Contribution ID: **34**

Type: **Plenary Lecture**

Quantum imaging with X-rays

Monday, 12 September 2022 14:30 (1 hour)

Quantum optics has been very fruitful and led to many seminal achievements in fostering quantum technologies in a variety of fields including imaging and spectroscopy [1]. However, the focus of quantum optics is on the optical range of the electromagnetic spectrum. The extension of concepts of quantum optics into the x-ray range can lead to remarkable applications with enhanced performances with respect to the present methodologies that are used in x-rays science and technology [2]. Recently, the properties of the strong time-energy correlations of photons produced by the process of spontaneous parametric down conversion (SPDC) have been extended to the x-ray regime to demonstrate the ability to improve the visibility and the SNR of an image with a small number of photons in an environment with a noise level that is higher than the signal by many orders of magnitude [3]. Another quantum imaging modality called ghost imaging has been reported as well [4]. More recently, the observation of the interaction of a single photon with a beam splitter has been observed [5] and extension of other quantum effects such as the Hong-Ou-Mandel effect to sub-attosecond sub-Angstrom optical path metrology with x-rays have been proposed [6]. Ghost imaging with SPDC of x-rays into visible radiation has been discussed for the high-resolution imaging [7]. Thereby, opening the possibility for future application of x-ray imaging and phase sensing applications with low radiation dose.
In my talk I will review the recent progress toward quantum x-ray imaging and discuss the potential advantages of using quantum technologies for x-ray sensing.

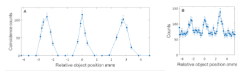

Figure 1:

Figure 1. Example for x-ray quantum imaging: Reconstruction of the image of the triple slit object by (A) quantum enhanced x-ray detection. (B) Classical imaging of the same object for comparison. In each of the panels the horizontal axis represents the relative position of the object and the vertical axis represents the number of events that are detected.

[1] S. Mukamel et al. "Roadmap on quantum light spectroscopy", J. Phys. B: At. Mol. Opt. Phys. 53, 072002 (2020)
[2] R. Röhlsberger, J. Evers, and S. Shwartz, Quantum and nonlinear optics with hard x-rays, in Synchrotron Light Sources and Free-Electron Lasers: Accelerator Physics, Instrumentation and Science Applications, edited by E. J. Jaeschke, S. Khan, J.R. Schneider, and J.B. Hastings (Springer International Publishing Cham 2020), pp. 1399–1431, https://doi.org/10.1007/978-3-030-23201- 6_32.
[3] S. Sofer, E. Strizhevsky, A. Schori, K. Tamasaku, and S. Shwartz, "Quantum enhanced x-ray detection", Physical Review X, 9, 031033 (2019).
[4] A. Schori et al. "Ghost imaging with paired x-ray photons", Physical Review A ,97 , 063804 (2018).
[5] A. Schori and S. Shwartz "X-ray ghost imaging with a laboratory source", Optics Express, 25,
14822 (2017)
[6] E. Strizhevsky, D. Borodin, A. Schori , S. Francoual , R. Röhlsberger , and S. Shwartz, "Efficient Interaction of Heralded X-Ray Photons with a Beam Splitter " Physical Review Letters 127, 013603

Primary author: Prof. SHWARTZ, Sharon (Physics Department and Institute of Nanotechnology, Bar Ilan University, Ramat Gan)

Presenter: Prof. SHWARTZ, Sharon (Physics Department and Institute of Nanotechnology, Bar Ilan University, Ramat Gan)

Session Classification: Plenary