Project summary

In the recent years, quantum continuous variables (QCV) have emerged as a tool of major importance for developing novel quantum communication and information processing protocols. Encoding quantum continuous information into the quadrature of a quantized light mode or into the collective spin variable of a mesoscopic atomic ensemble has proven to be a very interesting alternative to the standard concept of quantum bit-based processes. Several experimental breakthroughs have been achieved recently demonstrating this concept, namely the quantum teleportation of a coherent state, the generation of entangled light beams with soliton pulses in nonlinear fibers, the preparation of distant entangled atomic ensembles, or the implementation of a quantum key distribution scheme relying on coherent states. In view of these spectacular results, many developments of QCV information systems can be foreseen.The present project aims at initiating an exploratory research on new quantum informational concepts involving continuous variables, both on the theoretical and experimental sides. It departs from the “traditional” approaches of quantum computing in that we do not address the “scalability” of some potential technology for quantum information processing which is not yet applicable. Instead, we start from a concept that has already been proven very successful in the laboratory. The topics which we plan to cover include improved or novel quantum communication protocols, quantum memories and quantum repeaters based on the light-atoms quantum interface, and the generation of squeezed or entangled solitonic light beams based on various nonlinearities in fibers. The role of non-Gaussian states of light will also be investigated in order to make new QCV informational processes possible. Another focus of this project will be the study of the fundamental physics governing the off-resonant interaction of light with an atomic ensemble.