INTERNATIONAL BIWEEKLY ONLINE SEMINAR ON ANALYSIS, DIFFERENTIAL EQUATIONS AND MATHEMATICAL PHYSICS

Coordinators: Prof. Alexey Karapetyants, Prof. Vladislav Kravchenko

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24 July 2025, 6 pm (UTC+3)

A 120-Year Exploration of Prandtl's Unsteady Laminar Boundary Layer Problem and New Thoughts on the Fundamental Equations of Turbulent Phenomena

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To simplify the Navier-Stokes equations for solvability, the renowned German scholar L. Prandtl proposed the boundary layer theory in fluid mechanics in 1904. The theory divides fluids into two regions: a thin layer near the solid wall where viscous effects are considered, namely the boundary layer, and the flow outside the boundary layer is regarded as an inviscid ideal fluid. The boundary layer theory has greatly simplified the Navier-Stokes equations, but the derived unsteady laminar boundary layer equations have not been well solved even since 1904. The report will review the arduous exploration process of 120 years on this issue, and introduce the story of the author solving this problem by introducing a special similarity transformation; for the turbulent phenomenon, it is pointed out that due to the large velocity gradient of fluid motion, the quadratic term of the velocity gradient in the constitutive equation cannot be omitted but needs to be retained, and a new thought on deriving the basic equations of fluids is put forward.

Related achievements:

[1]. Bo Hua Sun, Similarity Solutions of a Class of Unsteady Laminar Boundary Layer, Physics of Fluids, 36, 083616 (2024);

[2]. Bo Hua Sun, Fundamental equations for the turbulent motion of an incompressible viscous fluid, Physics of Fluids 37, 055144 (2025).

*Seminar website: https://msrn.sfedu.ru/sl. The seminar uses Microsoft Teams online platform.

Please send questions to ademp.seminar@gmail.com (Tatiana Andreeva, scientific secretary).

The seminar is organized by the coordinators Alexey Karapetyants and Vladislav Kravchenko within the activities of the Regional Mathematical Center of the Southern Federal University in collaboration with Institute of Mathematics, Mechanics and Computer Sciences of the Southern Federal University and the OTHA research group in Operator Theory and Harmonic Analysis.

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