G. Johnson, and J. D. Joannopoulos, "Cerenkov radiation in photonic crystals." Science 299, 368 (2003).

[2] V. Ginis, J. Danckaert, I. Veretennicoff, P. Tassin, "Controlling Cherenkov radiation with transformation-optical metamaterials."PRL 113, 167402 (2014).

[3] L. J. Wong, *I. Kaminer*, O. Ilic, J. D. Joannopoulos, and M. Soljačić, Toward Graphene Plasmon-Based Free-Electron IR to X-ray Sources, Nature Photonics10, 46 (2016)

[4] I. Kaminer, M. Mutzafi, A. Levy, G. Harari, H. Herzig Sheinfux, S. Skirlo, J. Nemirovsky, J. D. Joannopoulos, M. Segev, M. Soljačić, Quantum Cerenkov Radiation: Spectral Cutoffs and the Role of Spin and Orbital Angular Momentum,PRX 6, 011006 (2016).

[5] I. Kaminer, Y. Tenenbaum Katan, H. Buljan, Y. Shen, O. Ilic, J. J. Lopez, L. J. Wong, J. D. Joannopoulos, M. Soljačić, Quantum Čerenkov Effect from Hot Carriers in Graphene: An Efficient Plasmonic Source, Nature Communications, 7, 11880 (2016).

[6] N. Rivera, *I. Kaminer*, B. Zhen, J. D. Joannopoulos, and M. Soljačić, Shrinking Light to Allow Forbidden Transitions on the Atomic Scale, Science published July 15 (2016).

Registered

Yes

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