1.Conducator de doctorat:

Curriculum Vitae

SOFONEA Victor Matei Constantin

Educational background:

- PhD in Physics (1996) - University of Bucharest, Romania
  Title of the thesis: *Collective Interactions in Magnetic Fluids*
  Advisor: Professor Ioan-Iovitz Popescu, Member of the Romanian Academy

- BSc (1978) - Department of Physics, West University of Timisoara, Romania

Professional experience (positions held) :

- *since 2011 :* PhD Advisor
  Doctoral School of Physics, West University of Timisoara, Bd. Vasile Parvan 4, Timisoara

- *since 1997 :* Senior Researcher (CS1)
  Center for Fundamental and Advanced Technical Research, Romanian Academy, Bd. Mihai Viteazul 24, 300223 Timisoara, Romania

- *1990 - 1997 :* Researcher, Research Center for Hydrodynamics, Cavitation and Magnetic Fluids, “Politehnica” University of Timisoara

- *1986 - 1990 :* Physicist, Department of Physics, West University of Timisoara

- *1981 - 1986 :* Researcher, Institute for Welding and Materials Testing, Timisoara

Scholarships and invited research stages abroad (> 1 month) :

- Institute for Computer Applications, University of Stuttgart, Germany (1993);
- Laboratory of Acoustics and Condensed Matter Optics, Pierre and Marie Curie
  University, Paris, France (1994);
- International Centre for Theoretical Physics, Trieste, Italy (1994);
- Department of Theoretical Physics, University of Wuppertal, Germany (1996);
- Laboratory of Colloid Sensors, Jean Monnet University, Saint Etienne, France (1997),
- Department of Physics, Carnegie Mellon University, Pittsburgh, Pennsylvania, USA
  (1998, 2001, 2004 and 2005);
- Department of Physics and Astronomy, The University of Edinburgh, UK (2000),
- Department of Physics, University of Bari, Italy (2004, 2005, 2006, 2009, 2011, 2013
  and 2014);
- Department of Mechanical Engineering, Kobe University, Japan (2007 and 2008);
- Laboratory of Plasma and Energy Conversion, Paul Sabatier University, Toulouse,
  France (2009, 2010, 2013, 2014 and 2015).

Awards

"Aurel Vlaicu" prize of the Romanian Academy (1999) , for the group of papers entitled *Lattice Boltzmann Morphological Models for Complex Fluids* (with Dr. Klaus Mecke, University of Wuppertal, Germany).

Involvement in national and international research projects:

- Since 1997 - various projects (supported by the Romanian Academy or the Romanian National Authority for Scientific Research) related to transport processes in rarefied gases as well as to structure formation in multicomponent and multiphase fluids.

- Research team member in NASA projects (1997 - 2005) on binary diffusion under stochastic microgravity.

- Two US Air Force European Office of Aerospace Research and Development (EOARD) projects: *Lattice Boltzmann models for multicomponent fluids* (1998 - 1999) and *High order numerical schemes for Lattice Boltzmann models: applications to flow with variable Knudsen number* (2005 - 2007), respectively.

- Exploratory research project: *Kinetic models for micro-scale transport phenomena and structure formation in complex fluids: implementation on GPU-based parallel computing systems* (2011 - 2016).

- Collaborative project France - Romania: *Lattice Boltzmann models for predicting the deposition of inertial particles transported by turbulent flows* (2013 - 2016).

Other activities :

- Scientific Secretary of the 8th International Conference on Magnetic Fluids held June 29 - July 3, 1998 în Timișoara, Romania

- Editor (2003 - 2014) for Computational Physics papers at the journal *Open Physics* (formerly *Central European Journal of Physics*, published by Springer and now by de Gruyter)

- Invited talks and lectures on Lattice Boltzmann models for transport phenomena, non- equilibrium flows and microfluidics, delivered at the *University of Bari, Italy* (2005 and 2007); *Paul Sabatier University, Toulouse, France* (2007 and 2009); *University of Kobe, Japan* (2007 and 2008); *Institute of Space Propulsion Lampoldshausen, Germany* (2015); *Institute of Mechanics, Sofia, Bulgaria* (2018).

- Member of the Managing Committee of the *COST Action MP1305 Flowing Matter* (2014 - 2018), chaired by Prof. Federico Toschi, Eindhoven Institute of Technology, Netherlands.

- 51 scientific papers included in the WoS database, 8 papers published in Romanian Academy journals, 1 chapter in a book published by Springer Online, 3 Romanian Patents

2.Scurta descriere a domeniului de cercetare:

Fluid Physics and Kinetic theory

We are interested to develop PhD Projects in Fluid Physics using kinetic theory and computer simulations on parallel computing systems like Graphic Processing Units (GPUs) or multi-processor systems running the Portable Extensible Toolkit for Scientific Computation (PETSc). Two main directions may be considered:

• non-equilibrium fluid flows where the non-negligible value of the Knudsen number plays an important role.

• multi-component or multi-phase fluid systems

Recently developed models based on the Boltzmann equation and Gauss-Hermite quadratures will be used for computer simulation of the flow problems. Various types of boundary conditions will be considered (bounce back, diffuse reflection, Maxwell and Cercignani-Lampis). A particular attention will be given to the numerical schemes used to solve the evolution equations in the phase space.

Multi-phase fluid systems are of major interest in both engineering and basic science. In particular, we are focused on transport phenomena in multicomponent fluids, phase transition and domain growth, morphology of domains and their characterisation using Minkowski functionals, as well as on interfacial phenomena and instabilities.

Microscale fluid flow is an active research topic with numerous applications in vacuum technology, design and fabrication of micro- and nano-electromechanical systems (MEMS), transport through porous media (gas and oil extraction) or blood flow in capillary vessels. In such cases, as well as in rarefied gases or high altitude aerodynamics, the fluid is far from equilibrium and the Knudsen number (defined as the ratio between the mean free path of fluid particles and the characteristic size of the flow domain) becomes non-negligible. Under these circumstances, the well-known Navier-Stokes equations of fluid mechanics are no

longer valid and more elaborated models and computer simulation techniques need to be developed to ensure the accurate investigation of physical phenomena and technological processes.

Knowledge of statistical mechanics and thermodynamics is a prerequisite for the PhD candidate. Basic knowledge of Unix systems and computer programming (C or Fortran) is wishful, but not mandatory for applying. During the PhD project, the candidate will become acquainted with numerical schemes for hyperbolic equations, as well as with code programming on high performance parallel computing techniques including Graphics Processing Units (GPUs). After successful completion of the thesis, these skills are expected to help the candidate integrate in scientific or engineering activities in both the academia and the industry.

3.Tema de cercetare pentru studiul doctoral si bibliografia aferenta:

Discrete Boltzmann models for phase-separating fluids with variable temperature

The objective of this thesis is the development of a discrete Boltzmann model with variable temperature. The model relies on the Boltzmann equation and will use the Gauss-Hermite quadrature method to discretise the momentum space. Implicit-explicit numerical methods will be considered to get the evolution of the discrete set of distribution functions resulted after applying the quadrature method, as well as the evolution of the macroscopic fields (mass density, local velocity and temperature) during the fluid flow. The stability of the numerical methods and their numerical errors will be carefully investigated and appropriate boundary conditions will be designed. Finally, the model will be used to investigate the physics of liquid-vapor phase separation and the heat flow between parallel plates at different wall temperatures.

References:

1. S. Succi, *The Lattice Boltzmann Equation For Complex States of Flowing Matter,* Oxford University Press, 2018

2. V. Sofonea, A. Lamura, G. Gonnella, A. Cristea, *Finite-differencevlattice Boltzmann model with flux limiters for liquid-vapor systems,* Physical Review E **70** (2004) 046702

3. G. Gonnella, A. Lamura, V. Sofonea, *Lattice Boltzmann simulation of thermal nonideal Fluids,* Physical Review E **76** (2007) 036703

4. T. Biciusca, A. Horga, V. Sofonea, *Simulation of liquid-vapour phase separation on GPUs using Lattice Boltzmann models with off-lattice velocity sets*, Comptes Rendus Mecanique **343** (2015) 580

4.Teme propuse pentru proba de specialitate la admitere si bibliografia aferenta (de regula 5 subiecte)

1. Boltzmann equation
2. Navier-Stokes equations
3. Van der Waals fluid
4. Transport coefficients of fluids - diffusivity, viscosity, thermal conductivity
5. Derivation of Couette and Poiseuille flow equations from the Navier-Stokes equations

References:

1. S. Succi, *The Lattice Boltzmann Equation For Complex States of Flowing Matter,* Oxford University Press, 2018

2. G.M. Kremer, *An Inyroduction to the Boltzmann Equation and Transport Processes in Gases,* Springer Verlag, 2010

3. … and many University Textbooks