

Light from Disordered Media

Researchers have proposed that structural disorder can be harnessed to generate coherent, directional light from the passage of a charged particle.

By **Marric Stephens**

When a charged particle such as a relativistic electron passes through the interface between materials with different refractive indices, it emits so-called transition radiation. This effect is used in particle detectors, where the emission intensity depends on the velocity of the charged particle, and in light sources at particle accelerators, where relativistic electrons passing through metal foils generate THz radiation. In both applications, disorder in the target structures can degrade the coherence, the spectral purity, and the directionality of the emitted radiation. Now Zheng Gong of Zhejiang University in China and his colleagues have proposed a situation in which disorder can actually be advantageous [1].

Disordered structures are usually inimical to optical applications owing to a phenomenon called Anderson localization, which causes waves propagating through a disordered medium to become trapped. Gong and colleagues modeled this effect in stacks of alternating dielectric layers with different refractive indices. Disorder was represented by the layers' random thicknesses. The researchers considered a

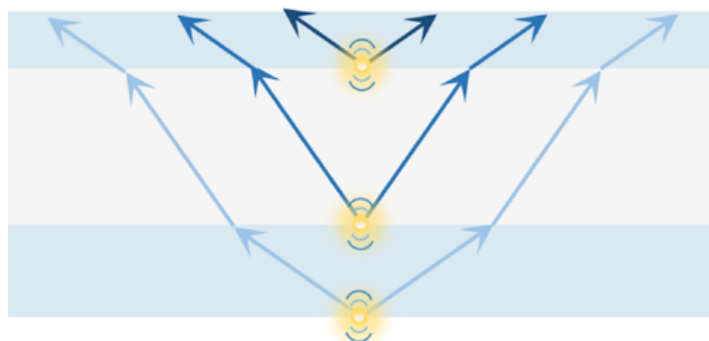
transiting electron generating transition radiation at every interface. Most of this electromagnetic radiation, which is emitted over a broad range of directions, quickly becomes trapped as the stack thickness increases. But some light escapes and propagates freely provided that it meets two criteria: It is emitted at a specific angle relative to the interface—the Brewster angle—and it is polarized in the same plane as that angle.

This “delocalized” light is coherent and has a broad spectrum with an intensity that depends on the electron’s velocity. But unlike in conventional free-electron light emitters, the electron’s velocity has no effect on the emission direction, which, at every interface, is along the surfaces of a pair of cones defined by the Brewster angle. The researchers say that these properties could enable simpler, more easily scalable platforms for broadband, directional light emission.

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REFERENCES

1. Z. Gong *et al.*, “Brewster-anomaly delocalization for free-electron radiation,” *Phys. Rev. Lett.* **137**, 186903 (2026).



Credit: Z. Gong *et al.* [1]