

The interaction of swift electrons with matter is used to study and image the structure of materials in the field of electron microscopy and diffraction. One particular form of this interaction is the emission of a photon due to the coupling of the electron's electromagnetic field with the polarization of the material in its vicinity, a phenomenon called cathodoluminescence. Recent theoretical works predict that it might be possible to observe the optical coherence imprinted upon the electron wavefunction by modulation through optical fields in the coherence properties of the emitted photons. In this thesis, we extend the theoretical formalism currently used to study this effect in order to gain a deeper understanding by studying different regimes of optical modulation of the electron beam. In the first chapter of this thesis, we discuss important aspects of electron-matter interaction arising from classical electrodynamics, and in the second chapter, we systematically construct a quantum electrodynamic formalism for studying the statistical properties of emitted photons. By using simple numerical simulations, we then visualize the expected dependence of their degree of coherence on relevant physical parameters based on derived analytical results.