

Fiber-Optic Quantum Communications and Information Processing

IEEE Photonics Society Distinguished Lecture

By Dr. Prem Kumar

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Abstract

There are significant efforts underway to develop practical resources for quantum communications and information processing in optical fiber networks. Entanglement, which refers to the nonclassical dependency of physically separated quantum systems, is one such resource that is essential for implementing many of the novel functions of quantum information processing. Entanglement has been historically produced by use of the spontaneous parametric down-conversion process in second-order nonlinear crystals, wherein one higher-frequency pump photon splits into two lower-frequency daughter photons which can be entangled. Coupling such down-converted photons into optical fibers without degrading entanglement, however, has remained a challenging task. Fortunately, the prospects have dramatically improved in the last few years by the emergence of a new technique that utilizes the Kerr nonlinearity of standard optical fiber to produce quantum correlated photons through the spontaneous four-wave mixing process. The correlated photons can be entangled in various ways by incorporating indistinguishable pathways in the four-wave mixing amplitude. In this lecture, the status of this field will be reviewed by describing recent experiments that demonstrate the generation and distribution of quantum entanglement in wave-division multiplexed optical fiber systems. Some recent results on utilizing such entanglement for quantum communications and information processing tasks are also presented.

Biography

Dr. Prem Kumar is the AT&T Professor of Information Technology in the department of Electrical Engineering and Computer Science and Director of the Center for Photonic Communication and Computing in the McCormick School of Engineering and Applied Science at Northwestern University. He is a fellow of the Optical Society of America (OSA), a fellow of the American Physical Society (APS), a fellow of the Institute of Electrical and Electronic Engineers (IEEE), and a fellow of the Institute of Physics, UK (IoP).

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