基于二阶级联非线性的超短脉冲群速度控制

Group velocity control of ultrashort pulses based on quadratic cascading nonlinearity

超短脉冲的群速度可以通过位相失配的二阶级联非线性过程来调制。我们分析了基于全光和电光两种方法在掺镁铌酸锂晶体中对飞秒脉冲的调控现象，实现超短脉冲的群速度通过调节外加的泵浦光场或者沿着晶体z向的外加电场的强度来有效控制。同时，我们在超宽的可延迟波长带宽内实现了远超自身入射脉冲宽度的延迟量，并且，在晶体中的入射脉冲的演化过程呈类孤子态的传输。

Group velocity of ultrashort pulse can be controlled by quadratic nonlinear interactions under phase mismatch. We propose and analyze all optical or electrical method to control the group velocity of femtosecond pulse in MgO doped periodically poled lithium niobate crystal (MgO:PPLN). The group velocity of an ultrafast pulse can be tuned by either the input pump pulse or the applied external electric field along the z-axis of the crystal. Group velocity of tunable signal pulse can be controlled within a wide bandwidth with large fractional delay. The evolution of the input pulse behaves like quadratic slow light solitons.

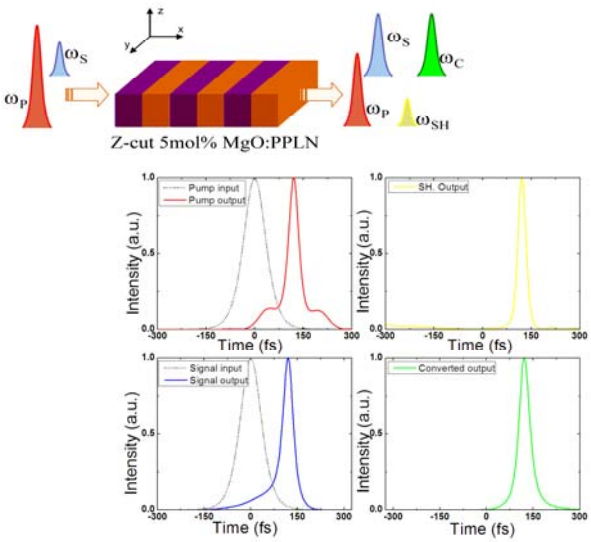

Figure 1 | Normalized pulse intensity of the interaction pulses. Dotted line (solid line) represents the input (output) pulse intensity.
图1 | 归一化的脉冲时域波形

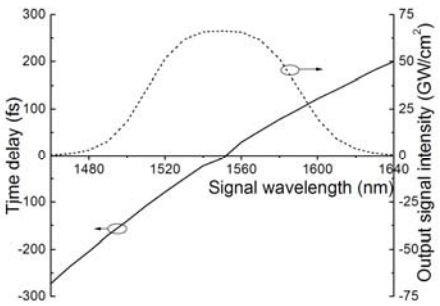

Figure 2 | Time delay and output signal intensity as a function of input signal wavelength.
图2 | 可延迟的波长带宽

Group velocity of tunable signal pulse can be controlled by another pump beam within a wide bandwidth of 180nm.

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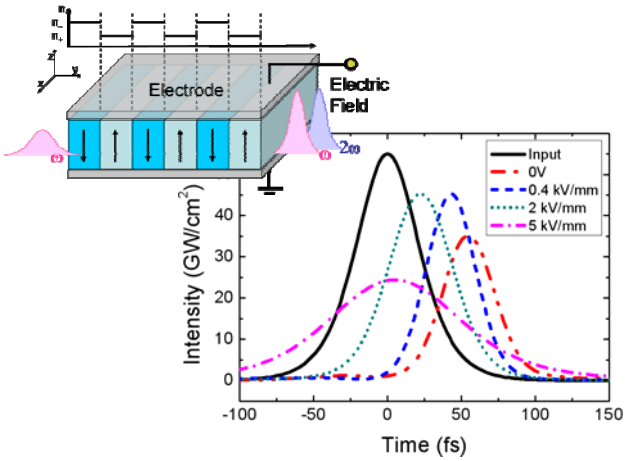

Figure 3 | Intensity profiles of the input and output pulses with different applied electric fields.
图3 | 不同外加电场下的出射脉冲

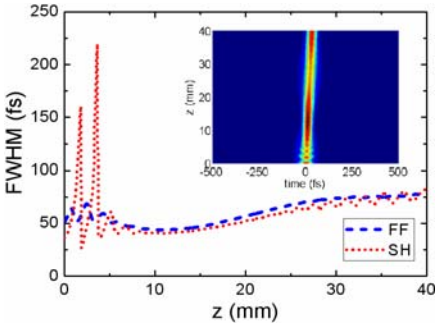

Figure 4 | Evolution of the pulse duration for the FF and SH pulses inside the MgO:PPLN crystal.
图4 | 脉冲在晶体中的演化

The evolution of the input pulse in a quasi-phase matching (QPM) grating behaves like quadratic slow light solitons, whose group delay can be tuned by changing the applied external electric field along the z-axis of the crystal.

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先进光子学材料和物理实验室
Laboratory of Advanced Photonic Materials and Physics