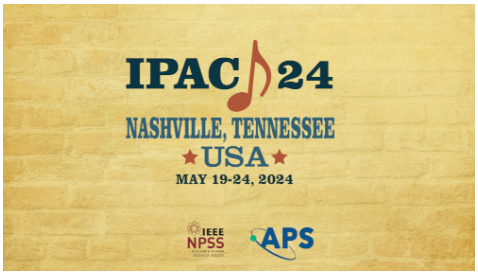

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Orbital angular momentum beams research using a free-electron laser oscillator

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Orbital angular momentum (OAM) photon beams are excellent tools for non-contact optical manipulation of matter in a broad photon energy range. A free-electron laser (FEL) oscillator is well-suited for studying OAM beams with various features including a wide spectral coverage, wavelength tunability, two-color lasing, etc. Here, we report the first experimental demonstration of superposed OAM beams from an oscillator FEL. Lasing at around 458 nm, we have generated superposed OAM beams up to the fourth order as a superposition of two pure OAM modes with opposite helicities. These generated beams have a high beam quality, a high degree of circular polarization, and high power. Using external rf modulation with frequencies from 1 to 30 Hz, we also developed a pulsed mode operation of the OAM beams with a highly reproducible temporal structure. FEL operation showcased in this work can be extended to higher photon energies, e.g. using a future x-ray FEL oscillator. The operation of such an OAM FEL also paves the way for the generation of OAM gamma-ray beams via Compton scattering.

Footnotes

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