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Conical emission from rubidium vapor pumped by fs laser

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An intense, near-resonant laser field can significantly modify the absorption and emission spectra of an atomic system. When a blue-detuned, intense, near-resonance laser beam propagates through the atomic vapor, a diffuse ring of light may be observed around the central laser spot in a far field. This phenomenon has been referred in the literature as conical emission (CE).

The effect was originally observed in potassium vapor [1] and has been the subject of intense theoretical and experimental investigation ever since. CE was observed both in resonant and nonresonant media, using pulsed nanosecond [2] and cw [3] lasers. Sarkisyan et. al. reported the observation of potassium atomic vapor CE produced by 2-ps laser pulses [4]. Recently, we reported about first experimental observation of CE based on a Cs_2 molecular resonance using a femtosecond laser [5]. Continuous wave (cw) and pulsed nanosecond (ns) conical emission was also observed in sodium [6], barium [7], calcium [8] and strontium vapor [9]. Picosecond (ps) and femtosecond (fs) conical emission was observed in glasses [10].

As physical phenomenon of strong field interaction with nonlinear medium, conical emission involves a whole range of classical nonlinear-optical effects, such as self-focusing,self-phase modulation, supercontinuum generation, four–wave mixing, stimulated Raman scattering, multiphoton ionization and many others, which add up together to produce emission in the form of a cone of broad spectra.

In the present work we report about the observation of CE in rubidium vapor induced by ~10 nJ, 100-fs laser pulses. The CE was observed when the central laser wavelength was in the 740-840 nm interval which covers Rb D2 and D1 resonance lines.

The self-focusing of the laser beam, spatial and spectral characteristics of the observed CE, cone angle dependence on the laser wavelength are described. The temporal characteristics of the laser pulses propagated through the Rb vapor is given using the cross-correlation technique with SHG crystal. Several physical mechanisms that could lead to the CE are discussed.

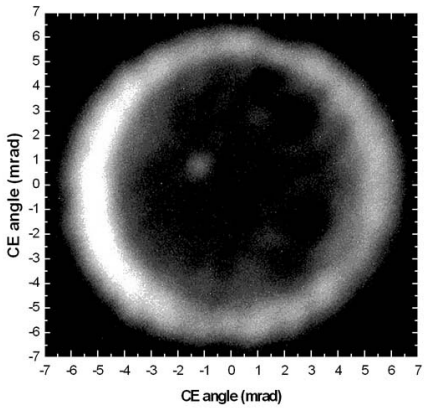

Figure 1. Picture of conical emission in alkalii vapor

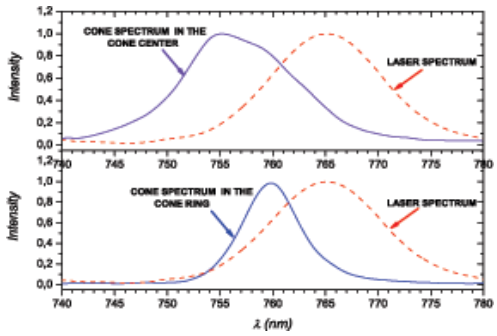

Figure 2. Blue shifted spectra of conical emission in Rb vapor

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