1, Process1: elastic process with the function like a*exp(b/Te+c), input (a ,b ,c, Te, density_list, mass, temperature) return coefficient rate, rate of density change, and energy change (all the process function have same output format including coefficient rate, rate of density change and energy change)

2, process 2, function like a*(Te^b)*exp(c/Te), input: a, b, c, Te, density list and energy change which is constant. Density_list contains the density of every reactors, and it is used to calculate the density change rate.

3, process 3: function a*density1 (constant) /density2, input a, density1, density2, energy change, density list.

4, process 4: function like a*Te^b, input: a, b, Te, density list and energy change.

5, process 5: function like a, input: a, density list and energy change,

6, process 6: function like diffusion coefficient/ diffusion length^2, input diffusion coefficient, diffusion length, density list and energy change.

7, Electron energy change: electron_density , power , volume, energy_list(contain all the energy from all the process in a system).

Arvalue: a list used to save the density of Ar in every step.

Ar1value: a list used to save the density of Ar*.

A_rvalue: a list used to save the density of Ar+.

Used for loop as time evolution.

For loop starts,

Calculate the power (after 200 us or not)

Calculate the rate coefficient, density change rate and energy change for every function by process functions above.

Form them as 3 list: [rc1, rc2…rc11], [dcr1, dcr2, dcr3…. dcr11], [ec1, ec2 ,…. ec11]

For each particle, there is a list to record if it is a reactor or not in every reaction. This list is the same length as the 3 list above. -1 as reactor, 1 as product and 0 as not in this equation. (In function 9, I used -2 for Ar* because it appears twice in the reactors.

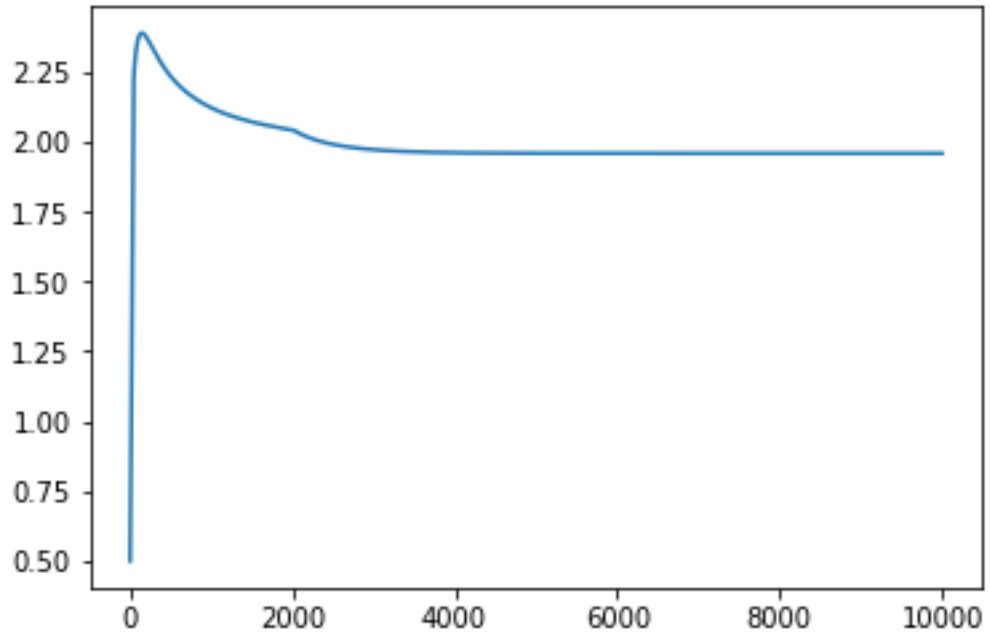
Multiply density change rate list and reaction list of each particle and sum it up. The calculate the density of each particle based on the time step and previous density.

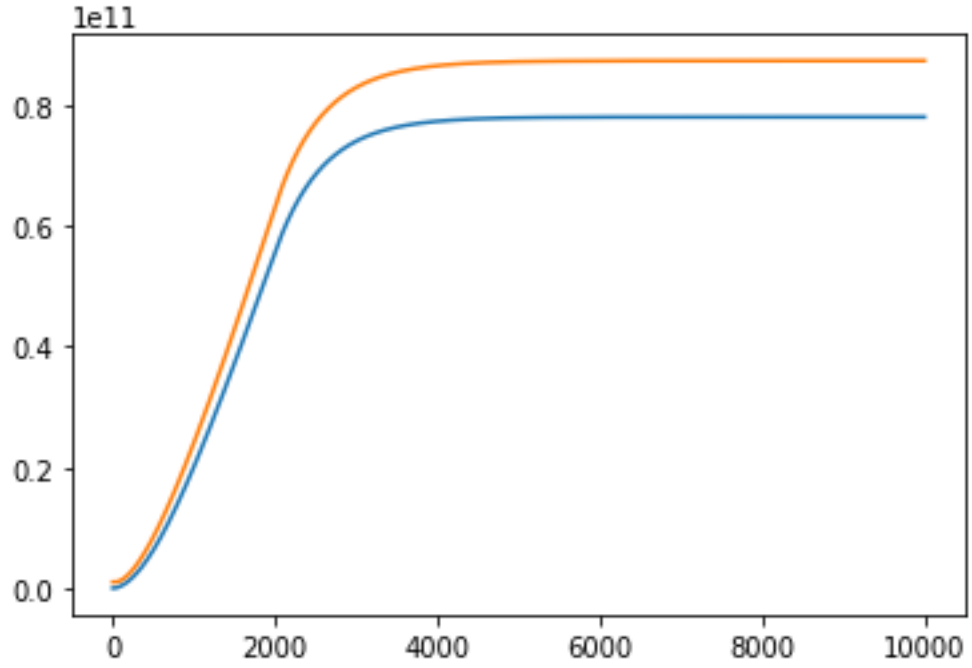
Calculate the dTe and Te.

Record the value of Ar, Ar* and Ar+.

For loop ends

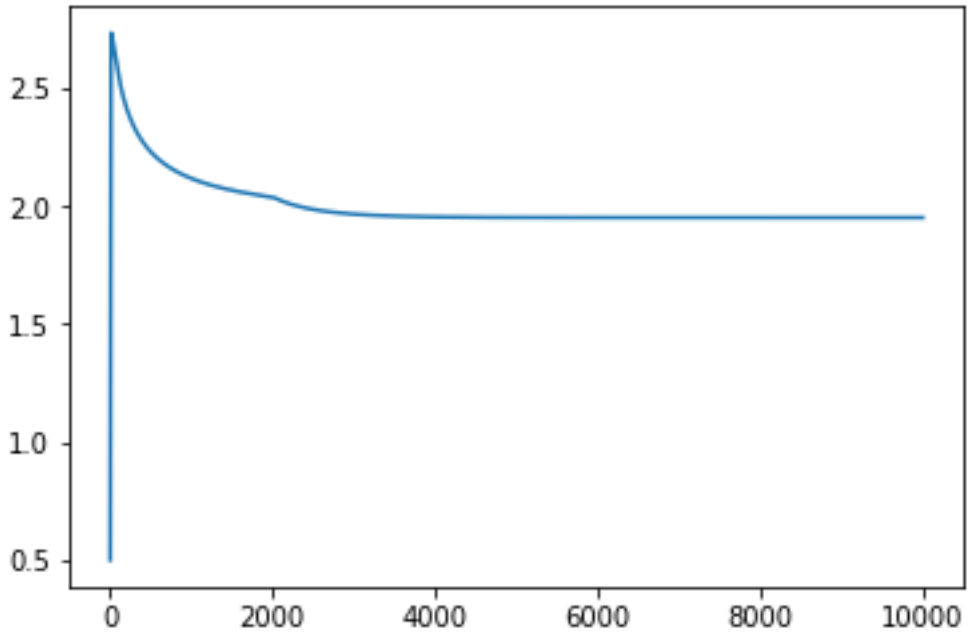
2, Te



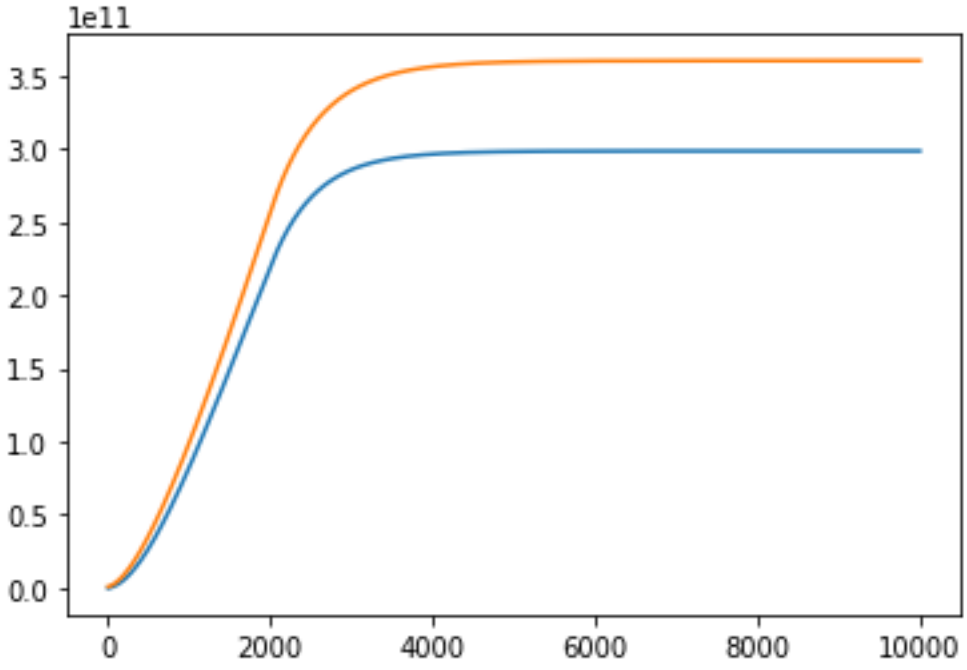


Orange Ar+

Blue Ar*

3, 

Te



Orange Ar+

Blue Ar*

2,a, Firstly, we separate the Te as 2 part,

Te1 (change as power change)

Te2 (change as density change)

Te1+Te2=Te

Te1 is power/volumn <power=400w/volumn ~10^17

At first the effect of power affect Te much more than the other part, but with evolution the particle density increased greatly and becomes the dominant factor which affected Te. In this way with power change, Te changed a little because of the little change of the other part

b, I do not really know the answer. But from the paper we read in HW1, with power increase, there will be more multi-step ionization which means more electron will be created. Thus more Ar+ will be created. However, when we increase the power, more Ar will be excited and become Ar*. I am not sure why the rate coefficient value of multi-step ionization is much larger than the rate coefficient of Ar---Ar*.

c, From the power change from 0-100-400, it is hard to conclude that Ar* will achieve constant as power keep increasing. But I guess this is because with power increases, the contribution to the ionization percentage of multistep-ionization become constant. And I think this means the rate of creating Ar* and Ar*- Ar+ comes to a balance, thus, the density of Ar* does not change too much and finally reach to an constant.

4,a, Te=1.95eV

Ar*=6.6*10^10

Ar+=7.3*10^10

b, 2 reasons:1, there is only one reaction related to e and due to the low density of im and e compared to Ar+Ar*+Ar+, the change rate of density is pretty low thus change a little bit about Te.

2, there is no im ion, So there will be no new electron be created. This is also a reason why the Te changes a little.

c, When we introduced im to the system, some existed electron are used to react with im. The total number of electron won't change and thus the electrons used to produce Ar+ and Ar* are less so the density of Ar+ and Ar* decrease.