

Review
of the thesis of
Elina Nestorova
on
Tree Level Processes in Quantum Electrodynamics with a Dark
Sector Extension

The bachelor's thesis of Elina Nestorova focuses on calculating the differential cross-section for Møller scattering (electron-electron scattering). The cross-section is computed by deriving the Quantum Electrodynamics (QED) Lagrangian and the corresponding Feynman rules. This result is then compared with numerical calculations obtained from the CalcHEP software package. Finally, the differential cross-section is calculated for the case of a dark photon exchange while varying its mass and coupling strength.

The thesis is written in English and spans across 33 pages. It contains 9 figures and 15 references, including 2 textbooks. The work consists of 10 chapters, preceded by an abstract. This thesis can serve as a useful practical handbook and a comprehensive guide for bachelor's and master's students learning to calculate lepton-lepton scattering processes.

Overall, the text is well-written, and the reader can easily follow the logic of the steps described in the calculations. There are very few stylistic mistakes, such as a missing reference to Figure 4 on page 20. Regarding the technical part, I have a remark that all calculations were performed in the system of natural units without being explicitly mentioned in the text. Concerning Figure 9 and the comparison of the cross-section for different dark photon masses, the difference would be better visualized if the graphs were not on a logarithmic scale. These minor remarks in no way diminish the value of the presented work.

Regarding the thesis, I have the following questions for the candidate:

- Could the author clarify why this hypothetical particle is called a dark photon if it possesses a non-zero mass?
- When considering electron on positron ($e^+e^- \rightarrow e^+e^-$) scattering, will the tree-level contributions to the processes be identical to those in electron on electron ($e^-e^- \rightarrow e^-e^-$) scattering?
- What is the underlying physical motivation for choosing an incoming electron energy of 550 MeV and a dark photon mass of 17 MeV?

In conclusion, the candidate has exceeded the academic requirements for a bachelor work. I highly recommend evaluating this thesis with the highest possible mark.

Sofia, Bulgaria
17/07/2026

Signature:.....
/Svetoslav Ivanov, PhD/