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### Optimal Control of Multiphoton Ionization Processes in $I_2$ Molecules with Time-Dependent Polarization Pulses

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**Abstract:** We have developed a closed-loop pulse shaping system with a spatial light modulator, where even a time-dependent polarization pulse can be generated and controlled. An outline of the developed pulse shaping system is described. We apply the developed pulse shaping system to the active control of multiphoton ionization processes in aligned  $I_2$  molecules. We perform two kinds of control experiments. First, we show the ability to selectively produce specific multiply-charged molecular ions. Second, we investigate a correlation between a femtosecond time-dependent polarization pulse and the production efficiency of evenly- or oddly-charged molecular ions. We achieve much better controllability of the correlation with a time-dependent polarization pulse than with a pulse having a fixed ellipticity. The results suggest the existence of an unknown tunnel ionization mechanism which is characteristic of an elliptically polarized pulse. Our experiments point to new directions in optimal control studies with molecular systems.

**Key Words:** [Optimal control](#), [Genetic algorithm](#), [Time-dependent polarization pulse](#), [Multiphoton ionization](#), [Alignment of molecules](#)

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