Maxwell equations applied to Mie scattering theory

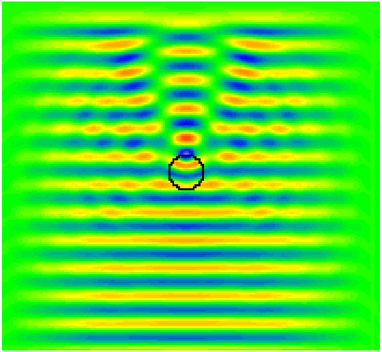
GONIN Alexis

University of Strasbourg

22th of August

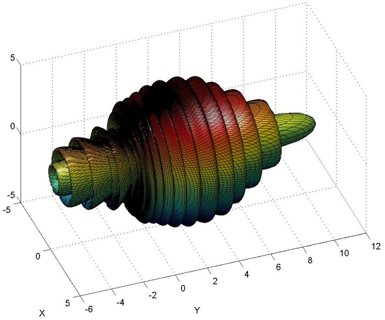
Objectives

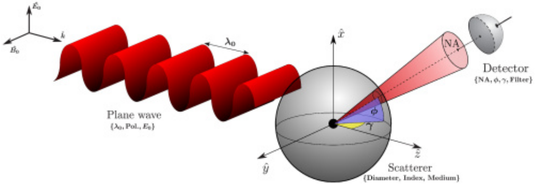
- Create a simple model to simulate Maxwell's equations in the context of Mie scattering theory.



Mie scattering theory

- Light scattering theory





Model Description

- Mathematical Equations
- Boundary Condition
- Mesh
- Initial Condition

Mathematical Equations

- Two dimensionnal system of equations

$$(1) : \mu_r \frac{\partial H_x}{\partial t} = -\frac{\partial E_z}{\partial y}$$

$$(2) : \mu_r \frac{\partial H_y}{\partial t} = \frac{\partial E_z}{\partial x}$$

$$(3) : \epsilon_r \frac{\partial E_z}{\partial t} = \frac{\partial H_y}{\partial x} - \frac{\partial H_x}{\partial y}$$

CFPDE

- Feel++ CFPDE toolbox
- $$d\frac{\partial u}{\partial t} + \nabla \cdot (-c\nabla u - \alpha u + \gamma) + \beta \cdot \nabla u + au = f \text{ dans } \Omega$$

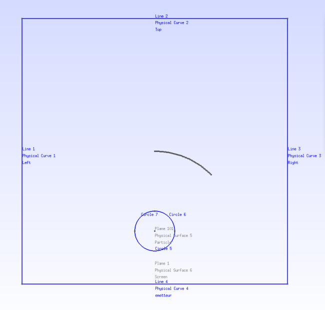
1. $d = \mu_r ; \gamma = (0, E_z)$
2. $d = \mu_r ; \gamma = (-E_z, 0)$
3. $d = \epsilon_r ; \gamma = (-H_y, H_x)$

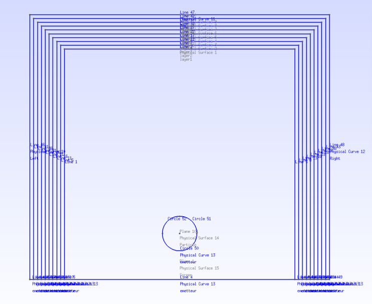
Boundary Condition

- $H \wedge n = 0$ and $\langle H, n \rangle = 0$
- Absrobing layer

Mesh

There are two background meshes, one for classic BC and one for absorbing BC. Then we can put any particle we want inside the screen.





Usage

- spherical particle
- variable wavelengt
- variable reflective index

Results

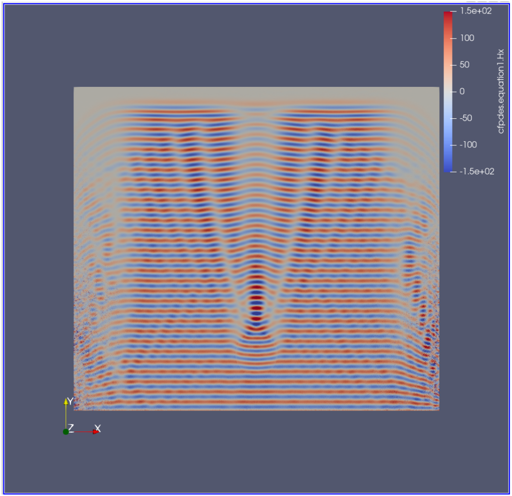


Figure: total field (incident plus scattered)

Results

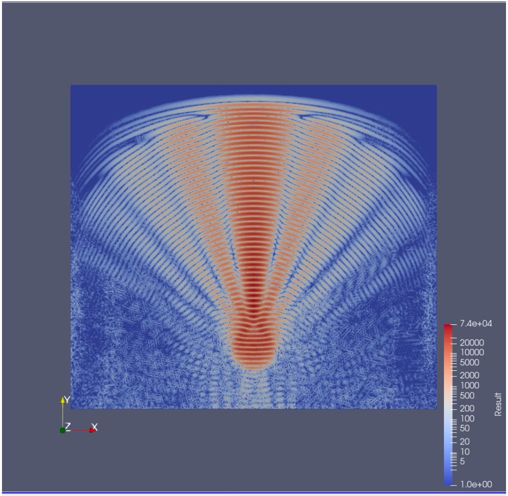


Figure: Scattered field (total minus incident) on a log scale

Results

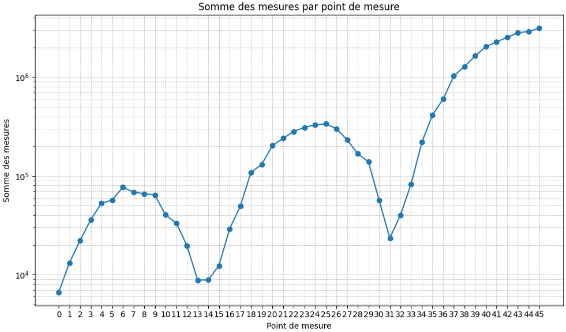


Figure: The angular scattering distribution for incident light

1. https://www.met.reading.ac.uk/clouds/maxwell/
2. https://arxiv.org/pdf/2302.02860 (chapter 2.1)
3. https://docs.feelpp.org/toolboxes/latest/cfpdes/manual.html
4. https://www.techno-science.net/glossaire-definition/Theorie-de-Mie.html
5. https://www.researchgate.net/publication/243492286