Laser-like spiking emission from continuous-wave excited alkali vapors

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We present an experimental study of temporal properties of the directional frequency up- and down-converted radiation emitted from hot alkali vapors excited to the lower D levels by resonant laser light [1, 2]. We find that despite cw laser excitation, both the infrared (IR) radiation generated on population-inverted transitions as well as the ultra-violet (UV) light produced by four-wave mixing consist of chaotic, partially overlapping spikes. It appears that the relative intensity noise of the generated optical fields is much larger than the noise of the applied laser light. The typical duration of isolated spikes is noticeably shorter than the natural lifetime of the corresponding energy levels. Also, directional IR and UV radiation reveal a high level of intensity correlation. We show that the observed stochastic behaviour is due to the quantum-mechanical nature of the cooperative effects rather than random fluctuation of the applied laser fields. The study of the temporal dynamics of stimulated directional radiation is critical for its possible applications in remote detection.

[1] A. M. Akulshin,N. Rahaman, S. A. Suslov, D. Budker, and R. J. McLean, Spiking dynamics of frequency upconverted field generated in continuous-wave excited rubidium vapors, JOSA B 37, 2430-2436 (2020).
[2] Alexander Akulshin, Felipe Pedreros Bustos, Dmitry Budker, Intensity-correlated spiking infrared and ultraviolet emission from sodium vapors, arXiv.org/abs/2101.06904v2.