First Workshop of the Math/Amsud Program

PHOTOM
Photovoltaic Solar Devices
in
Multiscale Computational Simulations

LNCC Petrópolis, Brazil
13-15 March, 2018

Abstract

This workshop is part of the collaborative Math/Amsud program and involves Brazilian, Chilean and French researchers in the field of applied mathematics, computational science and scientific computing. The general objective of the workshop is to kick off the Brazil-Chile-France PHOTOM project for taking full benefits of future developments, analysis, and high-performance implementations of innovative multiscale finite element methods for wave propagation models in grating media. This work is motivated by the use of multiscale numerical algorithms for the computational simulation of photovoltaic solar cells.

1 Summary of the Project

Solar energy is currently one of the main sources of clean energy and its importance has been growing up steadily in the last decades. Computational simulation of wave propagation in solar cells is crucial for the development of new photovoltaic devices. Modern solar cells embed complex multi-layer geometries that must be taken into account properly in numerical simulations. The new generation of parallel computers provides the necessary computational power to handle realistic three-dimensional wave propagation phenomena in complex multi-layer photovoltaic devices. Nevertheless, numerical methods must be revisited entirely to take full advantage of such new parallel facilities.

The PHOTOM project aims at devising, analysing and implementing innovative numerical algorithms, which are naturally prompt to be used in massively parallel computers, for the Helmholtz

and the Maxwell equations. The physical coefficients contain highly heterogeneous and/or high contrast features in order to model wave propagation in grating media in view of the computational simulation of photovoltaic solar cells. The PHOTOM project corresponds to a two-year international collaboration between universities and research laboratories from Brazil, Chile and France. The researchers may be split in the following 3 fundamental themes (i) *Mathematical modelling of solar devices*; (ii) *Numerical schemes for PDE models*; (iii) *High-performance software systems.* coming from the LNCC - National Laboratory for Scientific Computing in Brazil, from Inria in France, and from PUCV - Pontifcia Universidad Catlica and UDEC - Universidad de Concepciòn in Chile.

2 Practical Informations

The First PHOTOM meeting will take place at LNCC (Avenida Getulio Vargas, 333 25651-075 Petrópolis, RJ, Brazil [1]). The research center is about 50 km far away from the Antonio Carlos Jobim airport[2].

3 Brazilian Participants

- Antonio Tadeu Gomes (LNCC)
- Alexandre Madureira (LNCC)
- Frédéric Valentin (LNCC)
- Roberto Molina (LNCC)

4 Chilean Participants

- Rodolfo Araya (UDEC)
- Diego Paredes (PUCV)
- Manuel Solano (UDEC)

5 French Participants

- Théophile Chaumont-Frélet (Inria)
- Stéphane Lanteri (Inria)

[1] http://www.lncc.br
[2] http://www.aeroportogaleao.net/en/

6 Program

- **March 13th**

9:30-9:50 Welcome and Summary of Activities
Frédéric Valentin: Coordinator

9:50-10:10 Stephane Lanteri: French coordinator
The Inria's Perspective

10:10-10:30 Diego Paredes: Chilean coordinator
The PUCV's Perspective

10:30-11:00 Coffee Break

11:00-11:20 Rodolfo Araya (Skype)
The UDEC's Perspective

11:20-11:40 Frédéric: Brazilian coordinator
The LNCC's Perspective

- Session: Modelling

  11:40-12:10 Stephane Lanteri
  Overview of wave propagation models in the context of solar devices: The time domain case

  12:10-12:40 Manuel Solano (Skype)
  Overview of wave propagation models in the context of solar devices: The frequency domain case

12:40-14:30 Lunch

- Session I: Numerical Algorithms

  14:30-15:00 Frederic Valentin
  The MHM method: Motivations and main ideas

  15:00-15:30 Theophile Chaumont
  The MHM method for the Helmholtz equation

  15:30-16:00 Diego Paredes
  The MHM method for the Maxwell equations in time domain

16:00-16:30 End of 1st Day

- **March 14h**
  - Session II: Numerical Algorithms

    9:00-9:30 Rodolfo Araya (Skype)
    Error estimator and adaptivity in the context of MHM methods

    9:30-10:00 Alexandre Madureira
    The MH^{2}M method

    10:00-10:30 Manuel Solano (Skype)
    A finite element method with a PML approach for the Helmholtz model

  10:30-11:00 Coffee Break

  - Session II: Numerical Algorithms

    11:00-11:30 Stephane Lanteri
    HDG methods for the Maxwell Equations

  - Session I: Solvers and Computational Aspects

    11:30-12:00 Antonio Tadeu Gomes
    The MHM method: Parallel implementation aspects

    12:00-12:30 Roberto Molina
    Domain decomposition methods: The FETI case

  12:30-14:00 Lunch

  - Session II: Solvers and Computational Aspects

    14:00-14:30 To be defined

    14:30-15:00 To be defined

    15:00-15:30 To be defined

  15:30-16:00 End of 2nd Day

- **March 15th**
  - Session I: Scientific Contributions and Benchmarks

    9:30-11:00 Round table
    Scientific (open) questions to be addressed

  11:00-11:30 Coffee Break

  - Session II: Scientific Contributions and Benchmarks

    11:30-12:30 Round table
    Benchmark settings

12:30-14:30 Lunch

14:30-16:30 Future Perspectives and Summary of the Workshop

16:30-17:00 End of the Workshop

19:30 Meeting Point for the Dinner

7 Sponsors

- INRIA
- CAPES
- CONICYT