01a

Director de tesis: Dra. Laura Elena Casandra Rosales Zárate

Sinodales:

Dr. Joel Briones Hernández
(Sinodal Interno, Secretario)

Dr. Roberto Ramírez Alarcón
(Sinodal Interno, Vocal)

Dra. Laura Elena Casandra Rosales Zárate
(Directora de Tesis, Presidenta del Jurado)

Tesis: **"THEORETICAL STUDY OF THE GENERATION OF THREE ENTANGLED AND STEERABLE OPTICAL MODES BY A THIRD-ORDER NONLINEAR INTERACTION"**

Resumen:

The emergent quantum technologies have awoken a great scientific interest and effort to manipulate quantum systems. For these systems, quantum correlations are one of the characteristics on which emergent quantum technologies are based. It has been observed that in order to generate quantum correlations, as entanglement or EPR steering, non-linear optical devices are very useful. Even more, lately, generation of multipartite entanglement has become an important field of study for new applications on quantum protocols. One of the proposals to generate a genuine tripartite entangled state is to use a third-order nonlinear optical interaction. In this thesis we investigate three Hamiltonians for non-linear processes as third harmonic generation, spontaneous parametric down conversion, sum and difference of frequencies generation of third order. The Hamiltonians under consideration are composed of one high-frequency mode ($b\hat{}$) and low-frequency modes ($a\hat{}_i$). The difference between these three Hamiltonians is the freedom for the low-frequency modes to be strictly equals (one annihilation operator $a\hat{}\hat{}3$) or might be different ($a\hat{}_1\hat{}2\ a\hat{}_2$ or $a\hat{}_1\ a\hat{}_2\ a\hat{}_3$). In order to study these Hamiltonians and their capability to produce multipartite entanglement, we will use phase-space techniques and the theory of stochastic processes. Throughout this thesis, we will explain the mathematical framework of both theories and how they are connected. To certify entanglement and steering we use what are known as witnesses. Thus, we identify in which cases bipartite and multipartite entanglement are present. Finally, we found that bipartite entanglement and steering are always achieved for all the Hamiltonians under study. However, only in the case of or $a\hat{}_1\ a\hat{}_2\ a\hat{}_3$we found is possible to generate a tripartite steerable state in the three low-frequency modes and even more a four-modes entangled multicolored state.