# Relativistic Dynamics in 1D with a constant force

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 In these exercises, you will determine the motion of a proton in a uniform electric field. We will begin by simulating a proton in an electric field using the NON-relativistic version of Newton's 2nd Law. Then we will modify this simulation to take special relativity into account. In the process, we will observe the transition from non-relativistic to relativistic dynamics. In order to generate results, we will see that we need to be careful when working with non-SI units. In particular, we will need to pay close attention to factors of eV and $c$.

## Exercises

**Exercise 1:**

The file ending with "Version1" contains code to simulate a proton in an electric field using the non-relativistic acceleration derived above. (This code uses the "Euler algorithm" described in the "Theory" section.) Execute this code, and look at the plots of position versus time and speed versus time. Explain why these plots have the shapes that they have.

# relativisticDynamicsVersion1.py

from pylab import \*

c = 2.998e8 # Speed of light in m/s

m = 0.938e9 # Mass in eV/c^2

Efield = 1 # Electric field in Volts per meter

x = 0 # Position in meters

v = 0 # Velocity in meters/second

t = 0 # Time in seconds

dt = 0.01 # Time STEP in seconds

# Create arrays using initial values

tArray = array(t)

xArray = array(x)

vArray = array(v)

while t < 1:

# The dynamics:

a = Efield \* c\*\*2 / m

t = t + dt

x = x + v\*dt

v = v + a\*dt

# Append the new values onto arrays

tArray = append(tArray, t)

xArray = append(xArray, x)

vArray = append(vArray, v)

# Create plots

figure(1)

plot(tArray, vArray)

xlabel('Time (sec)')

ylabel('Speed (m/s)')

grid(True)

show()

figure(2)

plot(tArray, xArray)

xlabel('Time (sec)')

ylabel('Position (m)')

grid(True)

show()