HIGH-ORDER NUMERICAL METHODS FOR HYPERBOLIC EQUATIONS WITH APPLICATIONS TO AERODYNAMICS, RAREFIED GAS DYNAMICS AND PARALLEL COMPUTING

Moscow Institute of Physics and Technology (National Research University)

Degree or qualification is awarded: **PhD (Candidate of Science)**

Language of study: **English**
Mode of study: **full-time**
Duration: **4 years**
Availability of free education: **no**
Price: **375 000 RUB**

Programme webpage at the university website:
https://eng.mipt.ru/programs/high-order-numerical-methods-for-hyperbolic-equations-with-applications-to-aerodynamics-rarefied-gas/

Programme curator: **Denis Ustyuzhaninov**
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Entry requirements:

- Master's degree / equivalent in a related field
- B2 level of English
- Good track record of publications related to the topic of the intended research
- Strong research proposal 1,500 - 3,500 words

Research supervisor:
Vladimir Titarev
PhD, DSc

Supervisor's research interests:
Dr Titarev is a specialist in the field of computational fluid dynamics and associated numerical analysis. His research interests include the Boltzmann equation with model collision integrals, hyperbolic conservation laws and numerical methods, very high-order essentially non-oscillatory methods in particular, for partial differential equations with applications in gas dynamics, rarefied flows, reactive multiphase flows as well as non-linear elasticity.

Research highlights:

- The possible program of research may include investigation of high-order methods on unstructured meshes, implicit time-accurate schemes for kinetic equations with stiff source terms. The emphasis will be on applications to complex problems. Supervisor's specific requirements:
- Knowledge of basic numerical methods to solve PDEs, integration and differentiation.
- Good working skills in programming in Fortran 90/2003 or C.
- Basic knowledge of compressible gas dynamics.
- Basic knowledge of parallel computing is a bonus.

Main publications:

- V.A. Titarev, A.A. Frolova, V.A. Rykov, P.V. Vashchenkov, A.A. Shevyrin, Ye.A. Bondar. Comparison of the Shakhov kinetic equation and DSMC method as applied to space vehicle aerothermodynamics // Journal of Computational and Applied Mathematics. 2020. V. 364. P. 1-12. DOI: 10.1016/j.cam.2019.112354.
- V.A. Titarev. Application of model kinetic equations to hypersonic rarefied gas flows // Computers and Fluids.

2018. V. 169. P. 62-70.
- P. Tsoutsanis, V.A. Titarev and D. Drikakis. WENO schemes on arbitrary mixed-element unstructured meshes in three space dimensions // Journal of Computational Physics. 2011. V. 230, N. 4. P. 1585-1601.
- M. Dumbser, M. Käser, V.A. Titarev and E. F. Toro. Quadrature-free non-oscillatory finite volume schemes on unstructured meshes for nonlinear hyperbolic systems // Journal of Computational Physics. 2007. V. 221, N.2. P. 693-723.
- V.A. Titarev and E.F. Toro. ADER schemes for threedimensional nonlinear hyperbolic systems // Journal of Computational Physics. 2005. V. 204. N. 2. P. 715-736.
- V.A. Titarev and E.F. Toro. Finite-volume WENO schemes for three-dimensional conservation laws // Journal of Computational Physics. 2004. V. 201, N. 1. P. 238-260.

Specializations within this programme