SPH: Part III

06 April 2020 09:29

Review:

$$\rho_a = \sum_b m_b W_{ab}$$

$$\dot{\underline{v}}_a = -\sum_b m_b \left(\frac{P_a}{\rho_a^2} + \frac{P_b}{\rho_b^2} + \Pi_{ab} \right) \nabla_a W_{ab}$$

This must also be accounted for in the energy equation.

$$\dot{e}_a = \left(\frac{P_a}{\rho_a^2} \right) \sum_b m_b (\underline{v}_a - \underline{v}_b) \cdot \nabla_a W_{ab}$$

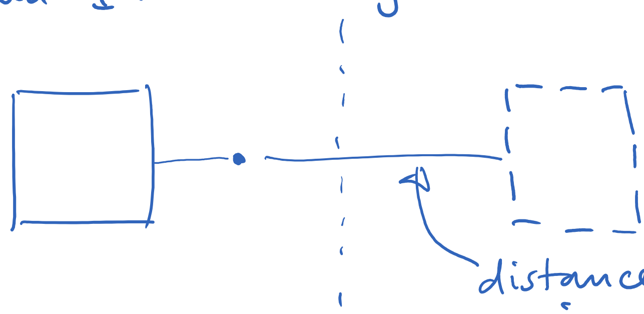
$$\dot{e}_a = \sum_b m_b \left(\frac{P_a}{\rho_a^2} + \boxed{\cancel{\frac{P_b}{\rho_b^2}}} + \Pi_{ab} \right) (\underline{v}_a - \underline{v}_b) \cdot \nabla_a W_{ab}$$

$$\dot{e}_a = \sum_b m_b \underbrace{\left(\frac{P_a}{\rho_a^2} + \Pi_{ab} \right)} (\underline{v}_a - \underline{v}_b) \cdot \nabla_a W_{ab}$$

$$\dot{e}_b = -\sum_a m_a \left(\frac{P_b}{\rho_b^2} + \Pi_{ab} \right) \underline{(\underline{v}_b - \underline{v}_a)} \cdot \nabla_b W_{ab}$$

Periodic Boundary Conditions:

Method 1: Modify the Ball-Box intersection Test



distance to the image

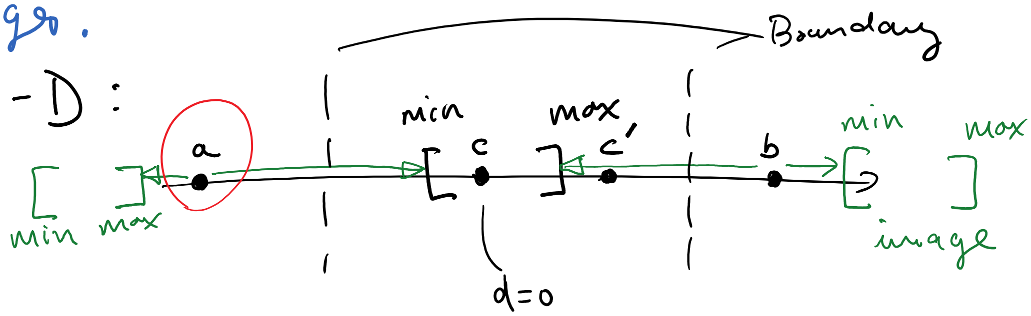
Take the shortest distance to any image

Every Cell will have 1 unique distance, which is the shortest over all periodic images.

Boundary

image.

In 1-D:




```
def Dist2Periodic(cell, l, in_r, out_r):
    fDist2 = 0
    dx = cell.min - in_r
    dx1 = in_r - cell.max
    if (dx[0] > 0)                      true: we are doing case (a)
        dx1[0] += l[0]
        if (dx1[0] < dx[0])
            fDist2 += dx1[0] * dx1[0]
            out_r[0] = in_r[0] + l[0]
        else
            fDist2 += dx[0] * dx[0]
            out_r[0] = in_r[0]
    else if (dx1[0] > 0) {              case (c') dx[0] < 0
        dx[0] += l[0]
        if (dx[0] < dx1[0])
            fDist2 += dx[0] * dx[0]
            out_r[0] = in_r[0] - l[0]
        else
            fDist2 += dx1[0] * dx1[0]
            out_r[0] = in_r[0]
    else
        case (c)
        out_r[0] = in_r[0]
    return fDist2
```

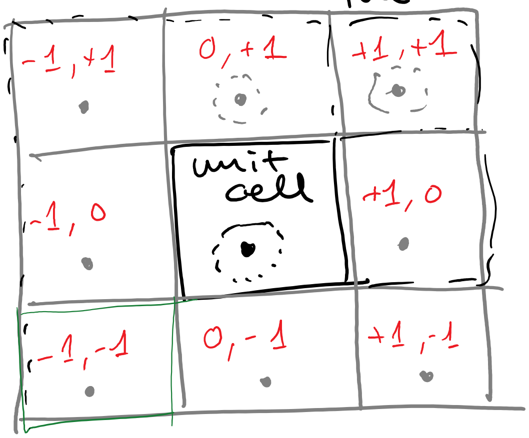
do this for components 0, 1, 2 x, y, z

search ball

Works as long as your search ball is less than $\frac{1}{2}|\mathbf{l}|$! Careful

We only consider 1 image (as closest) in the particle-cell distance test.

<u>Method 2</u>: Must walk each of the images of the unit cell (root of the tree).



NN_walk(c, pq, $\underline{r}_s$)

$\underline{r}_s = \underline{r} + \underline{\text{rOffset}}$

<u>However</u>: make sure we walk the closest image first, since $\underline{r}$ is inside the unit cell, choosing to walk the unit cell first is the best strategy.

$\underline{\text{rOffset}} = \langle 0, 0, 0 \rangle$

$\boxed{\text{NN\_walk}(c, pq, \underline{r})}$

for all images ($\underline{\text{rOffset}} \mathrel{!=} \langle 0, 0, 0 \rangle$)

$\underline{r}_s = \underline{r} + \underline{\text{rOffset}}$

NN_walk(c, pq, $\underline{r}_s$)

Will shrink the search radius substantially, so that usually there is almost no work to be done for the images!