2.6 Origin of the Lobe Structure in Photorefractive Beam Fanning

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A laser beam passing through a photorefractive medium spreads into a filamenting fan of light that arises from stimulated scattering. This beam fanning is seen on the one hand as an impediment to practical applications of photorefractive materials such as holographic storage, yet on the other hand it is the progenitor of such remarkable phenomena as self-pumped and mutual phase conjugation. Beam fanning is a hallmark of photorefractive nonlinearity whose qualitative physics is well understood: It consists of amplification of low-intensity spatially broad band light scattering by the primary beam as they both propagate through the medium. The far-field fanning pattern in $BaTiO_3$ crystal has a very enigmatic structure, which, for many years, failed to be understood with standard models of photorefractive interactions. It is a three-lobed structure consisting of a central lobe in the positive direction of the crystal *c* axis and two symmetric side petals making angles of about 55^o with the central one. We have shown that this enigmatic fanning structure reflects the nature of the elasto-optic and piezoelectric tensors as well as the electro-optic tensor and dielectric tensor of the material, giving a further evidence that the previously overseen mechanical consequences of the photorefractive space-charge field are substantial.