ADVANCED QUANTUM OPTICS

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Contents

Advanced quantum optics will take on from the compulsory first term Quantum Optics subject, and apply the fundamentals learnt there to more specific applications. In this regard, this subject will focus more on the experimental aspects of quantum optics. Half of the subject (2 credits) will be of classroom lectures, revisiting a number of legacy experiments and learning the history of their lab implementations, difficulties, achieved feats, et cetera. The second half (2 credits), will be lab practices of some of the learnt experiments using quTools company's quED (QUantum Entanglement Demonstrator) machine, Thorlabs' Quantum Optics Educational Kit, and Kwan-Tek's KWANTEACH machine.

List of topics covered in the theoretical part:

- Experimental Aspects of Interferometry. Single-photon Michelson interferometer (wave nature of the light), double Michelson interferometer, Hong-Ou-Mandel 2-photon interference, Franson Interference.

- Measurements and Entanglement. Violation of Bell's inequality, Quantum Zeno effect, measurement of central wavelength, measurement of coherence length, interaction-free measurements.

- Quantum Tomography. Tomographic state reconstruction, single photon and entangled photon states, methods and application.

- Hanbury-Brown & Twiss. Particle nature of photons, wave-particle dualism (Michelson+HBT), HOM+HBT

- Experimental Aspects of Quantum Cryptography. Quantum key distribution, quantum random number generation, BB84 protocol, BBM92 protocol, Eckert protocol

List of potential experiments:

- Characterization of entanglement and quantum correlations using photon pairs

- Photon indistinguishability and Hong-Ou-Mandel interferometry

- Single-photon Michelson Interferometer

- Hanbury-Brown & Twiss effect

- BB84 cryptographic protocol

- Hands on optics: laser alignment and Mach-Zender and Michelson interferometry

- Time-resolved absorption spectroscopy
- Grangier-Roger-Aspect experiment with a with a fluorescent light source and a BBO pair source
- Hanbury-Brown & Twiss experiment with a strongly attenuated laser

Bibliography

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List of journal references to be found in moodle

Assessment

Assessment by continuous evaluation through **lab reports of the experimental part, and an individual work of the theoretical part**