TARGISOL hands on session.

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Abstract

Imagine that we sample n pairs of uniform random numbers $\{rand_x(i),\ rand_y(i)\}$ between 0 and 1 and that we check whether these coordinates are within a circle of radius 1, i.e. $rand_x^2(i) + rand_y^2(i) < 1$. For big samples, the fraction of points of inside the circle will tend to the ratio of areas between the circle of radius 1 and the square of side $2 \cdot 1$, thus $f \rightarrow \frac{(1^2 \cdot \pi)}{2^2} = \pi$. This is a way to compute π. Similar schemes can be applied to reproduce physical laws in the so-called Monte Carlo codes. `RIBO` is a MC code that simulates the transport of atoms and isotopes, including the laws of collisions in the walls, ionization ...

1 Effusion

1. `RIBO` needs reads the data from an input file and it allows to set up many options at runtime. The input file is divided in four cards, the first defining the bodies of the system (planes, cylinders, ellipsoids ...) which are described by the 10 parameters of a quadric (plus the body number, a free parameter and the temperature, defined at the beginning of each line.). Each body occupies a line. The second card contains the boolean logics (intersection) that defines the cells in terms of the bodies. The third card has the source parameters and the fifth one the tally options (end conditions).

   (a) How many surfaces has the input file ellipse.t?

   (b) What kind of surfaces can you identify?

   (c) How many regions are there? what do you think that it could be the first region?

   (d) Make a 3D plot of the geometry by typing 'bash 3D-view ellipse.t 3'

   (e) Plot a trajectory that contains between 400 and 450 collisions. Use trajectory.sh *A- bash trajectory.sh; 450 400; 8 2 2; -2 -2 -2*

2. Now run the simulation code specifying the following parameters: **Name of the input file** ellipse.t, **Name of the output file** ellipse.out, **histogram mode(Y,N)** N, **Source limited ...** 1, **what kind of ionization?** 1, **SELECT MODE ...** 2, **CHOOSE THE OUTPUT MODE** 3, **What kind of treatment ...** B, **Average energy(Y,N)** Y, **Sticking time** 0, **target filling** S, **residual pressure?** 0

   (a) By consulting the output file, find out the 'Average intrinsic delay time'
   A- It fluctuates (stochastic figure). $\simeq 7.4\ ms$

   (b) What was the 'Average free path'? what was the average distance between 2 consecutive collisions
   A- Around 7 m in total!! 1.54 cm between collisions.

   (c) What is the average number of collisions? Where do they mostly take place?
   A- Around 450, 360 take place in the target oven (the ellipse).

3. A batch file has been created. Open it. It contains all the run-time instructions. Save it as batch1.

   (a) Rename ellipse.out as ellipse.out1. Re-run the simulation by doing './RIBO<batch1'. Compare the new results with the former ones.

   (b) Edit ellipse.t and change the mass of the isotope from 7 to 14. Rerun the simulation. What is the average flight path? And the average release time?
   A- The trajectory is not changed, but the speed changes, $v \sim \sqrt{1/M}$.

   (c) Reestablish the mass to 7. Edit the batch1 file to change the sticking time from 0 to 0.01 s. Re-simulate. What is the average flight path? And the average release time?

   (d) Set again the sticking time to 0. Rerun the simulations. Imagine that in an experiment of TARGISOL we had measured an average release time of 1.0 s. What sticking time could we infer from this measurement?
   A- ./RIBO<batch1.
   $measured\,time = < rel.\,time(t_s = 0) > + (< collisions > \cdot < sticking\ time/collision >)$
   $\Rightarrow \ < sticking\ time\ per\ collision > \rightarrow \frac{1.5 - 0.07}{445} = 3.2\ ms$

   (e) Imagine that we had a source of photons in the sphere 1, instead of atoms X. Let us suppose that the walls of the system acted as optic guides with mirror-like reflection and that $1\ \%$ of the light intensity would be lost upon each reflection. What would be the intenisty of

light at the exit?

A- Edit batch1 and replace the collision law B (diffuse reflections) by S (specular). ./RIBO<batch1. $I \rightarrow I_0 \cdot 0.99^{440} = 0.012\cdot$

4. Transfer lines may have a chemical selection roll. They may absorb certain species, cleaning the beam and preventing the ion source to be quench by overload of malicious impurities. In the input file the decimal part of second numbers in the *Surfaces* card contains the adsorption coefficient in $\%$, e.g. the third surface has 0.02, thus each time a particle hits that surface it has 2 $\%$ of chances to remain stuck.

   (a) Edit the batch1 file and replace the option 'No ionization' by 'Adsorption', that is, change the 1 in the fifth entry by a 4. Rerun the simulation to obtain what is the cleaning efficiency of a certain unwanted isobar that has an absorption coefficient of 0.02 (2 $\%$)

   A- 4(S); ./RIBO<batch1; in output file adsorption "efficiency" $\rightarrow$ *71.24* $\%$.

   (b) The geometric viewing factor is an important figure for radiation calculations. What would the view factor between the source sphere and the exit hole?

   A- set 0.99999 in the second number of all surfaces to establish full absorption. Since the source is isotropic, the view factor is $\rightarrow \ 1 - 0.9986$ *the solid angle would be* $4\pi \cdot (1 - 0.9986)$

2 Ionization

1. Run again the program interactively (./RIBO) but this time choose surface ionization, specify that there is only one ionizing cell (number 3) with a single ionizing cell (number 3), and imagine that the atom is Li(z=3) and the substrate is W(z=74). What is the ionization efficiency?

2. Repeat the calculation with an electric field $E_x = 10000$

   A- Edit readEfield.f and recompile (bash compile.sh) Then do ./RIBO<batch1