

Third Workshop of the Math/Amsud Program

PHOTOM
Photovoltaic Solar Devices
in
Multiscale Computational Simulations

Universidad de Concepción - UDEC

Concepción, CHILE

21-23 January, 2020

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 UDEC - Universidad de Concepción in Chile.

2 Practical Informations

The third PHOTOM meeting will take place at the *Facultad de Ciencias Físicas y Matemáticas*¹ (Faculty of physical and mathematical sciences) of the University of Concepción (Avda. Esteban Iturra s/n - Barrio Universitario Concepción - Chile). The Faculty is about 10 km far away from the Carriel Sur airport².

3 Brazilian Participants

- Wesley Pereira (UFJF)
- Frédéric Valentin (LNCC)

4 Chilean Participants

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

5 French Participants

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

¹www.cfm.cl

²www.carrielsur.cl

6 Program

- **January 21st**

9:30-9:40 Welcome and Summary of Activities

09:40-10:00 Diego Paredes: Chilean coordinator
The UdeC's Perspective

10:00-10:20 Frédéric: Brazilian coordinator
The LNCC's Perspective

10:30-11:00 Coffee Break

- Session I

11:00-11:20 Talk 1: Manuel Solano
An MHM method for diffraction grating problems PART I

12:00-12:20 Talk 2: Diego Paredes
An MHM method for diffraction grating problems PART II

12:30-14:30 Lunch

14:30-16:00 Work-groups I - part 1

16:00-16:30 Coffee Break

16:30-18:00 Work-groups I - part 2

- **January 22nd**

- Session II

10:00-10:20 Talk 3 : Stéphane Lanteri
Optimization of material nanostructuration for light trapping in solar cells

10:30-11:00 Coffee Break

11:00-11:20 Talk 4 Wesley Pereira
An MHM method for wave propagation: theory and application on intricate geometries

11:30-11:50 Talk 5: Patrick Vega
A posteriori error estimates of an HDG method for wave propagation models in diffraction gratings

12:00-12:30 Discussion

– 12:30-14:30 Lunch

14:30-16:00 Work-groups II - part 1

16:00-16:30 Coffee Break

16:30-18:00 Work-groups II - part 2

- **January 23rd**

- Session II: To be defined

- 10:00-10:20 Talk 6: Théophile Chaumont

- Optimal convergence rates for space refinements in multiscale hybrid-mixed methods*

- 10:30-11:00 Coffee Break

- 11:00-11:20 Talk 7: Frédéric Valentin

- A posteriori error estimates of an HDG method for wave propagation models in diffraction gratings*

- 11:30-12:30 Discussion

- 12:30-14:30 Lunch

14:30-16:00 Global discussion

16:00-16:30 Coffee Break

16:30-18:00 Conclusions: F. Valentin

19:30 Meeting point for dinner

7 Sponsors

- INRIA
- CAPES
- CONICYT