Introducing Dynamic Walls into Integer Lattice Gas Simulations

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May 10th, 2018

Introduction

- Explore interactions between gas and rigid shapes
- Build off of existing Lattice Gas Simulation Code

$$
\begin{array}{lll}
n[x][y][0] = (-v_x, +v_y) & n[x][y][1] = (0, +v_y) & n[x][y][2] = (+v_x, +v_y \\
n[x][y][3] = (-v_x, 0) & n[x][y][4] = (0, 0) & n[x][y][5] = (+v_x, 0) \\
n[x][y][6] = (-v_x, -v_y) & n[x][y][7] = (0, -v_y) & n[x][y][8] = (+v_x, -v_y
\end{array}
$$

initial goals

- Non leaking dynamic walls
- Make complex shapes out of these dynamic walls
- reproduce the Feynman tube experiment.

Method 1

Expected value of flow

$$< \mathit{flow} >= \text{particle density} * \text{wall velocity}$$

$$0 < \mathit{flow} < \text{min particle density}$$

Results

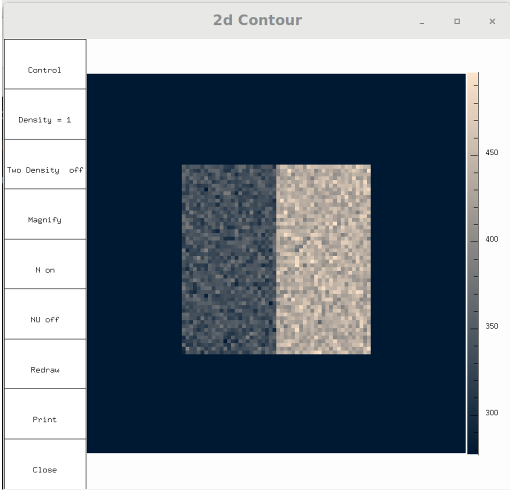

Figure 1:

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Results

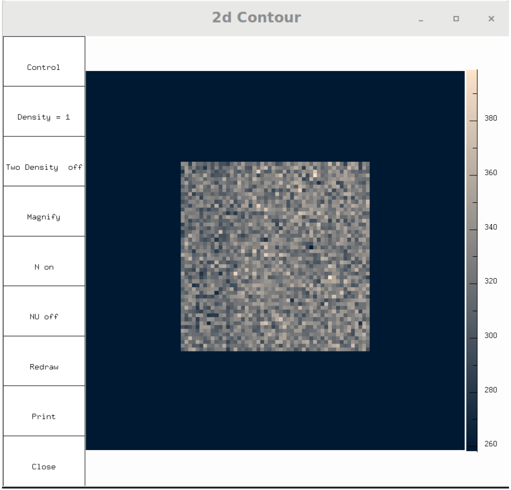

Figure 2:

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Results

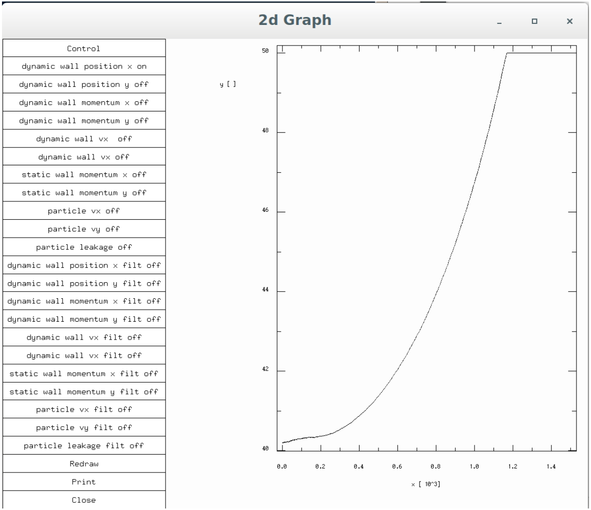

Figure 3:

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Results

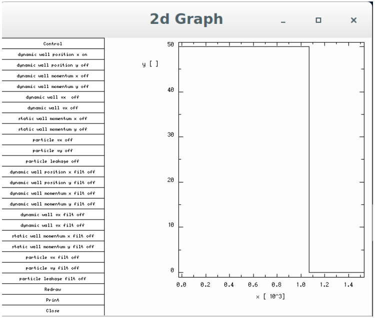

Figure 4:

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Results

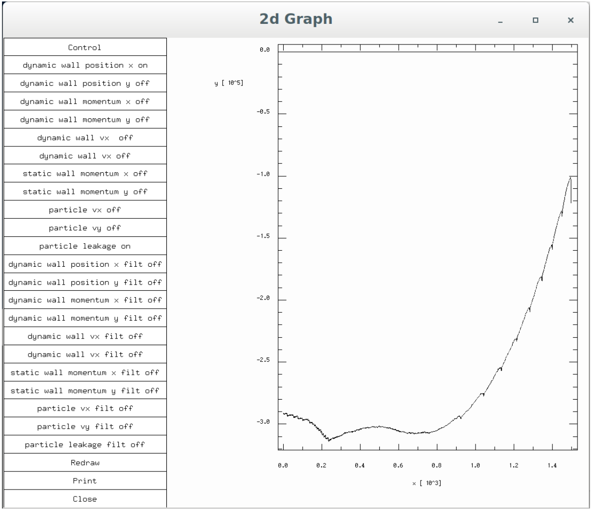

Figure 5:

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Method 2

In more detail, the probability that

$$pr * \text{particle density}$$

number of particles will be moved is

$$pr = \frac{\text{Wall Vx}}{1 - (\text{real(Wall x) - int(Wall x)})}$$

.

Results

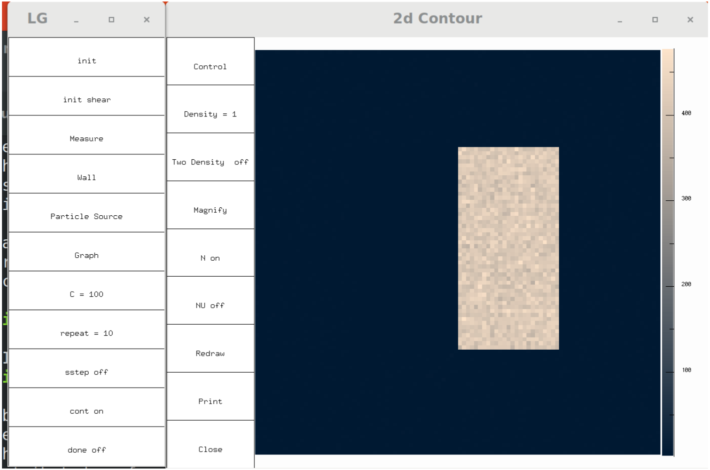

Figure 6:

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Results

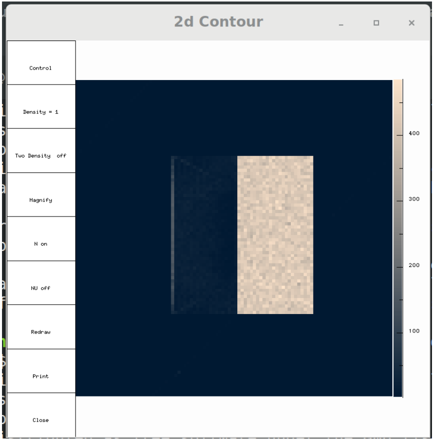

Figure 7:

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Results

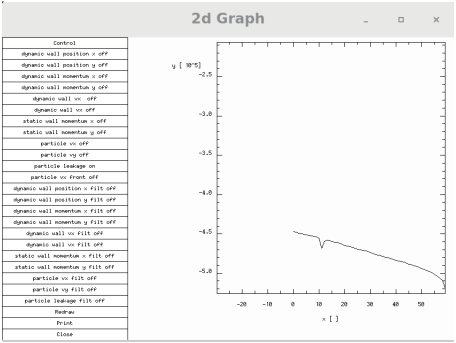

Figure 8:

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Results

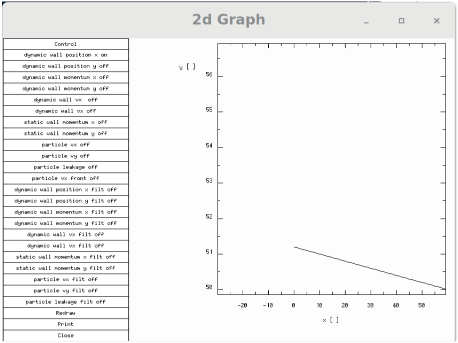

Figure 9:

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Method 3

$$\frac{\partial \rho}{\partial t} + \frac{\partial(\rho u_i)}{\partial x_i} = \nabla(\rho) + \upsilon * \nabla(\nabla(U) + (\nabla(U)T)) \quad (1)$$

The partial for ρ and ρu_i can be set to zero. This gives us:

$$0 = \nabla(\rho) + \upsilon * \nabla(\nabla(U) + (\nabla(U)T)) \quad (2)$$

$$\nabla(\rho) = F$$

$$0 = F + \upsilon * \nabla(\nabla(U_x)) \quad (3)$$

Solving the differential equation for

$$U_x$$

(mean velocity) above gives us:

$$U_x = \frac{F}{2 * \upsilon} * (x(x - L)) \text{Where L is the length of the tube in Lattice sites} \quad (4)$$

Results

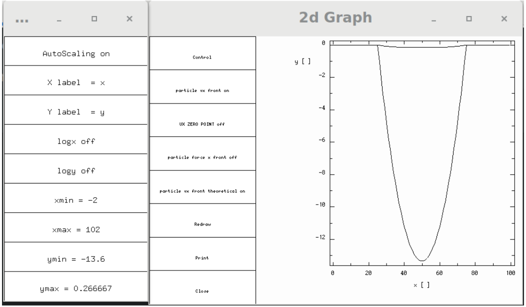

Figure 10:

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Results

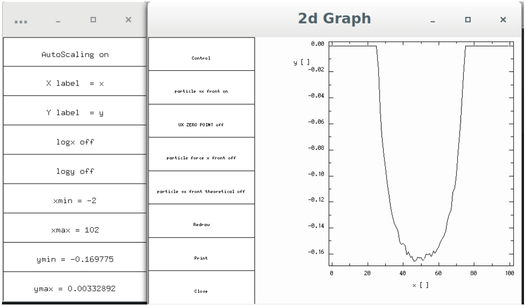

Figure 11:

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Results

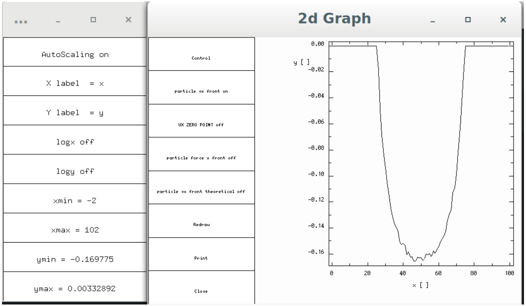

Figure 12:

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Conclusions and Final thoughts

- significant leakage for most walls
- partially working
- problem depth and complexity
- Approach 3 Issue might be solvable