Invited Paper

Super-resolution from single-photon emission: toward biological application

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ABSTRACT

Properties of quantum light represent a tool for overcoming limits of classical optics. Several experiments have demonstrated this advantage ranging from quantum enhanced imaging to quantum illumination. In this work, experimental demonstration of quantum-enhanced resolution in confocal fluorescence microscopy will be presented. This is achieved by exploiting the non-classical photon statistics of fluorescence emission of single nitrogen-vacancy (NV) color centers in diamond. By developing a general model of super-resolution based on the direct sampling of the kth-order autocorrelation function of the photoluminescence signal, we show the possibility to resolve, in principle, arbitrarily close emitting centers. Finally, possible applications of NV-based fluorescent nanodiamonds in biosensing and future developments will be presented.

Keywords: Super-resolution, quantum imaging

1. INTRODUCTION

In recent years, quantum light has proven to be an extraordinary resource to realize enhanced measurements[1,2] beating the classical limits in several applications such as interferometry,[3,4] biological particle tracking,[5] phase contrast microscopy,[6] quantum imaging[7,8] and quantum illumination.[9] Very recently it has been suggested that photon anti-bunching can allow surpassing the diffraction limit in wide-field microscopy.[10,11] Here we present some possible application of color centers in diamond for imaging and bio-sensing purposes. The work is structured in two parts: in Sec. 2 we will describe the super-resolved imaging of Nitrogen-Vacancy (NV) centers in diamond (surpassing Abbe's diffraction limit)[12] obtained exploiting single-photon-sensitive confocal microscopy and experimental sampling of the generalized k^{th}-order Glauber function; In Sec. 3, we will show preliminary studies on the feasibility of bio-sensing protocols based on magnetometric properties NV centers in fluorescent nanodiamonds.

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