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Self-focusing and self-defocusing of fs laser light in rubidium vapor

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We studied the emission from dense rubidium vapor under 100-fs pulsed laser excitation in the 730 – 820 nm range. Self-focusing along with conical emission (CE) was observed for the excitation in the blue wing of D2 atomic resonance. This effect was earlier observed for fs-pulsed excitation in Cs_2 molecules [1]. For the far blue-wing excitation, the CE consists of a bright ring without central spot. The magnitude of the cone angle as a function of detuning from the resonance obeys $\sim\Delta^{-1.5}$ dependence (Δ being frequency detuning from the resonance) which is in accordance with the theory of self-focusing [2]. The evidence of self-focusing along with the spectral broadening leads to the conclusion that the self-phase modulation generates observed phenomena.

Self-defocusing occured for the red-wing excitation. When the laser wavelength is tuned at two-photon allowed transition at 778 nm, $5s_{1/2} \rightarrow 5d_{3/2}$, the output pattern shrinks into a small spot whose wavelength is around 762 nm. This can be explained by two-photon resonantly enhanced FWM.

References:
[1] D. Aumiler, T. Ban, and G. Pichler, Phys. Rev. A **71**, 063803 (2005).
[2] R. W. Boyd, *Nonlinear Optics, 2nd edition* (Academic Press, San Diego, 2003).