Modeling and Numerical Simulation of Multiphase Flows with Interfaces

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In an algebraic VOF method, the fluid interface is modeled by the indicator function H_0. We have developed a new interface capturing method by choosing the multidimensional Heaviside function via a single parameter variable τ for H_0 and analytically deriving its consecutive integral functions.

$$H_0(\tau) = \mathrm{Heaviside}(\tau) = \begin{cases} 1 & \tau > 0 \\ 1/2 & \tau = 0 \\ 0 & \tau < 0 \end{cases}$$

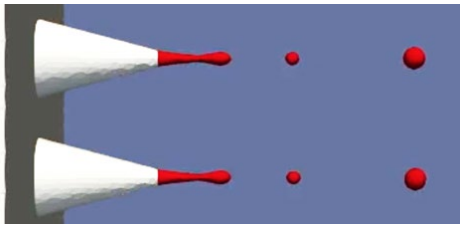
$$\tau = n_x \xi + n_y \eta + n_z \varsigma + d$$

$$H_1(\tau) = \int H_0(\tau) d\tau = \tau H_0(\tau)$$

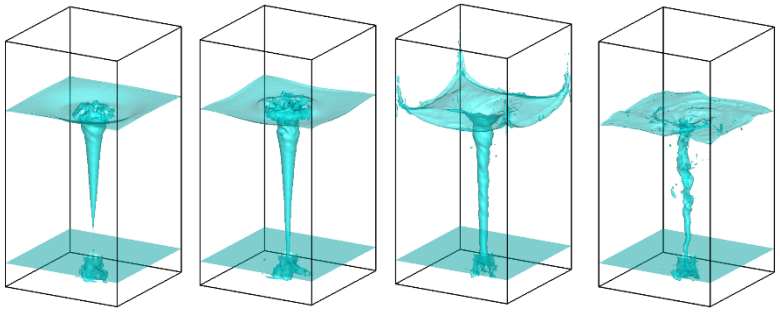
$$H_2(\tau) = \int H_1(\tau) d\tau = \frac{1}{2}\tau^2 H_0(\tau)$$

$$H_3(\tau) = \int H_2(\tau) d\tau = \frac{1}{6}\tau^3 H_0(\tau)$$

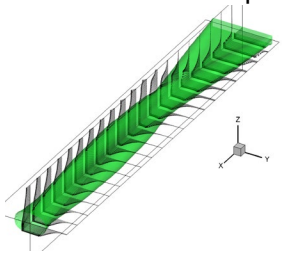
Ultrasonic spray simulation



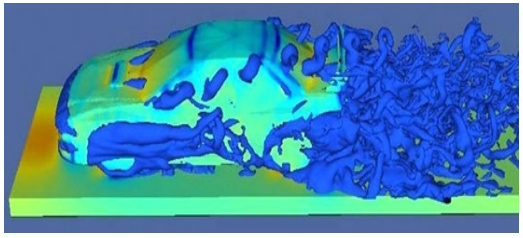
Simulation of swirling/descending water flow



Simulation of slab liquid jet



Simulation of flow around a car



Content:

Our research interests center around modeling and numerical simulation of multiphase flows with complex deformation, separation, and merging of fluid interfaces.

We have developed a new interface capturing method by choosing the multidimensional Heaviside function as the interface indicator function. The new method captures the interface in one grid cell. We have devised the center of mass approximation for the MTHINC method. This significantly reduced the algorithmic complexity of the original method while maintaining accuracy. We have designed an analytically and consecutively differentiable/integrable interpolation function that converges to the Heaviside function. We aim to apply it to simulation technology. We are also working on modeling and optimization of microscale ultrasonic atomization.

Appealing point:

We are actively engaged in industry-academia collaboration, and welcome joint research on modeling and numerical simulation of multiphase flows.

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