LITHUANIAN ENERGY INSTITUTE

ADMISSION TO PHD STUDIES FOR THE YEAR 2025

DOCTORAL RESEARCH TOPIC:

Study of turbulent flow phenomena and interactions

RESEARCH FIELD:

Energetics and Power Engineering (T 006)

BRIEF DESCRIPTION OF RESEARCH TOPIC:

Turbulence is one of the least understood phenomena in physics, despite its widespread occurrence in nature and technology. The goal of this research thematic is to bridge gaps in our understanding and create more accurate turbulent flow models to address a variety of engineering challenges. These include developing safer, more efficient energy solutions and tackling environmental issues by analysing flame-turbulence interactions, studying flow structures in complex geometries, and employing advanced experiments and numerical methods. By gaining deeper insights into turbulent flow physics, this research thematic aims to enhance the efficiency and safety of engineering systems.

Turbulence is a chaotic and nonlinear phenomenon present in both natural and technological systems. Its complexity makes it one of the most challenging aspects of fluid dynamics to comprehend, predict, and control. Turbulence influences numerous processes, from weather and ocean currents to energy production and industrial applications. Understanding its mechanisms is therefore essential for advancing science and engineering. By improving turbulence models, researchers can address critical challenges in energy, transportation, and environmental systems, leading to significant societal benefits.

The main objective of this research thematic is to study turbulence comprehensively, focusing on its structures and dynamics. The ultimate aim is to develop reliable models that can be applied to real-world scenarios. This will deepen our understanding of turbulence physics and enable more effective engineering solutions.

In engineering, turbulence spans multiple disciplines and impacts processes such as heat transfer, fluid-structure interactions, chemical reactions, and aerodynamic performance. It is pivotal to the design and optimization of energy systems, where safety and efficiency are paramount. Turbulence also plays a major role in environmental processes like pollutant dispersion, where better understanding could help mitigate risks. Thus, turbulence research has direct implications for energy efficiency, industrial optimization, and environmental protection.

One core challenge in turbulence research is the inability of existing models to accurately simulate complex flows. This limitation hinders our ability to predict and control turbulence-driven processes. For instance, in turbulent combustion, the interaction between turbulence and chemical reactions is vital for designing efficient and safe energy systems such as engines, gas turbines, and nuclear power plants. However, current models lack the precision needed to capture the intricate dynamics of flames under turbulent conditions. Similarly, in non-reactive flows, simulating complex geometries and interfacial interactions remains a major challenge. The fundamental mechanisms driving turbulent flow structures are not yet fully understood, limiting the development of accurate models and innovative solutions to engineering and environmental problems.

This research aims to enhance our understanding of turbulent flow dynamics, particularly in technologically relevant contexts. By advancing fundamental knowledge, researchers can improve the accuracy and predictive capability of turbulence models. This progress will support the creation of safer, more efficient energy systems and solutions to critical environmental challenges. The focus is on both chemically reactive and non-reactive flows, uncovering new insights into turbulence physics and applying them to real-world problems.

For chemically reactive flows, the research emphasizes numerical studies of flame-turbulence interactions in applications such as engines, gas turbines, and nuclear power systems. These investigations aim to understand how turbulence influences combustion processes, ultimately leading to more efficient and safer energy systems. In non-reactive flows, the research involves numerical and experimental studies of flow structures in complex geometries and interfacial interactions. The goal is to identify the mechanisms governing turbulent flow patterns and their evolution. These studies will provide new insights into turbulence dynamics and form the basis for developing more accurate models.

By addressing these challenges, this research will advance the science of turbulence and its applications, enabling innovative solutions to pressing engineering and environmental problems.

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