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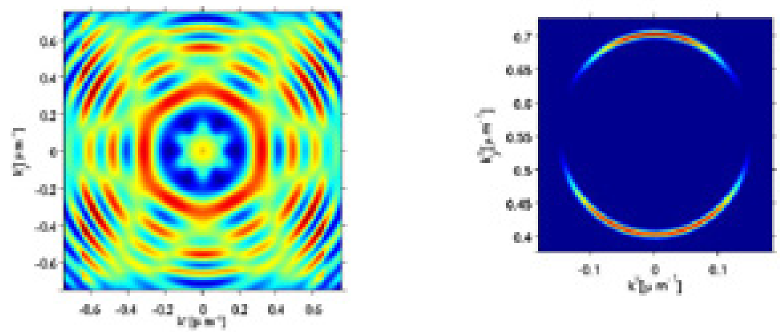
Nonlinear crystallography with structured light: Classical and quantum optics effects

Rocio Jáuregui
Universidad National Autonomy de México, México

An alternative to diffraction techniques is the characterization of the point symmetry group of a crystal by its effects on the nonlinear optical response encoded in the susceptibility tensors. In this work, we show that it is possible to perform complementary symmetry studies of nonlinear materials by using nonlinear processes besides second harmonic generation. We also show that structured light can enhance the tracks of the symmetry of a crystal on its nonlinear optical properties. We focus on the usage of light beams that can be described as the superposition of plane waves with wave vectors confined in a cone and with cylindrical symmetry on the angular spectrum (Bessel beams). This is equivalent to observing the crystal simultaneously from many different angles. The polarization structure of these beams out of the paraxial regime allows to incorporate information from all the components of the susceptibility tensors using a single structured illumination beam. The crystallographic analysis is exemplified for the parametric down conversion process. It is shown that, for an uniaxial birefringent nonlinear crystals, a proper orientation of a non paraxial Bessel beam induces the emission of photon pairs in directions that reflect directly the point symmetry. Both the flux rate of signal photons (with a clear classical analog) and coincidence detections (with a pure quantum interpretation) exhibit traces of the crystal symmetries.



(i)Angular dependence of the flux rate of signal photons; and maximal flux rate of idler photons detections in coincidence with a signal photon for type I spontaneous parametric down conversion of GaSe illuminated by a Bessel pump beam with an axicon angle of 0.097.

Biography

Rocío Jáuregui performed her graduate and postgraduate studies at the Universidad Nacional Autónoma de México. (UNAM). She has worked on the interaction of light and matter from diverse points of view: high precision atomic spectroscopy, effects of boundary conditions on the electromagnetic field, pair creation and modification on atomic transition rates due to moving boundaries, classical and quantum description of structured electromagnetic fields and their effect on thermal and ultracold atomic samples, simulations of ultracold bosonic and fermionic atoms, and the analysis of quantum nonlinear optical response of different media. Her work has been supplemented by teaching activities. Nowadays, Prof. Jáuregui coordinates the Laboratorio Nacional de Materia Cuántica which incorporates 11 Mexican research institutions and chairs the Department of Quantum Physics and Fotonics of Instituto de Física (UNAM).

rocio@fisica.unam.mx

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