Direct numerical simulation of aerodynamic fragmentation of a liquid droplet

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J. W. J. Kaiser

Technical University of Munich

Department of Mechanical Engineering

Institute of Aerodynamics and Fluid Mechanics

1. Introduction

- Aerodynamic fragmentation = Breakup of large drops into smaller droplets

Source: www.w-dog.net

- Combustion processes
- Asthma inhalers
- Spray painting

- Complicated physical relationship between aerodynamics forces and final droplet size.

- For detailed analyses, high-resolution simulations necessary

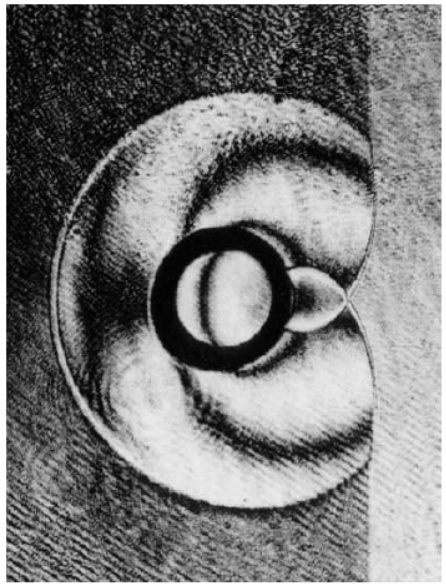
➢ several billion DOFs in 3D
➢ HPC required: hybrid parallelization (MPI and OpenMP)

Goal of our research: improve understanding of underlying physical mechanisms of aerodynamic fragmentation

2. Physical and numerical models

Physical model:

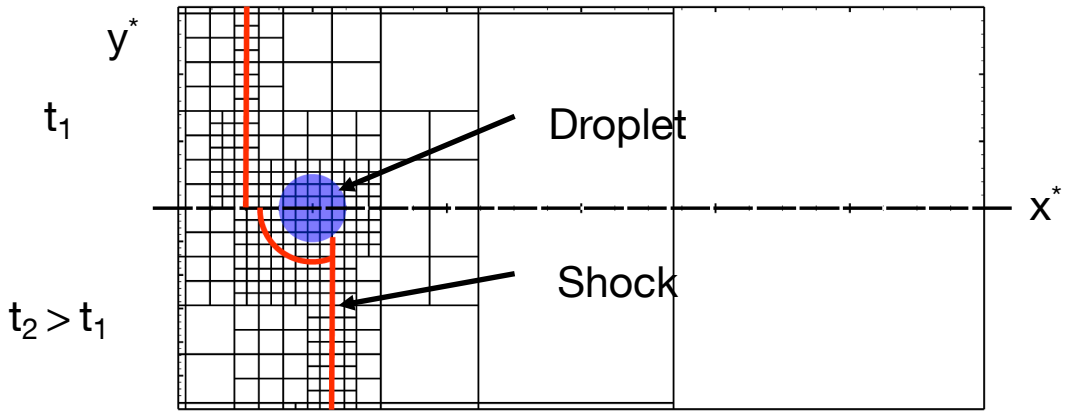
- Interaction of a Mach 1.47 shock in air with a water column (D = 4.8 mm) (cf. experimental investigation of Igra & Takayama, 2001)



Source: Igra & Takayama, Shock Waves, 2001

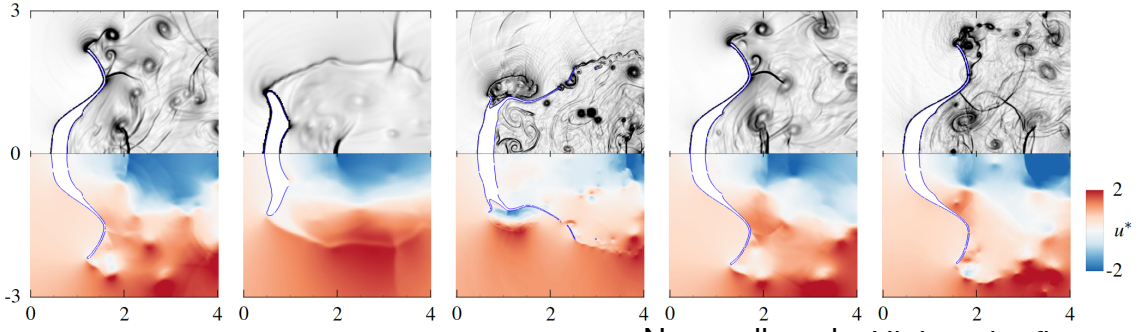
Numerical model:

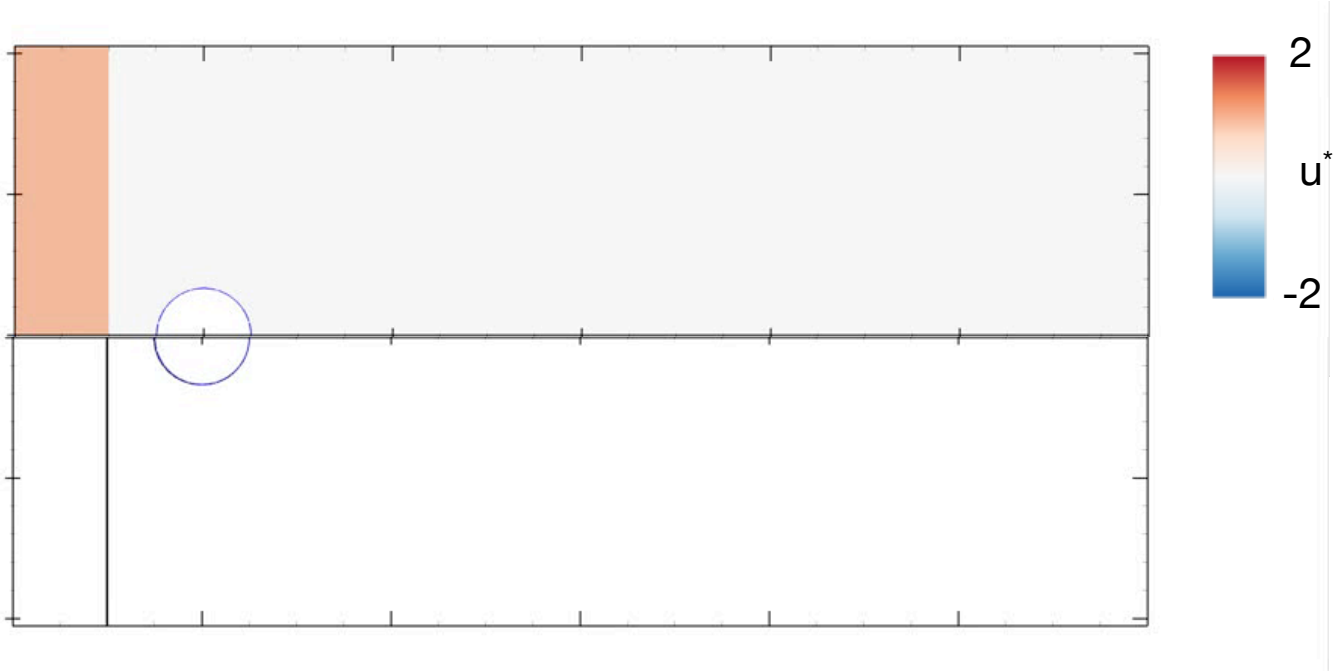
- Wavelet-based multi-resolution representation
- WENO-5, RK2-TVD
- Conservative interface interaction method for sharp-interface representation



3. Results

Small numerical disturbances
→ Influence on breakup?



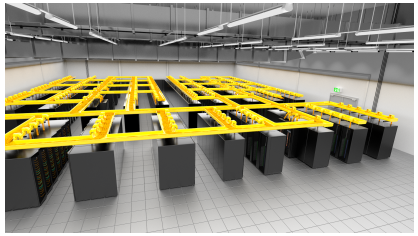


4. Outlook

Numerical model:

- **Improved communication** between domain regions, e.g. **one-sided communication**

DNS parameter study



Source: www.lrz.de

1 island with
512 nodes (28 CPUs each)