

# Realtime Computational Fluid Dynamics Simulations Using the Lattice Boltzmann Method

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# Uses for Fluid Dynamics

- Computer Graphics
- Aerodynamics and Engineering
- Meteorology
- Oceanography
- Plasma Physics
- and more

## The Boltzmann Equation

$$f(x + vt, v, t) = f(x, v, t) + \Omega(x, v, t)$$

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- Collisions

## The BGK Collision Operator

$$\Omega_{BGK} = \frac{f - f_{eq}}{\tau}$$

Collisions tend to push the system towards local equilibrium.

$f_{eq}$  is the equilibrium distribution function

# Discretization of Phase Space

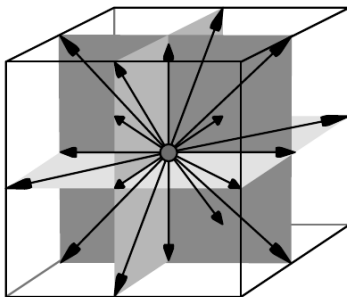
In order to solve the Boltzmann equation numerically, the domain must be split up into discrete components. This includes space, velocity, and time.

## Naming Scheme

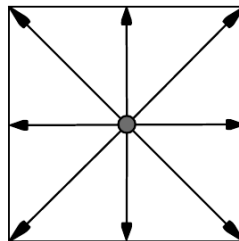
$DnQm$

- $n$  is the number of space dimensions
- $m$  is the number of velocities

# Lattice and Velocity Configurations



D3Q19

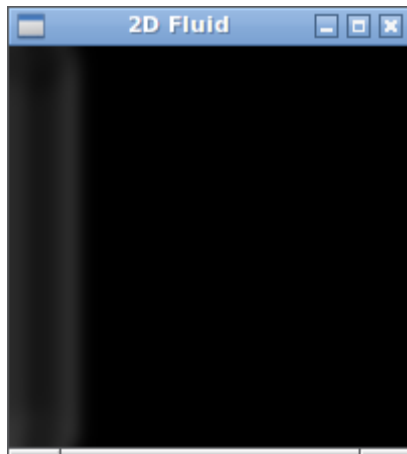


D2Q9



# Implementation Details

- C
- OpenGL



# Current Results

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