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**北京大学力工学院**

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湍流与复杂系统国家重点实验室



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| **Relationship between 0D Ignition and 1D Flame** |

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**Abstract:**

Engine knocking is a critical issue in Spark-Ignition (SI) engines, affecting both performance and longevity. This lecture presents a comprehensive analysis of the knocking phenomenon using data from a two-dimensional (2D) direct numerical simulation (DNS) that accurately replicates experimental conditions. Our study aims to elucidate the underlying mechanisms of knock onset. Initially, we validate that the reaction front behavior observed in the 2D DNS can be faithfully reproduced by a one-dimensional (1D) laminar premixed flame simulation. Through detailed analysis, we uncover a significant correlation between the timing of knock onset and the flame propagation limit of the 1D laminar premixed flame at elevated temperature and pressure. To further clarify this relationship, we introduce the novel theory of “explosive transition of deflagration.” This theory reveals that, for a Lewis number of unity, the temporal evolution of the normalized fuel mass fraction and temperature in a zero-dimensional (0D) homogeneous ignition scenario mirrors that of a 1D laminar premixed flame when appropriate spatiotemporal transformations are applied. Additionally, our findings indicate that the rate of decrease of the normalized fuel mass fraction in the preheat zone is dependent on the Lewis number. Specifically, when the Lewis number exceeds unity, no flame structure can be sustained above a certain threshold temperature. These insights have significant implications for the design and optimization of combustion

**Brief Biography:**

Youhi Morii is Assistant Professor at Tohoku University's Institute of Fluid Science, specializing in combustion research. He earned his Physics degree from Osaka University (2007) and PhD from SOKENDAI/JAXA (2012). His career includes rocket engine development at JAXA (2012-2017), automotive software development at Waseda University (2017), and his current position since 2018. His research focuses on ignition/flame theory, rocket combustion instabilities, and SI engine knocking, developing robust numerical methods for reactive CFD. Notable achievements include JAXA President's Award (2014), Director's Award (2015), authoring a key automotive engine numerical methods book (2019), and the Combustion Society of Japan Encouragement Award (2023) for groundbreaking knocking prediction work.

**时间：2025年7月7日（周一）下午 15:00－16:00**

**地点：北京大学 新奥工学大楼 3048会议室**

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