Prof. dr hab. Konrad Banaszek
Centre of New Technologies
University of Warsaw
ul. Banacha 2c
02-097 Warszawa
Poland
*Tel:* +48 22 55 43 750
*E-mail:* k.banaszek@cent.uw.edu.pl

Warsaw, 27th February 2017 r.

**Prof. RNDr. Ivo Frebort, CSc., Ph.D.**
**Dean, Faculty of Science**
**Palacky University Olomouc**
**17. listopadu 1192/12**
**771 46 Olomouc**
**Czech Republic**

It gives me a great pleasure to provide a recommendation letter for doc. Mgr. Jaromír Fiurášek, Ph.D. in relation to his application for the academic title of Full Professor. Jaromír has an outstanding research record in the area of quantum optics and quantum information science, documented by over 130 scientific publications in refereed international journals. Although his expertise mainly grows out from theoretical physics, Jaromír is a very highly valued collaborator in experimental projects, which is documented by many high-impact publications with experimental groups, both in Olomouc and abroad. Some of his earlier works have become standard references, collecting hundreds of citations. He continues to be a very active researcher, having published seven papers in 2016 alone. As his scientific interests cover a wide range of topics, I would like in the following to concentrate on selected highlights to illustrate the breadth of his efforts and the significance of obtained results.

The field of quantum information science started with an observation that preparing, processing, and measuring superpositions of logical states opens up new modes of information processing and communication, with the prominent example of quantum key distribution. Early works utilised mainly coherent two-level systems named qubits, which could be viewed as a generalisation of classical binary variables, i.e. bits. However, it was realised that quantum mechanical systems described by continuous variables (CV) provide more possibilities for quantum information processing and communication. Such variables are ubiquitous in the optical domain, for example a quadrature for a single mode of an electromagnetic field or the position in the case of an individual photon. Despite these appealing features, CV systems pose much greater theoretical challenges. While qubits are described by two-dimensional state vectors and operations on them (unitary transformations or quantum channels) can be represented by finite matrices, CV systems require the mathematical apparatus of infinite-dimensional Hilbert spaces. Important classes of states and operations admit a simplified description (e.g. using vectors of means and covariance matrices in the Gaussian case), but calculation and analysis of important quantum information quantities remains a non-trivial matter.

Jaromír has made a number of important contributions to the science of CV quantum information processing, in both theory as well as experimental proposals, data analysis and interpretation. One prominent example is the experimental demonstration of a quantum memory for light [B. Julsgaard *et* al., Nature **432**, 482 (2004)], where it was necessary to identify the classical limit for a realistic storage procedure and convincingly exhibit superior performance of the scheme based on an experimentally realised quantum memory. Another project, pursued by Jaromír on his own [J. Fiurášek, Phys. Rev. Lett. **89**, 137904 (2002)] presented limitations on the capability of Gaussian transformations to distill CV entanglement from a single copy of bipartite Gaussian state under the usual paradigm of local operations of classical communication, exposing also certain more general properties of Gaussian distillation protocols. Further, an interesting application of CV systems was a proposal for testing Bell's inequalities using homodyne measurements [R. García-Patrón *et al*, Phys. Rev. Lett. **93**, 130409 (2004)], which offer higher detection efficiencies than single-photon detectors, despite continuous technological progress in that area. The three articles mentioned here collected hundreds of citations, which is a clear evidence for the importance of the obtained results.

In parallel, Jaromír has been pursuing other problems in the area of quantum optics and quantum information. A prominent example from the same period of early 2000s is a widely cited single-author paper on conditional generation of multiphoton entangled states of light [J. Fiurášek, Phys. Rev. A **65**, 053818 (2002)]. The basic idea was to use a restricted set of primitives (single photon sources, linear optical elements, photon counters) to prepare in a conditional manner arbitrary superpositions of $N$ photon states distributed between two optical modes. Such states are required in many prospective quantum technology applications, such as quantum lithography, metrology, etc. Quantum information processing based on linear optics features strongly also in more recent projects realised by Jaromír, e.g. on optimal entanglement-assisted discrimination of quantum measurements [M. Miková *et al.*, Phys. Rev. A **90**, 022317 (2014)], tomographic characterisation of a linear optical quantum Toffoli gate [M. Micuda *et al.*, Phys. Rev. A **92**, 032312 (2015)], and experimental replication of single-qubit quantum phase gates [M. Micuda *et al.*, Phys. Rev. A **93**, 052318 (2016)]. These three papers illustrate a very fruitful collaboration with experimentalists based in Olomouc. Another interesting line of research follows the theme of CV systems, also pursuing experimental projects in collaboration with the group of Roman Schnabel based in Hannover/Hamburg. A recent highlight is efficient entanglement distillation without quantum memories [D. Abdelkhalek *et al.*, Nat. Commun. **7**, 11720 (2016)], which avoids the trap of exponentially vanishing efficiency for iterative distillation protocols. These activities are continuously carried out in parallel with theoretical projects, e.g. the analysis of CV quantum process tomography with squeezed state probes [J. Fiurášek, Phys. Rev. A **92**, 022101 (2015)].

The examples given above demonstrate that Jaromír has been able to make numerous important contributions to the field of quantum optics and quantum information that attract a lot of interest from the international scientific community. He continuous to be a very active researcher, looking for novel topics as well as initiating and pursuing new collaborations. What I personally find particularly noteworthy, is his ability to collaborate with experimental groups, which means leaving the typical theoretical “comfort zone” of standard elementary models and making an effort to understand operation of actual experiments as well as to identify opportunities for demonstrating interesting physical phenomena in a laboratory.

Overall, I am thoroughly convinced that the research record of Jaromír Fiurášek warrants the award of the academic title of Full Professor. His scientific results are truly world-class and over the years they have made an impact on the scientific field of quantum optics and quantum information at large.