

Physically-Based Simulation Project: Water Droplet

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Simulation Scenario

- Water droplet colliding with a floor
- Motivation: Simulate realistic water droplets with surface tension



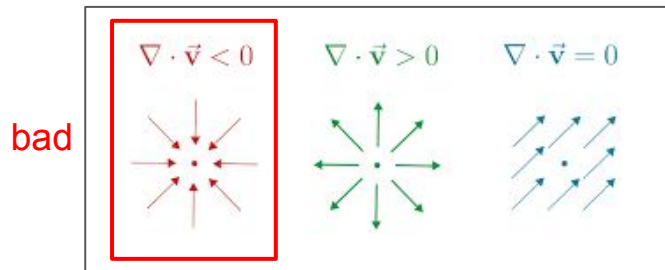
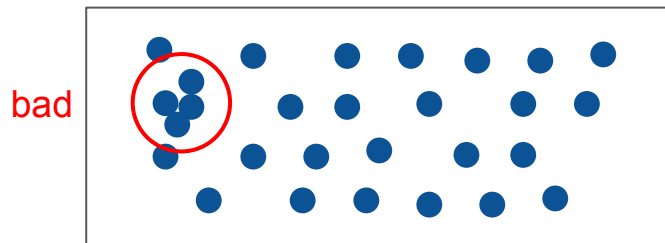
Simulation Method

DFSPH with surface tension:

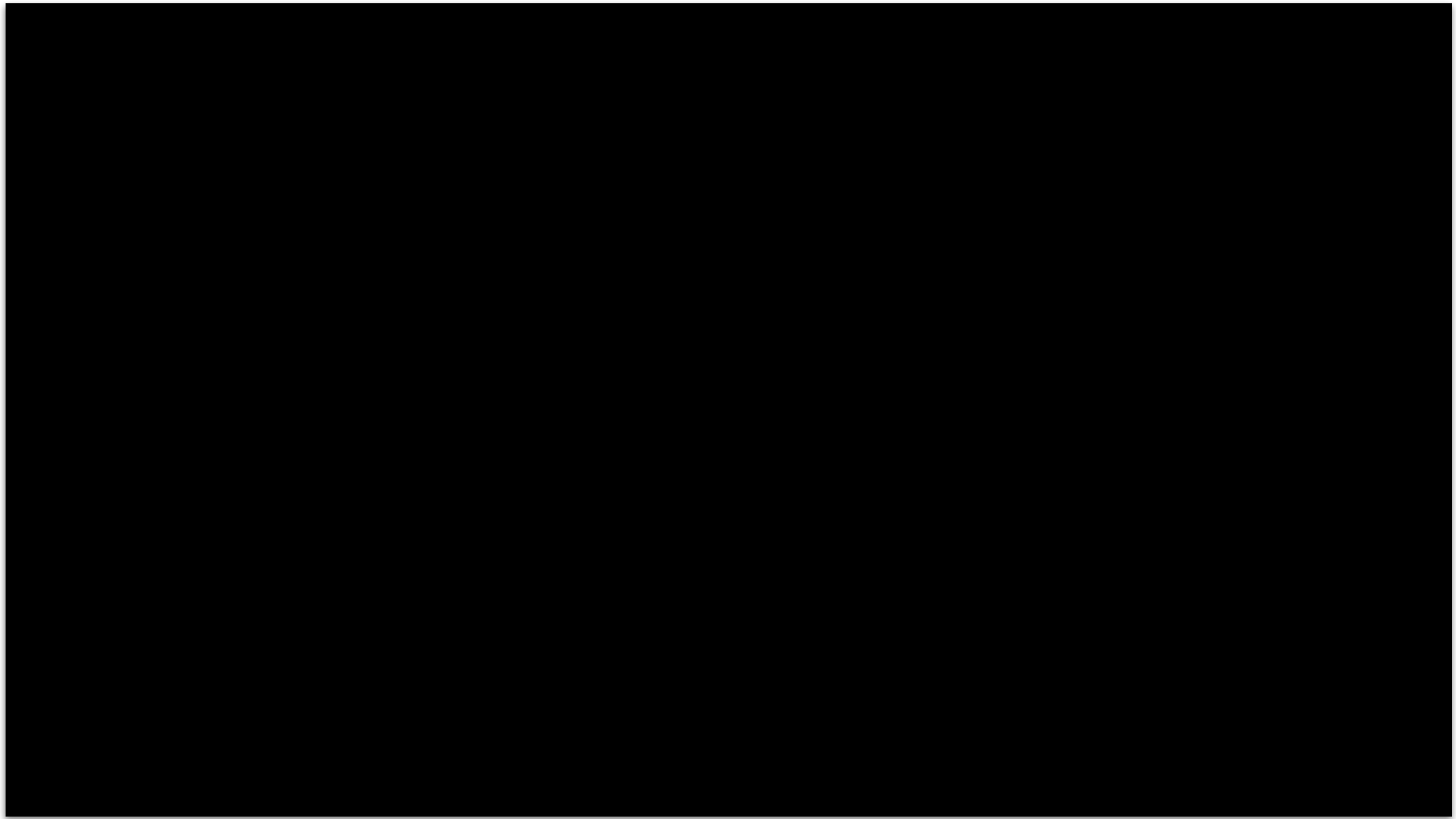
- Grid-based neighborhood search
- F_{visc} calculated as seen in the lecture
- Surface tension from [Akinci13]
- Divergence-free solver [Bender17]
- Boundary particles for floor
- Parallelized implementation

What is DFSPH?

- Divergence-free SPH
- Simulation loop (simplified):
 - Compute non-pressure forces
 - Gravity, viscosity, surface tension
 - Predict next velocity
 - Ensure density is constant
 - by iteratively updating predicted velocity
 - Update positions with predicted velocities
 - Ensure that divergence is non-negative
 - by iteratively updating predicted velocity
 - Update velocities with predicted velocities



Results





Limitations

- Performance
 - Despite multithreading, complex scenarios remain expensive
 - Kernel lookup as proposed in [Bender17] didn't work
 - -> Better neighborhood search/dynamic particle size
- Sensitivity to parameters
 - Simulation looks off if the parameters are slightly off
 - Lots of parameter tuning required
 - -> Rigorous choice of parameters
- ~~Low viscosity scenarios~~
 - Has been solved by adding incompressibility
- Adaptive timestep
 - Sometimes leads to instability

Looking back at our targets

Minimal Target

- Simulate water droplets with surface tension **Achieved**
- Basic interaction with flat floor **Achieved**

Desired Target

- Define floor elevation according to a heightmap **Achieved**
- Simulation of water droplet is realistic **Achieved**

Bonus Targets

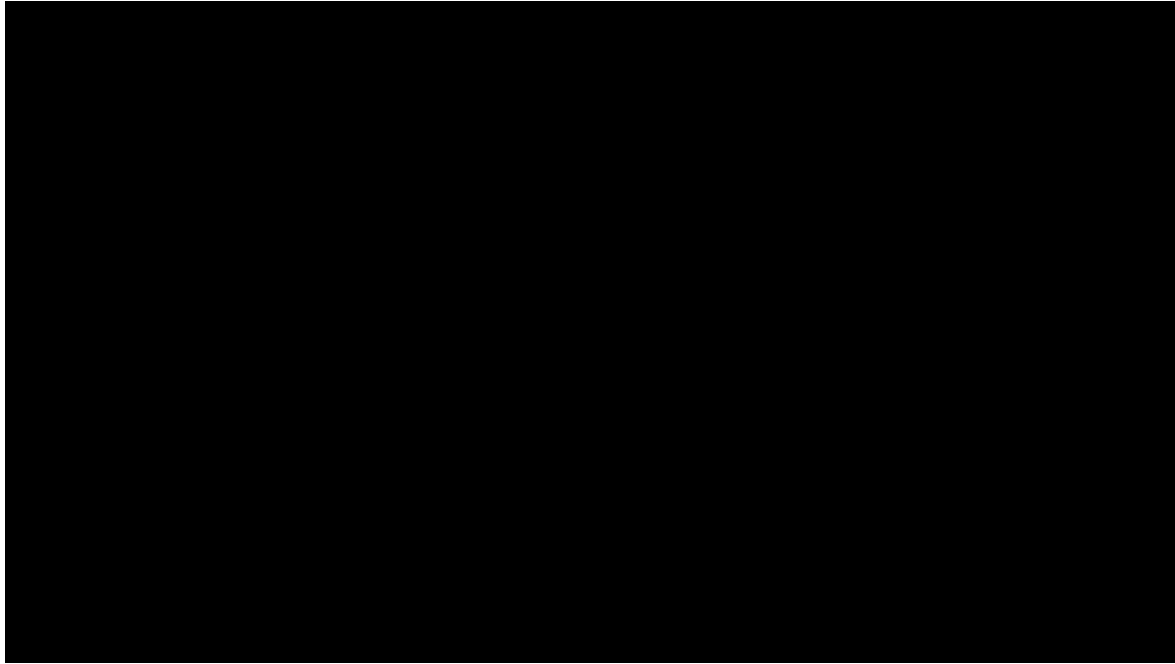
- More efficient version of SPH
- Maybe run implementation on GPU
- Rendering, make it look like water droplets

Achieved

Failed

Achieved (in post)

Thank You



[Bender17]
[Akinci13]

J. Bender. Divergence-free smoothed particle hydrodynamics.
N. Akinci. Versatile surface tension and adhesion for SPH fluids.