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Laser-induced echoes: from molecular alignment to harmonics generation in free electron lasers ILYA SH. AVERBUKH, E. GERSHNABEL, Y. PRIOR, Weizmann Institute of Science, Rehovot, G. KARRAS, E. HERTZ, F. BILLARD, B. LAVOREL, O. FAUCHER, Laboratoire Interdisciplinaire CARNOT de Bourgogne, UMR 6303 CNRS-Universite de Bourgogne, Dijon, J.-M. HARTMANN, G. SIOUR, LISA, CNRS (UMR 7583), Universite Paris Est Creteil, K. LIN, P. LU, J. MA, X. GONG, Q. SONG, Q. JI, W. ZHANG, H.P. ZENG, J. WU, State Key Laboratory of Precision Spectroscopy, East China Normal University, Shanghai — Recently we predicted a novel phenomenon of molecular alignment echoes, and demonstrated it by measuring laser-induced birefringence in a thermal CO_2 gas excited by a pair of femtosecond laser pulses [PRL 114, 153601 (2015)]. Here we report a new effect of fractional echoes observed in the same system via the third harmonic generation from a probe pulse [PRA 94, 033404 (2016)]. Moreover, using the technique of coincidence Coulomb explosion imaging (COLTRIMS) for the direct spatiotemporal analysis of molecular angular distribution, we observed a gamut of novel types of echoes, including fractional echoes of high order, spatially rotated echoes, and the counter-intuitive imaginary echoes at negative times [PRX 6, 041056 (2016)]. Remarkably, a phenomenon similar to fractional echoes of high order lies behind the recent demonstration of the efficient generation of high harmonics in free-electron lasers [Nat. Photonics 10, 512 (2016)].

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