Quantum jumps: from quantum optics to bits and pieces

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The analysis of photo detection signals defined the field of quantum optics in the early 1960'es and stimulated efforts to describe the quantum properties and evolution of quantum light sources. The ability to control single quantum systems and apply special superposition and entangled states of light and matter then led to the so-called ''second quantum revolution'' with potential for a range of applications and technologies. In the lecture, I shall discuss how the study of the simple elementary processes in modern quantum experiments have demanded the development of new theory. In particular, I shall discuss quantum measurements, and their description by quantum jumps and stochastic wave functions, which are integral part of today's analyses of experiments with atoms and with superconducting quantum devices. I shall finally discuss how hybrid quantum systems with atoms and solid state devices can be effectively coupled by optics, microwave or surface acoustic waves, and how this also raises demands for the development of new elementary quantum mechanics tools and formalism. Throughout the lecture, I shall call attention to how the new methods and results illuminate and challenge our interpretation(s) of quantum mechanics – a topic that will be further developed in the afternoon colloquium.