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Ultrafast visualization of an electric field under the Lorentz transformation

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EM field around a relativistically accelerated charged particle is known to be squeezed longitudinally, which is called Lorentz contraction. This behavior is well-believed and no inconsistent phenomena have been found so far. However, the Lorentz contraction of the EM field has not been directly confirmed by an experiment. The first direct observation of the Lorentz contraction of the EM field was recently performed by using an electron linac at Osaka University (*). The electric field around an electron beam with an energy of 35 MeV and a pulse width of 0.72 ps was measured by an electro-optical (EO) sampling method. A 1mm-thick ZnTe crystal was used for EO sampling, and the polarization of optical laser light was modulated by the electric field around the electron beam in the crystal. The modulated laser light was decoded into a spatiotemporal image of the electric field and the Lorentz contraction was directly confirmed. The evolution of the newly generated electric field after passing the beam through a metallic boundary was also visualized. This ultrafast measurement technique can help longitudinal diagnostics of a charged particle beam.

Footnotes

*: M. Ota, K. Kan, et al., Nature Physics 18, 1436-1440 (2022)

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