3.9 Photorefractive Two-wave Mixing with Gaussian Beams

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In recent years, photorefractive (PR) crystals such as $KNbO_3$, $Sr_xBa_{1-x}Nb_2O_6$ (SBN) and $BaTiO_3$ have been investigated for a wide range of applications such as optical phase-conjugation and four wave mixing. Due to practical reasons and in order to speed up the PR response, Gaussian beams are widely used in experiments. Any attempt to assess PR gain and time constants using focused and confined beams will require careful interpretation.

The most commonly used theory for analysing two-wave mixing (TWM) measurements is the extended coupled wave theory of Kogelnik, although it treats the case of uniform plane waves only. Because plane wave theory fails to explain TWM measurements with Gaussian beams, we developed a straightforward and fast numerical method for the simulation of PR TWM with arbitrary-profile beams. By using this model that takes the lateral intensity distribution of the two beams into account we have demonstrated that the gain and the time response for TWM of Gaussian beams differ considerably from plane wave theory. Therefore, numerical simulations are clearly required for the analysis of experimental results on TWM of focused Gaussian beams or arbitrary-profile beams in photorefractive waveguides and bulk crystals.