Source code documentation of APPM

Roman Fuchs

November 27, 2019

Contents

Todo list

APPM: asymptotic preserving plasma model.

1 Introduction

Aim of the code: show the feasibility of a plasma model that is based on the Maxwell Grid Equations (see Finite Integration Technique) for electromagnetism and the Navier-Stokes equations for the fluid.

Maxwell equations:

$$\partial_t \vec{B} + \nabla \times \vec{E} = 0 \tag{1a}$$

$$\partial_t \vec{D} - \nabla \times \vec{H} = -\vec{J} \tag{1b}$$

$$\nabla \cdot B = 0 \tag{1c}$$

$$\nabla \cdot D = \rho \tag{1d}$$

(ρ: space charge density)

$$\vec{D} = \varepsilon \vec{E} \tag{1e}$$

$$\vec{B} = \frac{1}{\mu} \vec{H} \tag{1f}$$

2 Mesh construction

Why a primal and dual mesh?

2.1 Primal mesh

How it is defined.

2.2 Dual mesh

How it is defined.

3 Data output

The data is visualized in ParaView[1] using XDMF[2] for data description and HDF5[3] for the heavy data.

Remark: instead of ParaView, one could also use VisIT for visualization. However, it does not support polygonal cells.

3.1 Mesh

Definition of cells and faces as given in the XDMF format.

For each face: facetype + list of vertex indices. Except for a polygon: facetype + number of vertices + list of vertex indices.

For each cell: celltype + list of vertex indices. Except for a polyhedral: celltype + number of faces + description of each face.

3.2 Data

4 Testcases

4.1 Uniform current, determine magnetic fields

Define current density in z-direction, at radius $r < r_0$.

[1] version 5.6.0, 64-bit
[2] `xdmf.org/index.php/XDMF_Model_and_Format`, version 3.
[3] version 1.10, 64-bit

5 TODO

Leapfrog scheme

Raviart-Thomas interpolation of magnetic flux B