

PhD research topic proposal
BME, Doctoral School of Mathematics and Computer Science

Name and degree of supervisor :

Dr Imre Ferenc Barna

Are you willing to supervise Stipendium Hungaricum applicants?

Yes

Title of the topic:

Searching for analytic solutions of physically relevant non-linear partial differential equations

Short description:

There are numerous fields in physics which deal with highly non-linear phenomena, and take place in space and time described by non-linear partial differential equations (PDE) such as wave phenomena, transport processes like fluid dynamics, plasma physics, high-energy physics or gravitation. There is no existing general mathematical theory of non-linear PDEs, however there are some trial functions (Ansätze) like self-similar solutions, traveling waves which give us physically relevant reasonable solutions helping to get a deeper insight into the internal properties of such systems.

In the last decades we investigated numerous PDEs, most of them were problems from viscous hydrodynamics [1], but heat conduction [2], non-linear electrodynamics [3] or quantum mechanical problems [4] were addressed as well.

The candidate should have a solid knowledge in basic theoretical physics and ordinary differential equations. We can offer problems in fluid dynamics -- which is under our present interest --, but the research field could be slightly changed and defined together with the PhD candidate.

For background information see papers at: <http://www.kfki.hu/~barnai>

[1] I.F. Barna, M.A. Pocsai, S. Lökös and L. Mátyás

"Rayleigh-Benard convection in the generalized Oberbeck-Boussinesq system"
Chaos Solitons and Fractals. 103, (2017) 336

[2] I.F. Barna and R. Kersner

"Heat conduction: a telegraph-type model with self-similar behavior of solutions"
J. Phys. A: Math. Theor. 43, (2010) 375210

[3] I.F. Barna

"Self-similar shock wave solutions of the non-linear Maxwell equations"
Laser Phys. 24, (2014) 086002

[4] Understanding the Schrödinger Equation: Some [Non]Linear Perspectives

Editor: Valentino Simpaio

I.F. Barna and L. Mátyás

"Self-similar And Travelling-Wave Analysis Of The Madelung Equations Obtained From the Free Schrödinger Equation"

an accepted book Chapter
Nova Science Publishers 2020

Requirements:

Solid knowledge of basic theoretical physics and ordinary differential equations
Good communication skills in English
Basic knowledge of the Latex, Maple and Mathematica softwares

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