流体力学特別セミナー

主催：日本流体力学会中部支部

Prof. Mikhael Gorokhovski（LMFA, Ecole Centrale de Lyon, Ecully, France)

日時：3 月 10 日（金） 15:00～17:00

会場：名古屋工業大学 2 号館 B 棟 6 階 611B 室

https://www.nitech.ac.jp/access/index.html

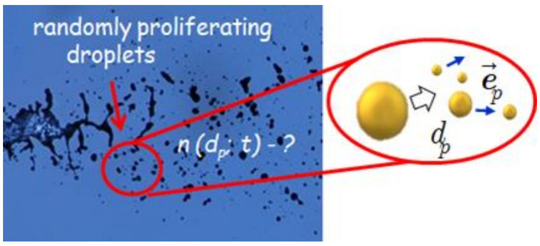
乱流および乱流噴霧で国際的に著名な Gorokhovski 教授が名古屋に 3 月 6 日から 1 週間滞在されます．この機会に、乱流中における水滴の分裂や粒径分布に関する理論、その LES におけるモデリングについて講演をしていただくことになりました．多数の方々のご参加を歓迎いたします．

Fragmentation, stochastic models of drop breakup and raindrop size distributions.

Mikhael Gorokhovski

LMFA, Ecole Centrale de Lyon, Ecully, France

Fragmentation, which is the production of random fragments (or particles) by continuous breakup of clusters, plays a key role in a variety of physical, chemical and geological processes, including turbulence, spray atomization, clouds fragmentation, solid particle decomposition, rock crushing, polymer degradation and network branching. Usually, each individual event of fragmentation is a complex microphysical process, with fluctuations and uncertainties, and the frequency of such events is high. Then it is natural to abstract an ‘effective’ fragmentation scenario, and either to search analytically its statistical universalities, or to simulate this scenario as stochastic process. In both approaches, the mechanism of fragmentation may be represented by effective parameters. In this talk we will discuss such a framework in the case of drop breakup in the turbulent conditions.



The ‘effective’ fragmentation scenario in the first part of this talk is the drop breakup under the scaling symmetry. Considering the kinetic equation of fragmentation in the continuity form, we will illustrate two types of its self-similar solutions: (i) the evolution of the size-distribution when the fragmentation frequency is constant, and (ii) the evolution of this distribution when the fragmentation frequency is decreasing with the size of proliferating droplets. The both solutions are very interesting. In the first case, the size-distribution evolves through its intermediate lognormal shape towards the power distribution (fractals), and when two first logarithmic moments of size are equal to each other, the latter is the Pareto distribution, which is often suggested for the exhalations of mucosalivary fluid. In the second case, the well-known Nukiyama–Tanasawa distribution appears to be the self-similar solution of the fragmentation equation. Such type of distribution immerges very often in the measurements of droplet size in the spray atomization process. On the other hand, at larger sizes, the Nukiyama–Tanasawa distribution approaches the Marshall-Palmer distribution, which is also well-known but as a broadly confirmed representative of raindrop size-distribution. This motivates to discuss on the origins of Marshall-Palmer's law in the representation of raindrops' polydispersity in terms of fragmentation under scaling symmetry. The evolution of Nukiyama–Tanasawa distribution for different rates of rainfall and for different dissipation rates of the turbulent kinetic energy will be displayed.

In the second part of our talk we will discuss the stochastic simulation of drop breakup on residual scales in LES of flows with sprays. One of the models is based on the stochastic mother-to-daughter relaxation of droplets. The relaxation is controlled by the viscous dissipation rate "seen" by the droplet along its trajectory, and simulated as the lognormal stochastic process. In the numerical applications, this model is discussed in comparison with other breakup stochastic models based on fragmentation under scaling symmetry.

連絡先：　渡邊威，後藤俊幸