Contribution ID: **20** Type: **Contributed Oral**

Spin and polarization-dependent Osiris QED module for the future strong field QED laser-plasma experiment

Tuesday, 8 November 2022 14:30 (20 minutes)

With the rapid development of high-power petawatt class lasers worldwide, exploring the physics in the strong field QED regime will become one of the frontiers for laser-plasma interaction research. Particle-in-cell codes including quantum emission processes are powerful tools for predicting and analyzing future experiments, where the physics of relativistic plasma is strongly affected by strong-field QED processes. Here, we present the development of a full spin and polarization-included QED module based on the particle-in-cell code OSIRIS. In this module, the dynamics of the lepton's spin involve both the classical spin precession process described by the classical T-BMT equation and the quantum radiation reaction-induced spin transition process. The photon polarization-resolved quantum radiation rate allows us to assign the polarization state for each generated photon in the simulation. We also consider the influence of the lepton spin and pho-ton polarization on the Non-linear Breit-Wheeler pair production process calculation. Compared with state-of-the-art, most common spin/polarization averaged QED modules, this full spin/polarization distinguished quantum module is able to more accurately simulate multi-staged processes like avalanche and shower type electron-positron pair production cascade processes. We also use this module to explore possible routines for generating polarized gamma-ray and lepton bunch through laser-plasma interaction.

Acknowledgments

This work is supported by the NSF (Award No. 2108075)

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Session Classification: WGs 2+7 Joint Session

Track Classification: Working Group Parallel Sessions: WG2 Oral: Computation for Accelerator Physics