

# Doublet degenerate four-wave mixing and frequency conversion

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In this paper, we extend quadruple degenerate four-wave mixing into doublet degenerate four-wave mixing so that frequency-conversion reconstructed waves which are phase conjugation of incident object waves can be obtained. Using this method 5320 Å object waves have been converted into reconstructed waves of another frequency 6300 Å. Furthermore, 1.06 μm infrared images have been converted into 5320 Å visible image. By using a medium which is a resonant absorber for infrared object wave but transparent for visible reconstruction wave, third-order nonlinear susceptibility can be resonantly enhanced so that nonlinear coupling efficiency has been increased. Using ~5 mj pumping pulse from a Q-switched (and frequency doubled) Nd: YAG laser, for a medium of 10<sup>-3</sup> mole organic dye 9740 in dichloroethane solution, conversion efficiency of 25% was achieved with 5 mm interaction length. Theoretical analysis of the doublet degenerate four-wave mixing shows that the conversion efficiency may be much higher than 1. The scheme of infrared-to-visible image conversion has the advantages of real-time, fast response, high efficiency, phase compensation and, in principle, appropriate to any wavelength.

## 二重简并的四波混频和频率转换

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本文把四重简并的四波混频推广到二重简并的情况,这样就可以获得入射物波的频率转换的位相复共轭再现波。用这种方法,我们已经把 5320 埃物波转换到另一频率为 6300 埃的再现波,进而实现了 1.06 微米红外象到 5320 埃可见象的红外象转换,使用对红外物波共振吸收而对可见再现波是透明的介质,可以使三阶非线性极化率共振增强,而使非线性耦合效率提高。使用 Nd<sup>3+</sup>:YAG 调 Q 倍频激光,用 ~5 毫焦耳的泵浦脉冲,在克分子浓度为 10<sup>-3</sup> 克分子的 9740 有机染料二氯乙烷溶液中,作用区长度为 5 毫米时,转换效率已达 25%。二重简并四波混频的理论分析表明,转换效率可以远大于 1。这种红外象转换的优点在于:实时、快响应、高效率,并具有位相补偿特性,在原则上适用于任何波长。