Supplementary Information

Spatio-Temporal Weak Measurement of Chiral Ultra Short Laser Pulse

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(Dated: August 13, 2025)

I. RETARDATION IN A PULSE VS. A CONTINUOUS WAVE

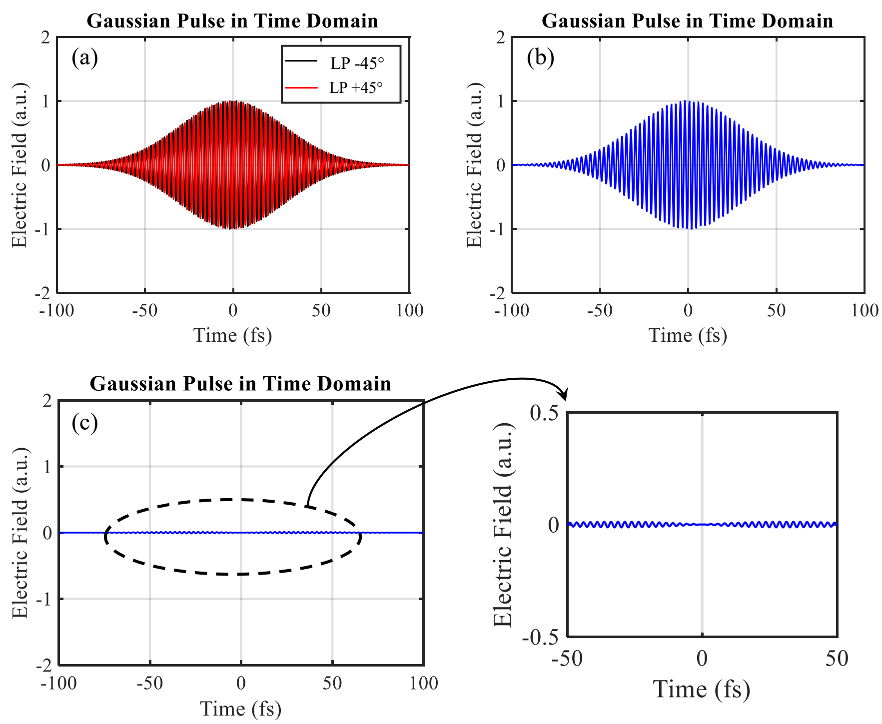

FIG. 1. (a) Directly calculated pulse shape after the transmission through a HWP at 45°. The initial vertical polarization splits into the polarization components at ±45°, marked with a red and a blue color. (b) An amplitude profile of the pulse calculated as the sum of the linear states. (c) A residual y polarization state after subtraction of the dominant x polarization. We used real values for the time duration and the central frequency of the pulse.

Figure 1 visualizes the effect of the weak measurement in time for a short laser pulse. We have used the real values of the laser pulse duration time and the central frequency to calculate the pulse shape after the retardation by a HWP at ±45°. In Fig.1a the retarded linear polarization components are shown together (in blue and red color). When

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summing up their amplitudes a Gaussian pulse exhibits mainly a linear polarization perpendicular to the incident one (see Fig.1b). Nevertheless, when removing this dominant component, one can recognize a minute signal in the orthogonal state (shown in Fig. 1c. Clearly, this appears to be a feature of time-limited laser pulse.

The illustration of the retardation effect on a CW beam is presented in Fig. refCWa. The $+45°$ and the $-45°$ linear components are retarded from each other by exactly a half of the period which results in a rotated linear polarization. The beam state does not experience any time variation, therefore there is no expected difference between the cases of the HWP rotated at $45°$ and $-45°$. We perform a test experiment with a CW laser at the same wavelength of $\lambda_0 = 785nm$ and present the results in Fig.2b. As predicted, no angular or spatial misalignment have been found for the studied cases.

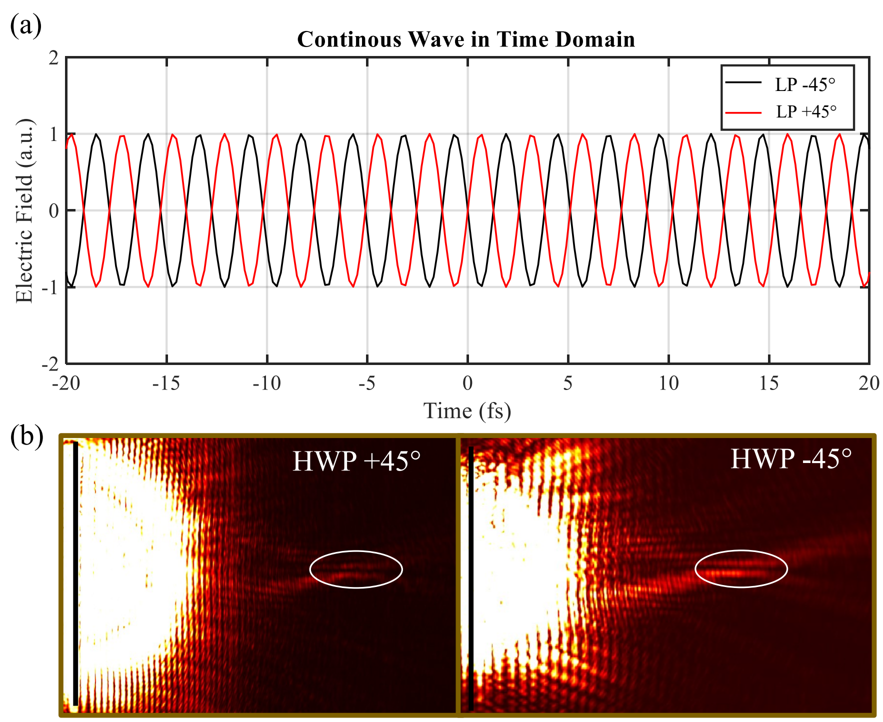

FIG. 2. In (a) CW for the LP $+45°$ and $-45°$ are very symmetric, (b) Weak measurement for the HWP $-45°$ and $+45°$ results for the two spots.

II. MEASUREMENT SCHEME FOR CIRCULAR BIREFRINGENCE AND Q-PLATE

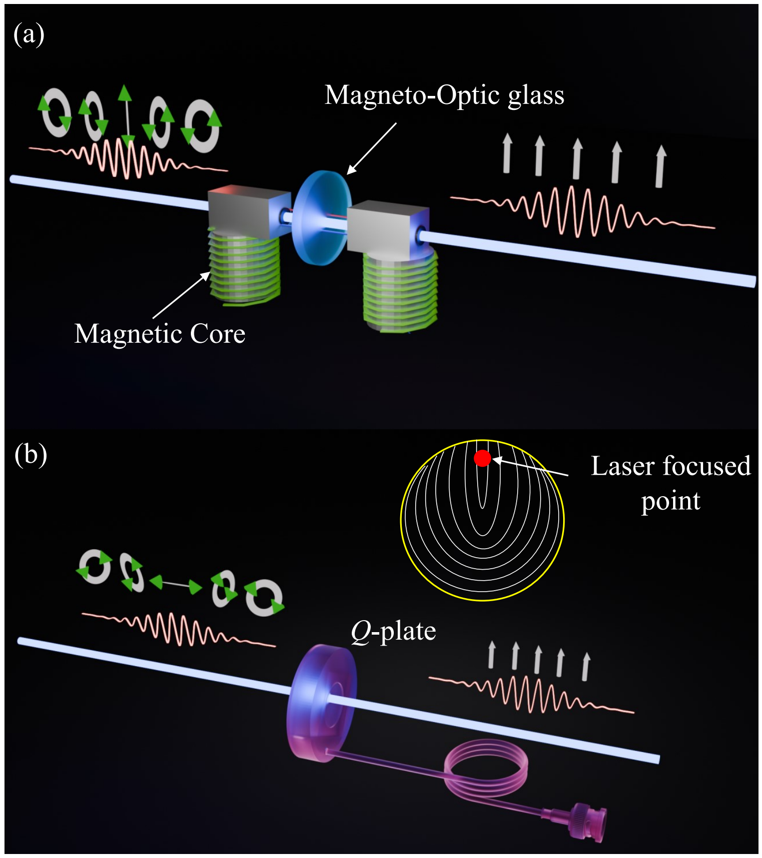

FIG. 3. (a) In the schematic setup, when the pulse passes through the MO glass, it generates a circular birefringence, leading to a variation in the susceptibility χ throughout the pulse. (b) When the pulse then passes through the Q-plate, simultaneous rotation of linear polarization and changes in the ellipticity of the polarization are observed.

To generate circular birefringence, we used MO glass MR3-2 subjected to a 300 mT external magnetic field, applied using a coil and a funnel that directs the magnetic field along the pulse path (see Fig. 3a). As the pulse passes through the MO glass, it experiences circular birefringence, which introduces ellipticity. To simultaneously generate both linear polarization rotation and ellipticity, we used a Q-plate (spiral plate, ARCoptix, Switzerland), as shown in Fig. 3b. This optical element is designed to generate a radial polarization. Accordingly it comprises of a liquid crystal molecules aligned with their primary axis rotating along the azimuthal angle (see inset in Fig. 3b). In the experiment the unexpanded laser beam ($\sim 2mm$ in diameter) passed through a upmost spot in the Q-plate (see inset in Fig. 3b).