

# Mathematical models involved in phase transitions of snow - water - vapor

**Team** (Faculty of Math., Univ. Wien):  
Christian Schmeiser,  
Marie-Therese Wolfram (PostDoc),  
Pedro Aceves Sanchez (PreDoc)

# Mathematical modeling and simulation are tools of technology development

- Understanding of technological processes
- Optimization of technological processes
- Reduction of the number of prototypes

## Examples:

**Car design:** drag reduction, noise reduction,  
optimization of combustion

**Semiconductor chips:** minituarizatziion, power reduction,  
cooling requirements, new functionalities

**Diaper production:** quality control

# Microscopic vs. Macroscopic Models

**Example:** the air in this room

**Microscopic description:** particles, 3D billiards

Problem: on the order of

10.000.000.000.000.000.000.000 molecules



**Macroscopic description:** averaged quantities

like density, pressure, temperature,

mean velocity → Navier-Stokes equations

# Microscopic modeling of the dendrite generator

**Unstructured** (vapor, ice) **and structured** (droplets, snow, graupel) **particles.**

Structured particles vary in size and shape.

Transitions between particle types by collisions and phase changes

Examples: **deposition** of vapor on ice, snow, graupel  
**collection** of droplets by snow, graupel  
**evaporation/condensation**

Heat balance: heating/cooling by phase transitions

# Macroscopic modeling of the dendrite generator

- Description by (a small number of) averaged quantities such as densities of particle types
- Parametrization of all possible shapes of snow flakes and of size distributions (supported by experimental results)
- Coupling with the air flow

# Goals and Outlook

- Derivation of a minimal model suitable for simulations (starting from models for natural clouds)
- Include an account for different shapes of snow flakes (i.e. different snow quality), supported by experiments
- Reasonable quantitative match between predictions and measurements for present forms of the DG
- Contribute to geometry optimization and snow quality control