Poincaré engineering of the nanofemto topology of surface plasmon polariton fields

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We perform ultrafast photoelectron emission microscopy of topological surface plasmon polariton fields. Evanescent fields at interfaces, such as surface plasmon polaritons are chiral. By illuminating coupling structures rendered lithographically in silver films to define the geometrical charge with optical fields carrying designed polarization, we generate surface plasmon polariton wave packets with orbital angular momentum. As surface plasmon polariton wave packets propagate in space and time towards a focus, they undergo spin-orbit interaction to generate topologically nontrivial spin textures, which break the time-reversal symmetry on the excitation pulse 20 fs duration time, and nanometer spatial scales. By Poincaré engineering, we generate plasmonic fields with half-integer and integer topological charge that carry magnetic monopole spin textures homotopic to meron and Skyrmion-like magnetic quasiparticles, as well as their arrays. We record nanofemto movies by photoemission electron microscopy of the evolving surface plasmon fields by imaging the nonlinear two-photon photoemission that they excite from silver. The artificial intelligence optical flow analysis method reveals their spin textures on <40 nm spatial and <20 fs temporal scales. The Poincaré engineering of plasmonic fields provides the means for nanofemto manipulation of qubits in quantum computing.