QuICHE
Quantum Information and Communication with High-Dimensional Encoding

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on behalf of

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Call 2019
PROJECT PROGRESS (highlights)

Main achievements:

• **High-dimensional witnesses and entanglement verification.**
  Construction of a new Schmidt-number witness requiring fewer measurements than other existing witnesses for fidelity evaluation.

• **High-dimensional Quantum Key Distribution.**
  Analytical and numerical results for asymptotic secret key rates in high dimensions, showing that a slight dimension enhancement (i.e. $d = 3$) significantly improves the asymptotic secret key rate and the error tolerance.

• **Quantum temporal imaging.**
  Development of theory of noiseless compression and stretching of temporal waveforms carrying high-dimensional quantum encoding
  
  ➢ transformation of quantum intensity correlations of light, observed by direct photodetection, by a single-lens temporal imaging scheme
  ➢ proof that such an imaging scheme performs noiseless stretching or contraction of the second-order intensity correlation function without deteriorating its nonclassical features: antibunching and sub-Poissonian statistics of the photons.
Main achievements:

- **Storage and retrieval of different temporal modes.**
  Experimental demonstration of storage & retrieval of a number of different temporal modes from a quantum memory, observing that the memory works as a single-temporal-mode filter – by using different temporal mode pulses for the control field – and that the memory can be used for bandwidth compression.

- **Multi-output quantum pulse gate**
  Development and realization of a multi output quantum pulse gate (mQPG), which serves as a decoder for high-dimensional QKD. The device is compatible with single-photon level inputs at telecommunication wavelengths and can features five outputs. A complete detector tomography reveals intrinsic fidelities in excess of 95%.

- **Single-photon detection**
  Achievement of single-photon detection with compatible spectral and temporal resolutions, where both the temporal envelope and spectral power density of an optical pulse can be experimentally probed.
IMPACT (RRI aspects)

**GENDER:** particular attention to gender balance (50% female PIs and 33% project contracts)

**SCIENCE EDUCATION:** promotion & involvement in activities for spreading QT concepts & education to high school students and teachers (e.g. European Quantum Week)

**PUBLIC ENGAGEMENT:** Active collaboration between theoretical and experimental physicists.
Active widening country involvement in the project.
Focus on real-world applications (QKD and q. networks).
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