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Detecting fluorescence emission in beta-barium borate crystals

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Nowadays, β-Barium borate (BBO) crystals are widely exploited to generate second-order nonlinear interactions due to their high values of birefringence and nonlinearity and to the wide transparency range (from 0.198 to 2.6 micron). In particular, BBO crystals are used to implement the spontaneous parametric down conversion (SPDC) process, which generates entangled optical states, namely the twin-beam (TWB) states, to be used in Quantum Information applications.

As in general the SPDC is obtained in the linear gain regime either at single-photon level or in the mesoscopic photon-number domain, to optimally select the TWB states it is important to prevent the simultaneous detection of spurious light.

Actually, during some experiments recently performed both in Como (Italy) and in Olomouc (Czech Republic), we revealed the presence of fluorescence when either an ultraviolet or blue pump beam was used as the pump of the dowconversion process.

To characterize such a fluorescent emission, we used different wavelengths to excite the medium. In particular, we employed the third (at 349 nm) and the fourth (at 262 nm) harmonics of a pulsed Nd:YLF laser and the light coming from a pulsed OPA at 280 nm. We also observed the same phenomenon by using the light emitted by a diode laser at 404 nm.

The spectrum emitted by different BBO crystals was observed in different configuration geometries by means of a spectrometer. In all cases, we noticed that at small wavelength values the spectrum is influenced by the exciting wavelength, whereas it presents a peak around 525 nm and ends at 700 nm for all the excitation wavelengths.

To be sure about the nature of this light emission, we also estimated its lifetime by exploiting a time-of-flight detection apparatus endowed with a state-of-art temporal resolution (30 ps).

The experiment was performed by exploiting the third harmonics (at 355 nm) of a pulsed Nd:VAN laser (5 ps time duration). The fluorescent decay has a lifetime of about 2 ns, in accordance with the typical values expected for fluorescence.

Finally, we investigated the conditions under which the fluorescence can be detrimental in Quantum Optics experiments: by changing the polarization of the pump beam impinging on a BBO crystal, we monitored the ratio between the intensities detected in TWB and in the fluorescence. We conclude that, in all the cases in which the SPDC gain is in the linear gain regime, it is better to select the TWB outside the fluorescence spectrum, otherwise it must be taken into account as possible source of spurious light.