

Exercise 8

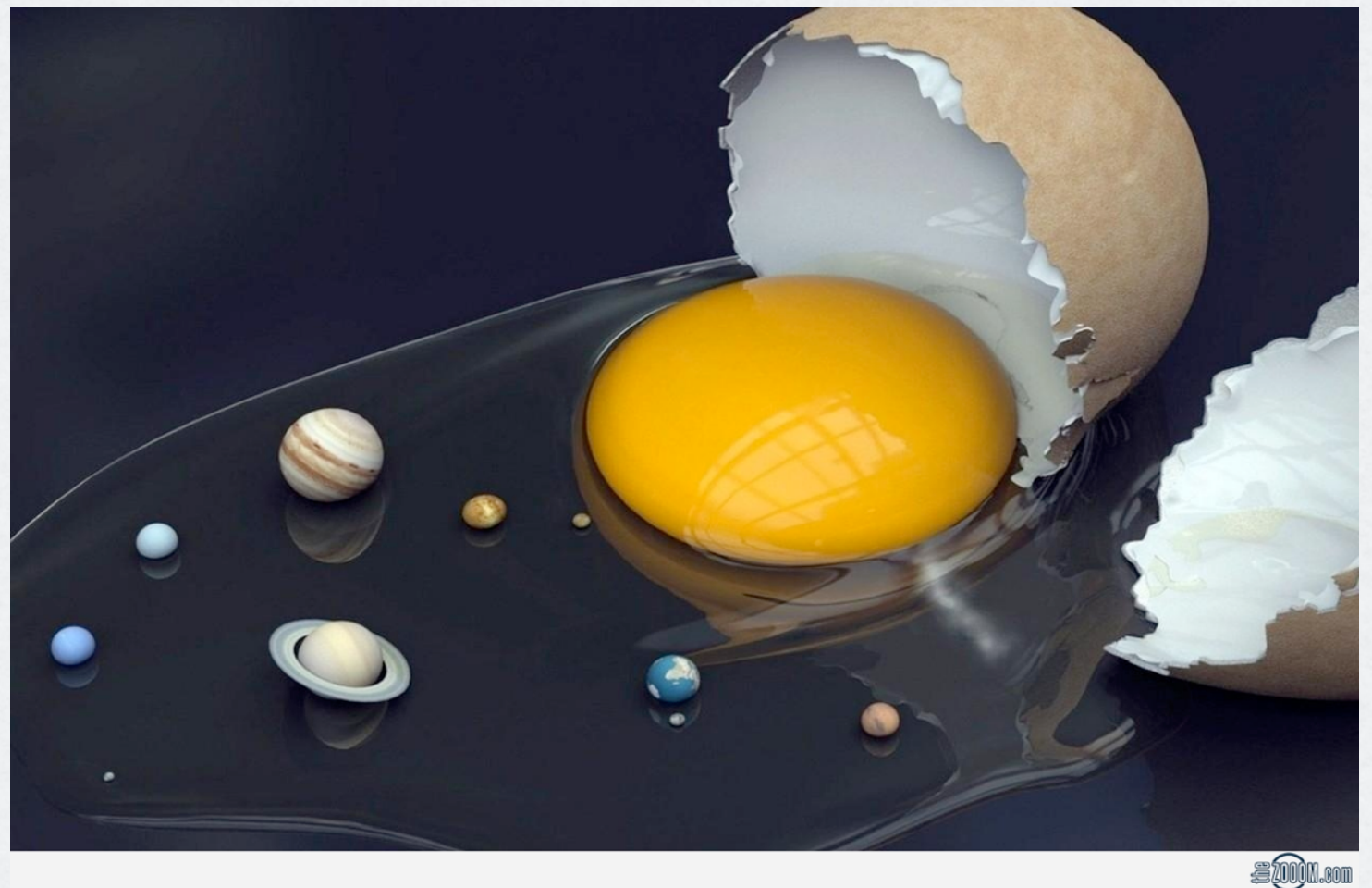
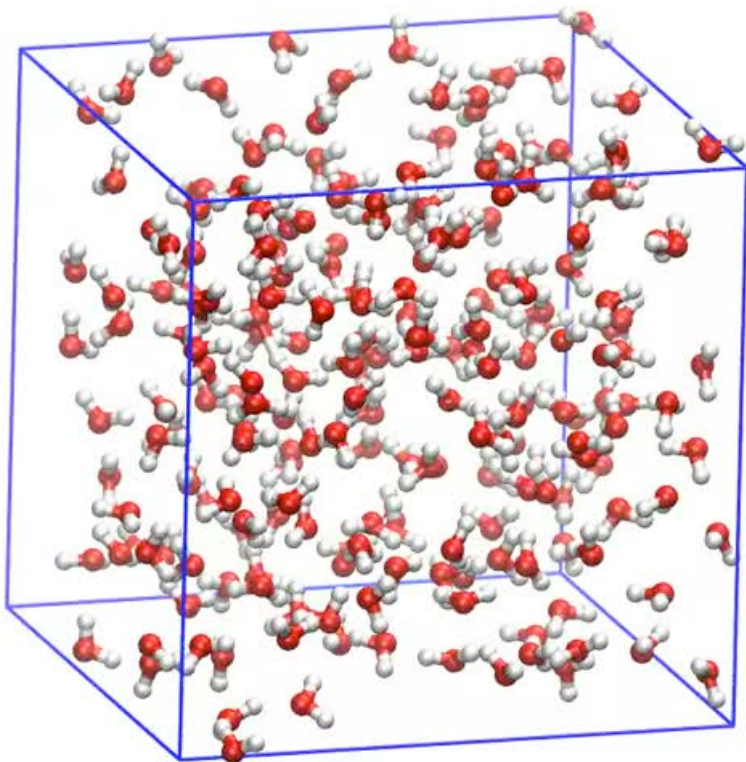
Particle Methods

High Performance Computing for Science and Engineering I

November 14, 2014

N-Body - What is it About

- N-body problem is a classical problem of predicting the individual motions of a group of objects interacting with each other under some physical law
- This can be celestial bodies under gravitational forces or molecules under Lennard-Jones potential



Vortex Sheet Roll-Up

Evolution of particle position

$$\frac{dZ_j}{dt} = \bar{V}(Z_j)$$

with

$$V(Z) = -\frac{i}{2\pi} \sum_{n=1}^N \frac{\Gamma_n}{Z - Z_n}$$

where

$$\Gamma(Z) = \gamma(Z)h$$

$$\gamma(Z) = -\frac{d}{dx} \left[\Gamma_s \sqrt{1 - \left(\frac{x}{0.5} \right)^2} \right]$$

Notation

$$Z \equiv x + iy$$

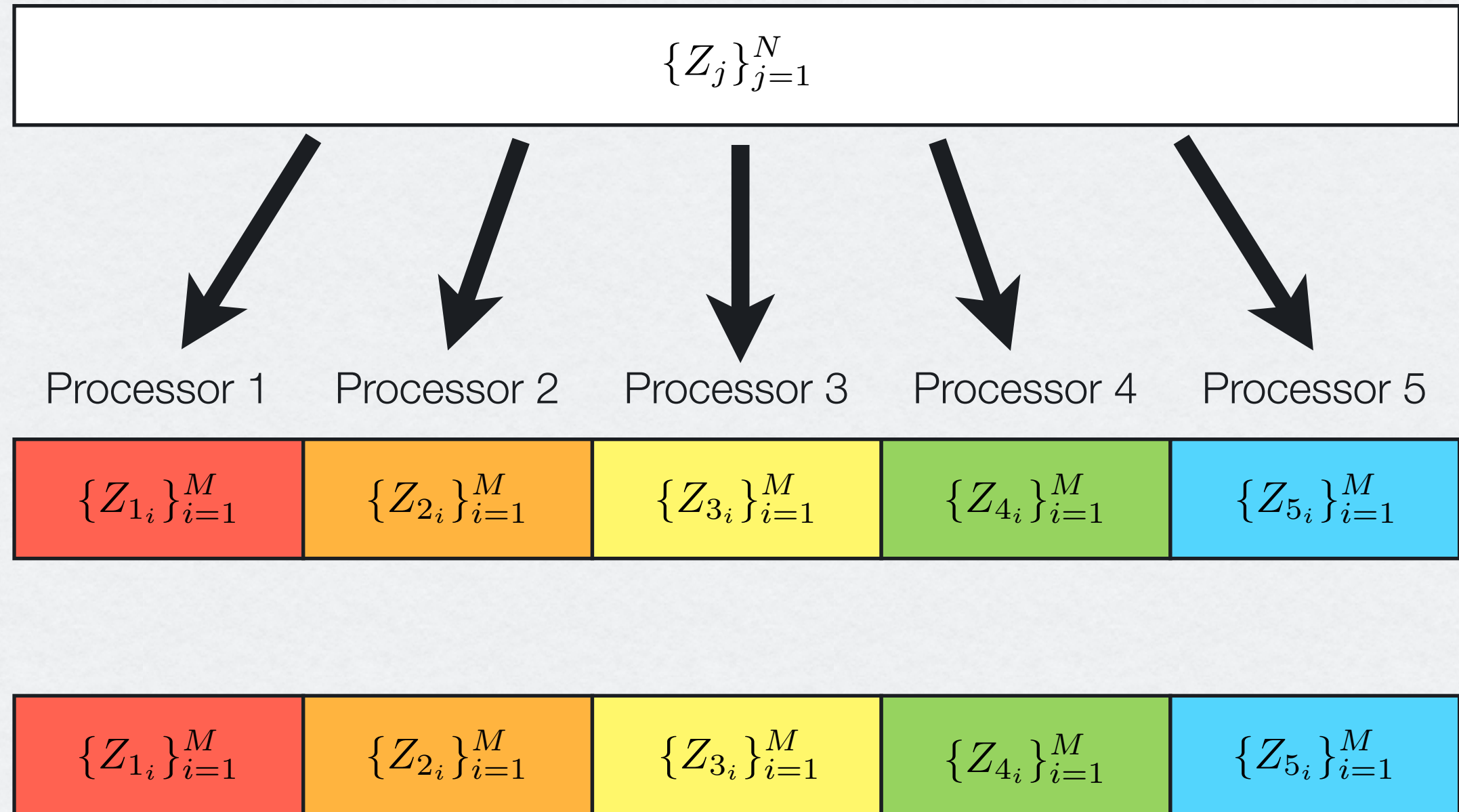
$$V(Z) \equiv u - iv$$

Careful with particle positions!

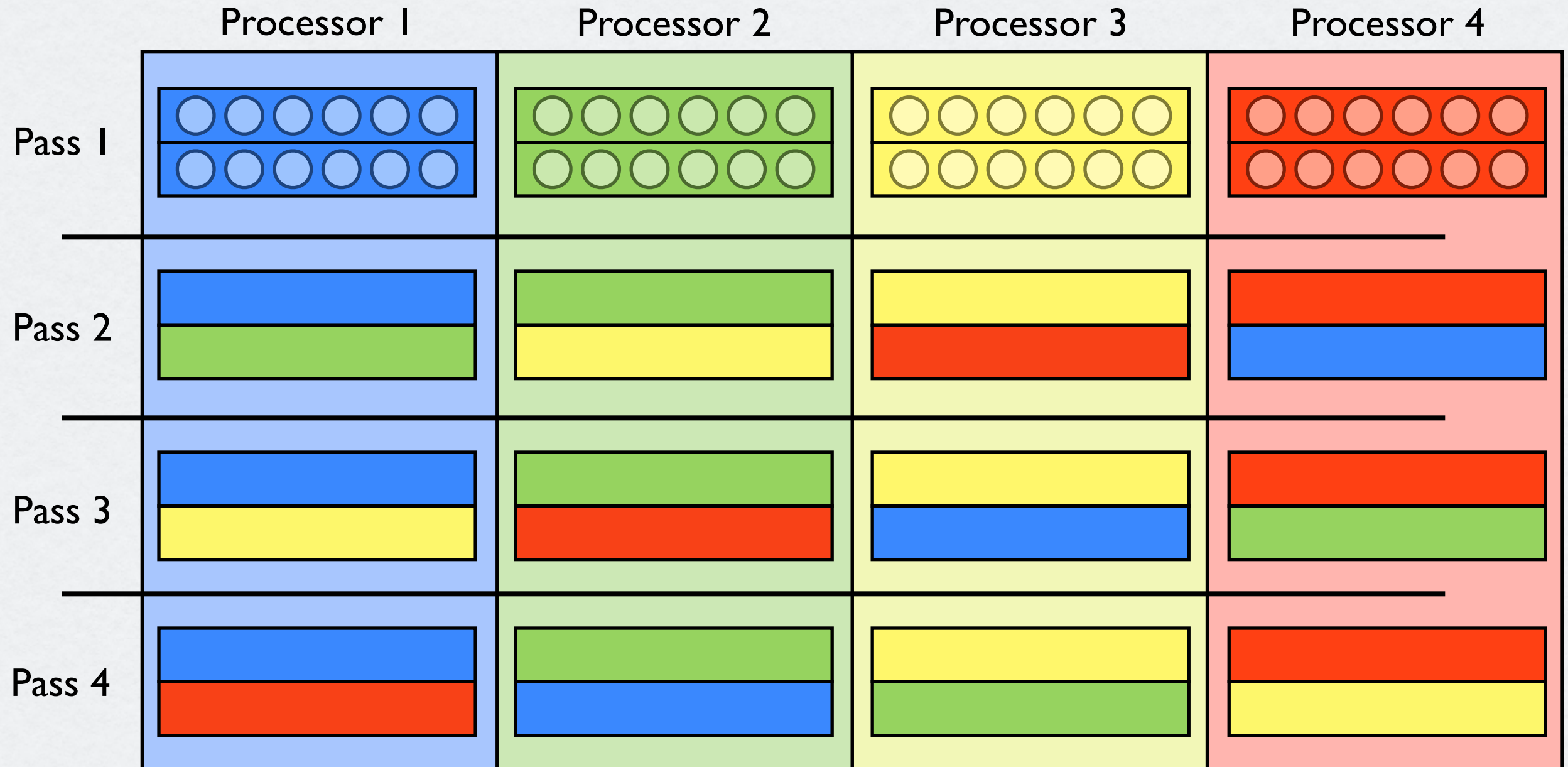
$$x_j = -0.5 + (j + 0.5) \cdot h$$

$$\text{where } h = \frac{1}{N}$$

Particles Distribution for MPI



Communication Pattern



Roll-up of 1D vortex sheet

