Institute Lecture

Ultrafast Processing of Photonic Entanglement: Technologies and Potential Applications

Prem Kumar, AT&T Professor of Information Technology
Director, Center for Photonic Communication and Computing,
Northwestern University, USA

Friday, 14th September 2012, Time: 6.00 PM, Venue: L-1, Lecture Hall Complex

Abstract

Many new techniques have emerged over the last decade for generating entangled photons at wavelengths relevant for quantum optical communications, in free space or in optical fiber. One technique that produces entangled photons directly in the fiber itself has dramatically improved the prospects for quantum applications in optical fiber networks. This technique utilizes the Kerr nonlinearity of optical fiber to produce quantum correlated photons through the spontaneous four-wave mixing process. The correlated photons can then be entangled in various ways by incorporating indistinguishable pathways in the four-wave mixing amplitude. The same Kerr nonlinearity also lends itself to ultrafast switching and routing of entangled photons with minimal loss and signal-band noise, and—most importantly—without disturbing the photons' quantum state. Modules exhibiting 10ps switching window and <1dB loss can be fabricated with commercial off-the-shelf components. Because such switches couple the temporal and spatial degrees of freedom, they provide an important new tool with which to encode multiple-qubit states in a single photon. As a proof-of-principle demonstration of this capability, we recently utilized the switch to perform a controlled-bit-flip operation on a two-qubit subspace of a two-photon, five-qubit system, where a temporally encoded qubit was used as the control and a spatially encoded qubit was used as the target. In this talk I will focus on the development of resources for efficiently implementing quantum optical communications over the standard telecom infrastructure. I will conclude by presenting some near-term challenges and the potential for applications of this quantum technology.

About the speaker

Prof. Prem Kumar did his MSc from IIT Kanpur in 1976 and Ph. D from State University of New York at Buffalo, NY in 1980. His research interests are Quantum fiber optics—generation and distribution of quantum entanglement over the fiber channel and quantum cryptography over fiber lines; Optical communications—novel optical amplifiers and devices for terabit/s communications; Nonlinear and quantum optics—applications of novel quantum states of light such as squeezed and twin-beams states in precision measurement and imaging systems. Prof. Kumar has edited a book, has 5 patents, and has published a large number of papers in leading journals and conferences.

Prof. Kumar has received several recognitions viz. Martin E. and Gertrude G. Walder Research Excellence Award by Northwestern University; International Quantum Communications Award by Tamagawa University, Japan. He is a Fellow of SPIE; AAAS, IEEE, Institute of Physics U.K., APS, OSA. Prof. Kumar was IEEE Photonics Society Distinguished Lecturer in 2008-09 and 2009-10. He is also the founder and managing partner of NuCrypt LLC.

Tea at 5.45 PM **All interested are welcome.**

A. K. Chaturvedi
Dean of Research and Development
IIT Kanpur