Towards decoherence studies in optical microfibers

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The discussions of the fundamental status of quantum mechanics have largely been centred around the Einstein-Podolsky-Rosen (EPR) paradox and the Schrödinger cat paradox [1]. Causality and non-locality, the main topics of the Bohr-Einstein dispute, were considered at time by most a philosophical topic. However, since Bell published the famous inequalities, and Aspect subjected these to experimental tests, it was clear that the collected experimental evidence definitely shifted focus, both on the importance in terms of quantum mechanics, as on the concept of entanglement.

On the other side, this final link to solve the Schrödinger cat paradox is not yet available. The quantum measurement problem, including both the wavefunction collapse vs. decoherence dispute, as well as the unambiguous identification of a quantum-to-classical threshold, consists, and it has to be taken for granted that the further collection of experimental evidence will be fundamental if any broader consensus concerning this question is to be achieved. Towards a proper clarification of this question, recent advancements of both experimentalist [2] as theorist [3] have significantly contributed.

The purpose of this paper is to share with the audience a concept that could eventually lead to decoherence studies with entangled photons. It is foreseen to be integrated and executed within an experimental setup that produces entangled photons obtained by parametric down conversion in two adjacent thin BBO crystals. We will discuss the experiments of the twin photon pairs propagating inside tapered optical micro- and nanofibers. The manufactured tapered fibers, obtained by the flame-brushing technique, offer the possibility to engineer precisely the local fiber radius length scale, associated to the transverse confinement of the photons. Hence, coupling and effective propagation constants can be adequately engineered, for example into interferometric structures [4]. It will be discussed in how far this measurement architecture could be employed, in principle, to study the decoherence issue.

[1]A. J. Leggett, *Science* **307**, 871 (2005).

[2]A. D. O'Connell et.al., *Nature* **464**, 697 (2010).

[3]S. L. Adler et.al. *Science **325**, 275 (2009).*

[4]M. Niehus et.al., *Proc. SPIE* **7727**, 194 (2010).