Alchemy as an optical problem: Theory and Experiments

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Using tracking quantum control, we theoretically unveiled an unexplored flexibility of nonlinear optics that a shaped laser pulse can drive a quantum system to emit light as if it were an arbitrary different system [1, 2]. This realizes an aspect of the alchemist's dream to make different elements *look alike*, albeit for the duration of a laser pulse. We will show how this unexplored flexibility of nonlinear optics opens new venues of investigation that include ultrafast artificial intelligence [3], chemical mixture characterization, and broadband epsilon-near zero (ENZ) materials with infinite phase velocity of light. Based on these theoretical insights, recent experimental results will be presented, showing how water can be transformed into alcohol and how ENZ materials can be dynamically created [5].

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