DROPIT

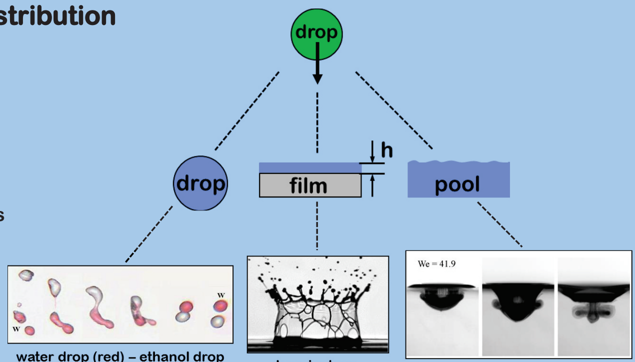
THEMATIC AREA C
DROP-LIQUID INTERACTION

FOCUS: DROP COLLISIONS WITH MISCIBLE FLUIDS (impact on film or on drop)

GOAL: To understand the influence of miscibility-gaps and thin-film micro-dynamics on large-scale dynamics and resulting drop size distribution

List of planned sub-projects (principal investigators):

- SP-C1: Micro and Macro Drop Impact Dynamics with Miscible Liquids
  (G. Lamanna, N. Roth, S. Tonini)
- SP-C2: Single and Multiple Drop Impact into a Deep Pool
  (M. Santini, G. Cossali, R. Helmig)
- SP-C3: High-order Numerical Methods for Multi-Component Incompressible Flows in Pools
  (F. Bassi, C.-D. Munz)
- SP-C4: Visualization of Droplet-Liquid Interaction
  (T. Ertl, M. Santini)
- SP-C5: Development of Novel Optical Techniques for Micro-Fluid Dynamics
  (B. Weigand, G. Lamanna, G. Cossali)



water drop (red) – ethanol drop collision [1]; hyspin drop - hexadecane film [2]; pigmented drop into deep pool [3]

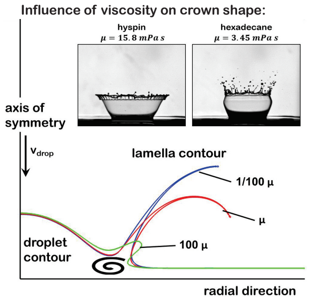
SP-C1: Micro & Macro Drop Impact Dynamics with Miscible Liquids

GOAL: Understanding of interplay between small-scale flow features and overall macroscopic impact dynamics

METHODS:

- High-speed visualisation of miscible binary drop collisions
  - Generation of a large, accurate database on binary fluid collisions
  - Classification of different impact regimes
  - Formulation of scaling law/comparison to models for immiscible drops
- Development/application of micro visualisation techniques for thin film dynamics (coop. SP-C5)
- Micro and macro flow visualisation of binary splashing experiments
  - How do flow dynamics in the neck region affect crown morphology?
  - Development of semi-empirical model for hole formation and crown shape
- Investigation of merging mechanism in thick layers (coop. SP-C2)

Influence of viscosity on crown shape:

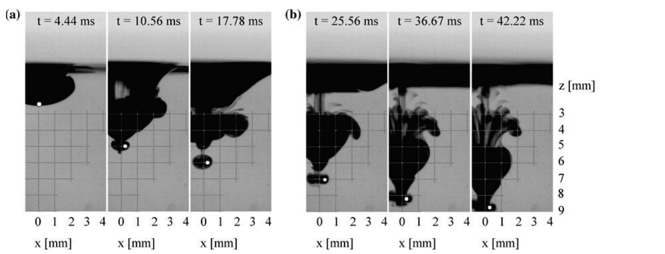


SP-C2: Single and Multiple Drop Impact into a Deep Pool

GOAL: Identification of mechanism for vorticity formation and evolution caused by single and multiple drop impact

METHODS:

- Flow field investigations via high speed visualisation, Laser Doppler Velocimetry (LDV) and Micro-PIV
  - Vortex structure map within the We-Fr ranges for single drop impact and multiple drop impact
  - Analysis of the influence of viscosity on vortex structures



Pigmented drop impact: expansion and recoiling visualization (a), drop remaining and vortex ring motion (b) [3]

SP-C3: High-order Numerical Methods for Multi-Component Incompressible Flows in Pools

GOAL: Development of an efficient simulation tool for interface problems in two-phase incompressible flows

METHODS:

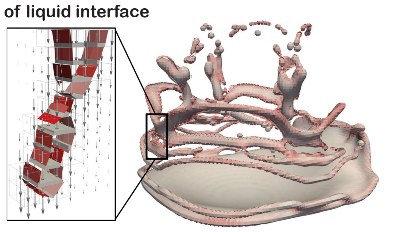
- Extension of MIGALE:
  - Adaption to the multi-phase case of the local incompressible Riemann problem
  - Implementation of high-order DG (two-phase model by [4,5])
- Development of stabilisation approach to control numerical oscillations when volume fraction discontinuities occur inside cells
- Solver validation against results from literature/obtained within the IRTG

SP-C4: Visualization of Droplet-Liquid Interaction

GOAL: Providing a set of visualisation approaches for numerical and experimental data for all TAs

METHODS:

- Investigation of surface dynamics and instabilities: Methods based on the interplay of velocity and surface tension
- Internal flow in micro-structures (micro-CT data): Interface reconstruction in porous media and visual tracking of liquid interface
- Analysis of miscible fluids: Texture- and particle-based dye advection visualizations
- Internal droplet flow: Glyph-based visualization/methods on integral lines
- Numerical visualization of vortex rings based on experimental data from SP-C2



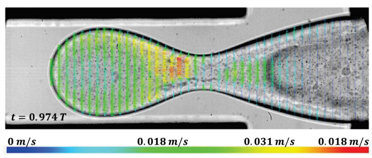
PLIC surfaces coloured by discontinuity between neighbouring patches. A close-up visualized using surface reconstruction and flux volumes shows unstable region. [6]

SP-C5: Development of Novel Optical Techniques for Micro-Fluid Dynamics

GOAL: Combining micro- and macro-scale measurement techniques into a multi-scale tool for thin film investigations

METHODS:

- Implementation of Micro-PIV in SP-C1 and SP-C2
- Implementation of Total Internal Reflection Fluorescence Microscopy (TIRFM) in SP-C1



Micro-PIV: Snapshot of flow field during necking [7]

References

[1] Gao et al., Exp. Fluids 38, 2005.
[2] Geppert et al., Atomization Sprays, 10.1615/AtomizSpr.2015013352, 2015.
[3] Santini et al., Exp. Fluids 54(9), 2013.
[4] Drew, D. A., Annu. Rev. Fluid Mech. 15, 1983.
[5] Saurel and Abgrall, J. Comput. Phys. 150:425-467, 1999.
[6] Karch et al., Proc. Pacific Visualization Symposium, 2013.
[7] Carrier et al., J. Micromech. Microeng. 25, 2015.

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