Minimum energy per bit in high bit rate optical communications and quantum communications

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Abstract
Optical direct detection usually operates far above the quantum limit, thanks to high thermal noise level of PIN photodiodes. For signal energy at the quantum level, the thermal effects in photon counters are also a strong limitation. The optical amplification or the heterodyne detection of the 2 quadratures of the field, widely used in high bit rate and long haul optical systems, overcome this limitation at the expense of a minimum 3db noise figure. By allowing a noise free mixing gain, as well as single quadrature measurements, the balanced homodyne receiver is allowed to reach quantum noise limited operation. The aim of this paper is to review the different quantum receiver implementations and to compare the minimum signal energy required to achieve a given bit error rate, or a given bit erasure rate, in high bit rate communication and quantum communication. Application to quantum cryptography will be also addressed.

Résumé
Philippe Gallion, is Professor at Télécom ParisTech, formerly Ecole Nationale Supérieure des Télécommunications, where he was the Communications and Electronics Department Chairman from 1988 to 2000. Philippe Gallion is also lecturing at the University Pierre and Marie Curie (ParisVI) as well as at various French and foreign universities. He carries out research at the Laboratory for Communication and Information Processing (LTCI), joint Télécom ParisTech research unit with the French Centre National de la Recherche Scientifique. Author of over 125 international technical publications and over 130 papers and lectures at conferences, including many invited one. Philippe Gallion is a Member of the Optical Society of America and a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE). He is the Chairman of the French Chapter of the IEEE Photonics Society Optics Society.