Simple Techonolgy to Freely Manipulating Nonlinear Optical Frequency Conversion Processes

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Nonlinear optical processes are strongly governed by phase relationships among the relevant electronmagnetic fields. Typical examples for manipulating phase relationships are phase-matching and quasi phase matching technologies.

We proposed the idea that phase relationships among the relevant electromagnetics fields could be manipulated arbitrarily in nonlinear optical frequency conversion process[1]. It can be easily implemented using glass plates inserted into nonlinear media[Figure1]. It is a simple but powerful technology to manipulate nonlinear optical frequency conversion process. We call it freely designable nonlinear optical frequency conversion.

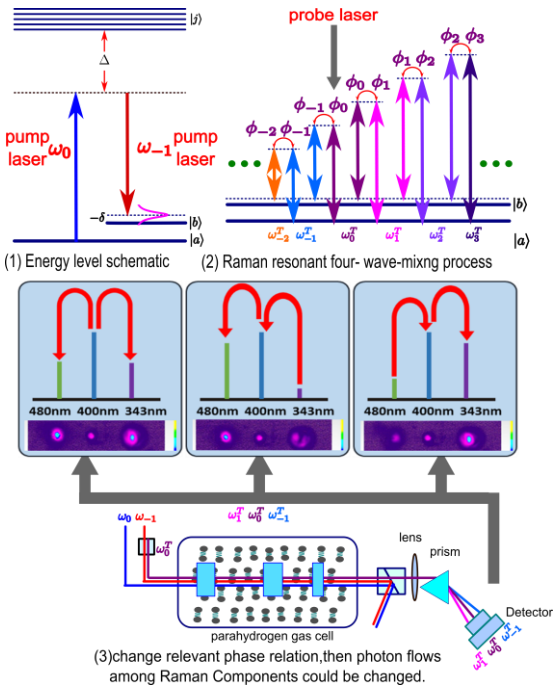

Figure1. schematic of principle and experimental setup

We firstly applied the technology to a Raman-resonant four-wave-mixing process in parahydrogen gas medium experimentally. Coherence established by using two incident electricmagnetic fields(ω_0,ω_{-1}) interacting with parahydrogen gas medium with frequency difference of the two incident fields nearly equal to vibrational energy diffrence of parahydrogen molecule. The coherent molecules perform as modulator, to modulate an additional incident field(ω^T_0) to generate its discrete frequency equidistant radiations($\omega^T_{\pm1}$, $\omega^T_{\pm2}$, ⋯). Utilizing freely designable nonlinear optical frequency conversion technology, the energy of additional incident field(ω^T_0) could be gathered at its first Stokes ω^T_{-1} or its first anti-Stokes ω^T_1 at will [2].

The manipulating among higher order Stokers or anti-Stokes is also believed to be feasible. With this technology, it is expected that tunable single frequency pulsed laser throughout the vacuum-ultraviolet range could be generated in future.

[1] Zheng, J., & Katsuragawa, M. (2015). Freely designable optical frequency conversion in Raman-resonant four-wave-mixing process. Scientific reports, 5, 8874.

[2] Ohae, C., Zheng, J., Ito, K., Suzuki, M., Minoshima, K., & Katsuragawa, M. (2018). Tailored Raman-resonant four-wave-mixing processes. Optics Express, 26(2), 1452-1460.