New developments in the OSIRIS simulation framework

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The OSIRIS [1] Electromagnetic particle-in-cell (EM-PIC) code is widely used in the numerical modeling of many kinetic plasma laboratory and astrophysical scenarios. In this work, we report on the new developments recently introduced into the framework. In particular, we address the implementation of new particle pushers and field solvers, that improve the accuracy of the PIC algorithm, especially for high field/high momenta situations and studying the evolution of particle spin, and also to deal with curvilinear coordinate systems. We report on our progress on our linear (particle-particle) Compton scattering and nuclear fusion modules, as well as improved boundary conditions for overdense plasmas. We present the new code features in terms of diagnostics, such as OpenPMD support, pressure tensor, and photon diagnostics for QED scenarios. Furthermore, we describe new features implemented in the Quasi-3D geometry, in particular the inclusion of QED effects, external EM fields and exotic laser beams. We also focus on the developments done in the General relativity module for modeling neutron star and black hole magnetospheres including strong gravitational fields. Finally, we present our recent work on dynamic load balance with enhanced shared-memory parallelization via tiles, and the application of this algorithm to our novel GPU implementations.

References

[1] R. A. Fonseca et al., Lecture Notes in Computer Science **2331**, 342-351 (2002)