AA 545 Kinetic Modeling
Vlasov-Poisson PIC
Part 1

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This report shows results of a computer code that evolves free streaming particles in phase space ($\mathbf{x}$, $\mathbf{v}_x$) and in one dimension. Forces and collisions are ignored. The position is evolved and the velocity of each particle is constant. Each particle i position evolution from time n to time $n+1$ is given by

$$\mathbf{x}_i^{n+1} = \mathbf{x}_i^n + \mathbf{v}_i dt. \tag{1}$$

The code works with arbitrary number of particles. Periodic boundary conditions in the x-direction are implemented. The particle positions are randomly initialized using an uniform distribution between $x = [-2\pi, 2\pi]$ and the velocity is randomly initialized using a Maxwellian distribution $v_x = [-5, 5]$ with a FWHM of 2. The code is implemented in python. The total kinetic energy is calculated at each time step by

$$E_{tot} = \frac{1}{2} m \sum_i v_i^2. \tag{2}$$

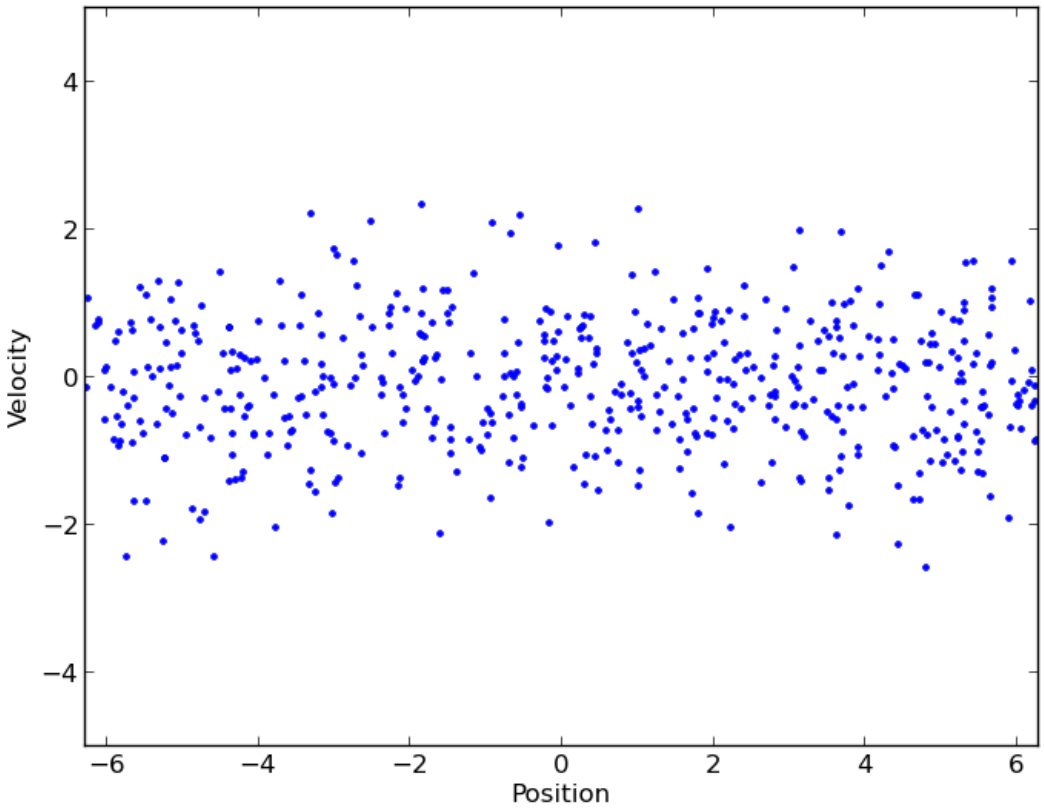

Figure 1: Position and velocity plots at $t = 0$ using $N = 512$ particles.

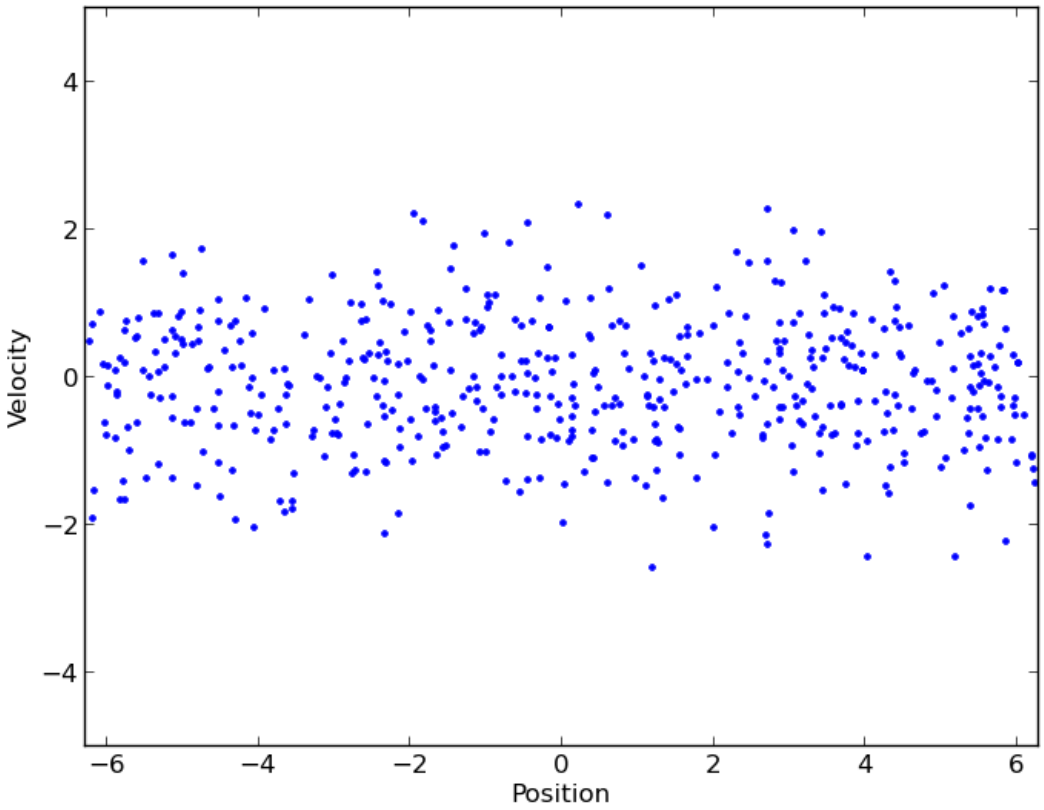

Figure 2: Position and velocity at $t = 2\pi$ using $N = 512$ particles.

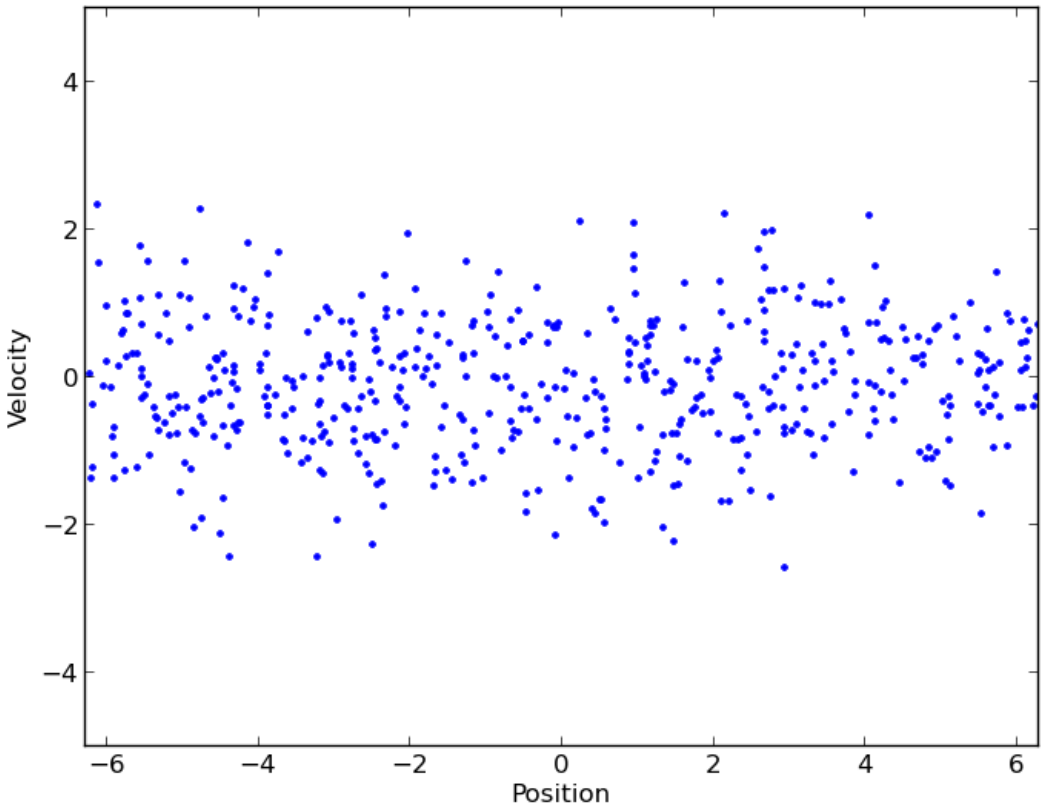

Figure 3: Particle position and velocity at $t = 8\pi$ using $N = 512$ particles.

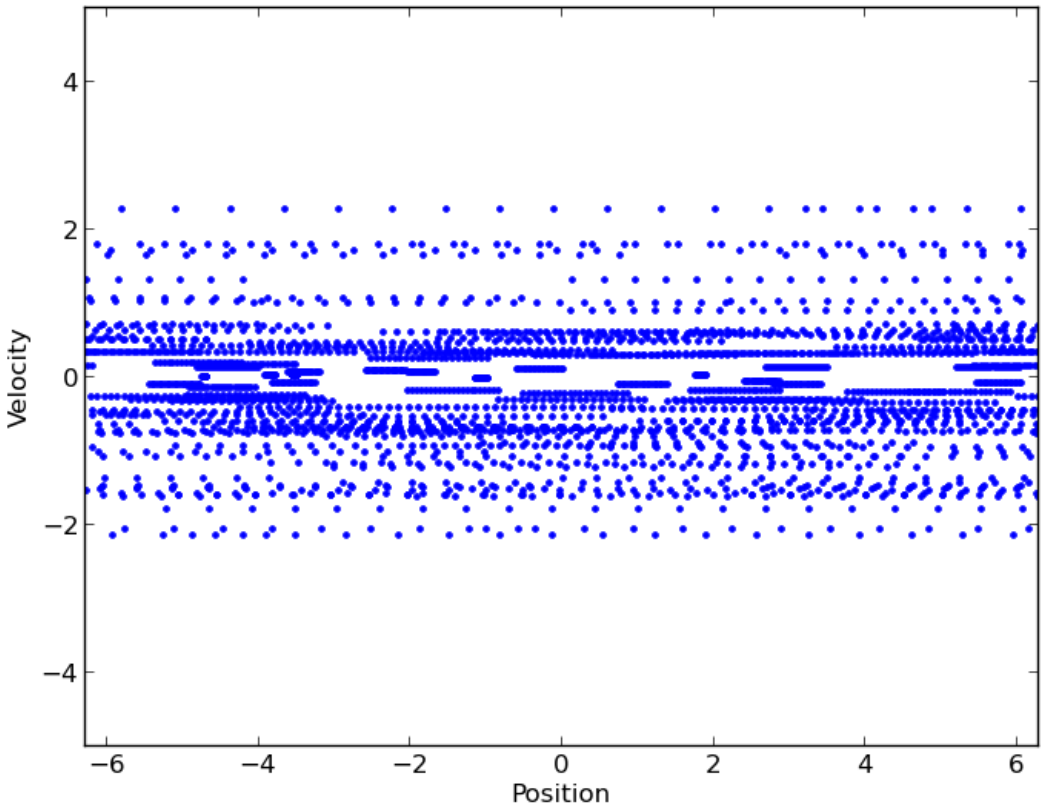

Figure 4: Particle trajectory and velocity at $t = 2\pi$ using $N = 128$ particles.

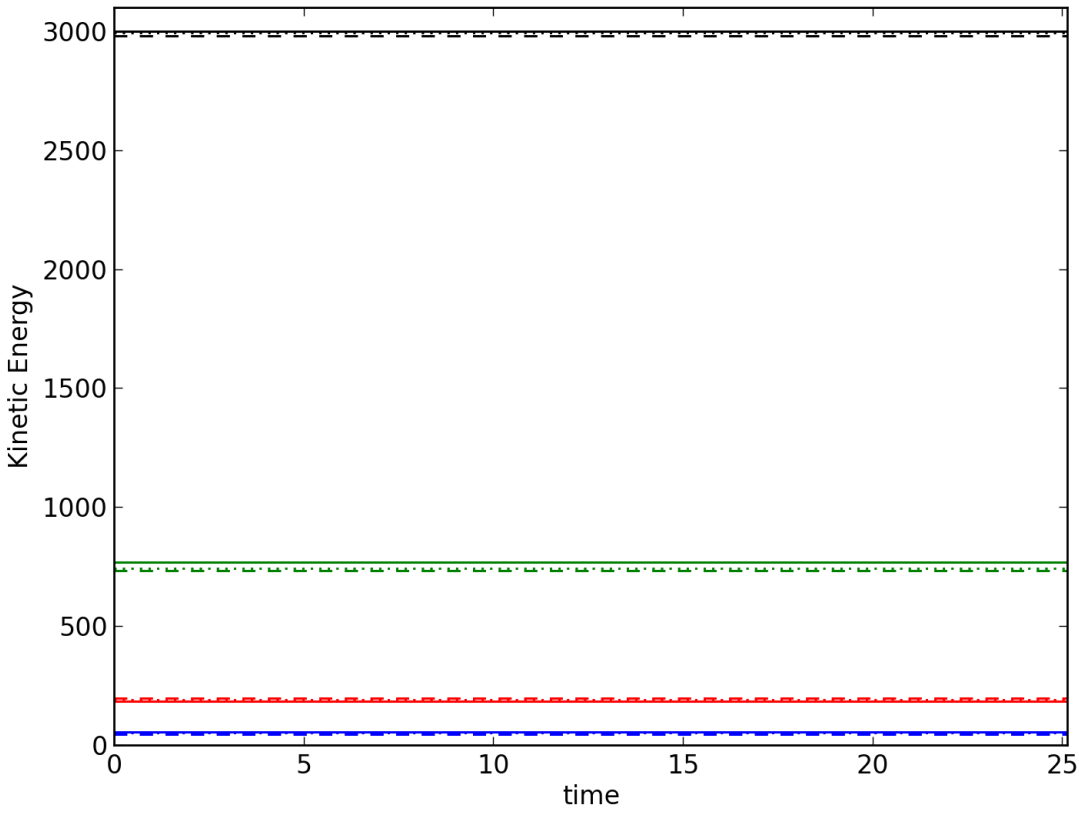

Figure 5: Kinetic energy history for different number of particle (**N=128**, **N=512**, **N=2048**, **N=8192**) and for different time steps (**−: dt=1.57**, **−−: dt=0.79**, **...: dt=0.39**).

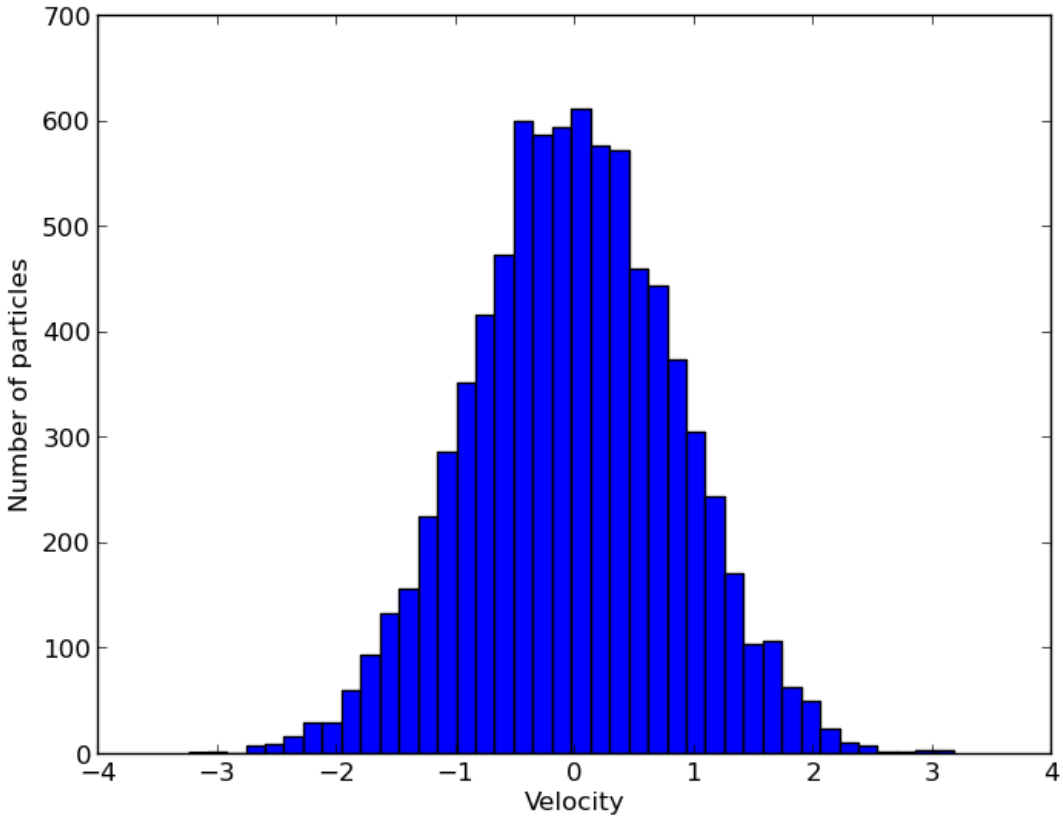

Figure 6: Particle velocity histogram for $N = 8192$ particles at $t = 0$.