1. Solve for the fields

- In electromagnetic PIC codes, only two equations need to be solved.
- The other two are satisfied as initial conditions, and they continue to be satisfied for appropriate choices of the numerical scheme.

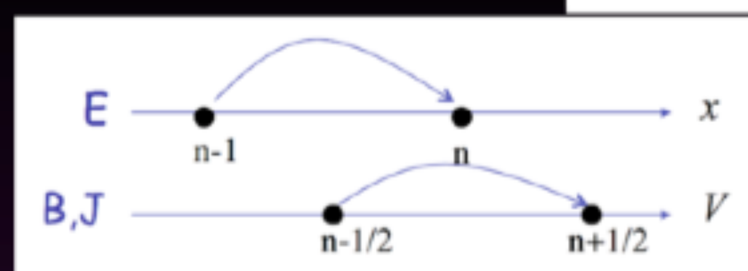
$$\partial_t B = -\nabla \times E,$$
$$\partial_t E = \nabla \times B - J.$$

$$\nabla \cdot E = \rho,$$
$$\nabla \cdot B = 0.$$

STAGGERING in time (leapfrog):

- second-order accurate in time

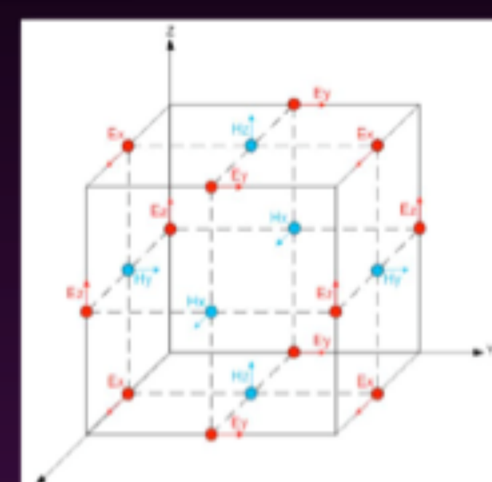
$$E^{n+1/2} = E^{n-1/2} + \Delta t[c(\nabla \times B^n) - 4\pi J^n]$$
$$B^{n+1} = B^n - c\Delta t \nabla \times E^{n+1/2}.$$



STAGGERING in space (Yee's mesh):

- electric fields on cell edges, magnetic fields on cell faces
- second-order accurate in space
- maintains divergence-free B

$$\partial_t B = -\nabla \times E,$$
$$\partial_t E = \nabla \times B - J$$



2. Interpolate fields to particle positions

- The fields obtained from Maxwell's equations are determined only at the grid points, they need to be interpolated to the particle positions.
- The interpolation is done by assuming a particle shape function.
- The shape function needs to be:
  1. isotropic
  2. zero outside some range
  3. higher order B-splines are computationally more expensive, but more accurate and less "collisional"