QUIZ 2
OPTICAL TWEEZERS
-Group 2G

Theory:

The motion of the trapped particle can be described by Langevin equation as shown below:

$\gamma \dot{b} + \kappa b = F_{th}$

Where γ is the drag coefficient (= 3πηD), on particle of size D, η is viscosity of the medium and F_{th} random thermal forces with white noise floor given by $2k_B\gamma T$.

Aim:

The aim of the assignment is to find the motion of the particle, according to the Langevin equation and thus plot the RMS distance of the particle as a function of temperature.

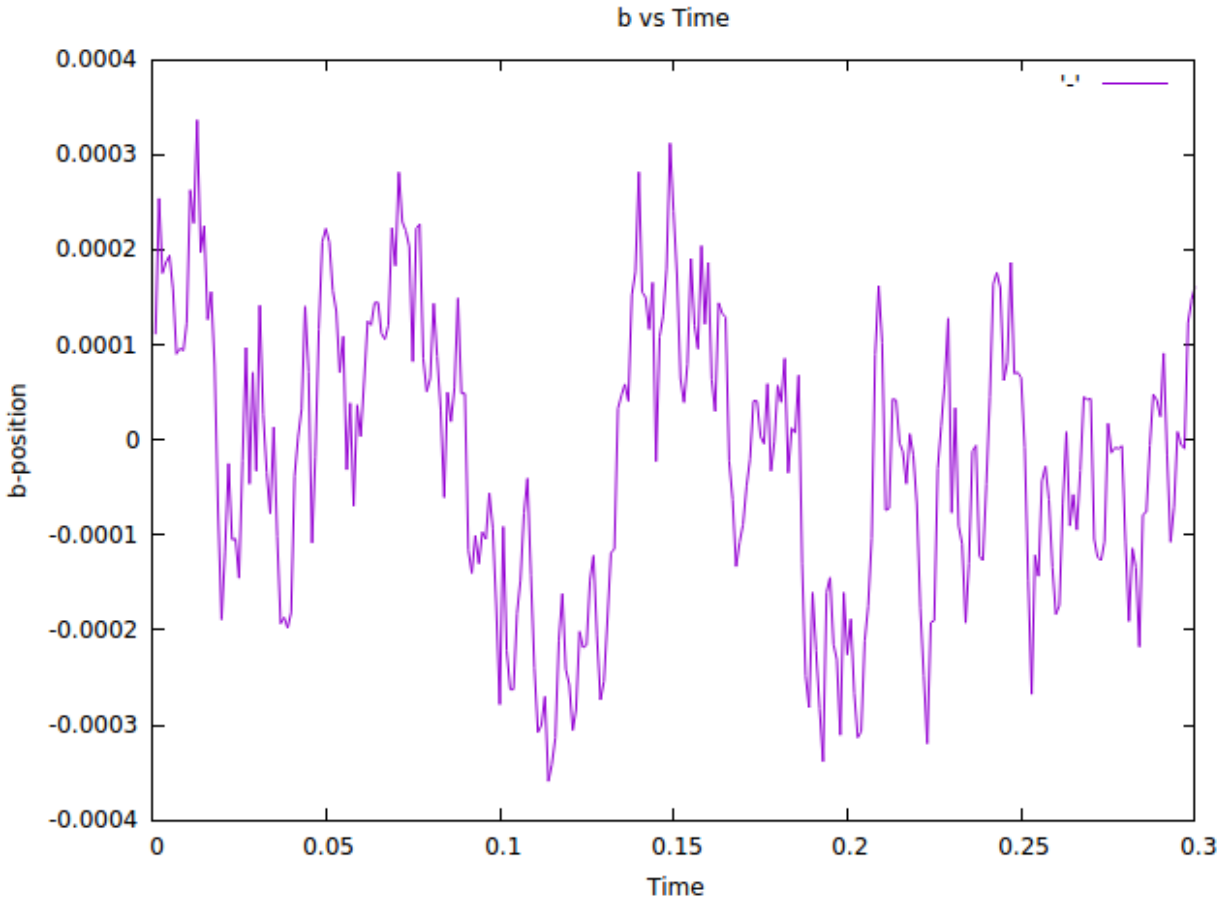
Method:

There are three important parts of the program:
1) Randomizing the value of thermal forces to vary from $-2k_B\gamma T$ to $2k_B\gamma T$ using the F function.
2) Plotting the b (position of particle) vs the time graph for temperature equal to starting temperature.
3) Plotting RMS values of b (position of particle) vs Temperature ranging from starting to final temperature.

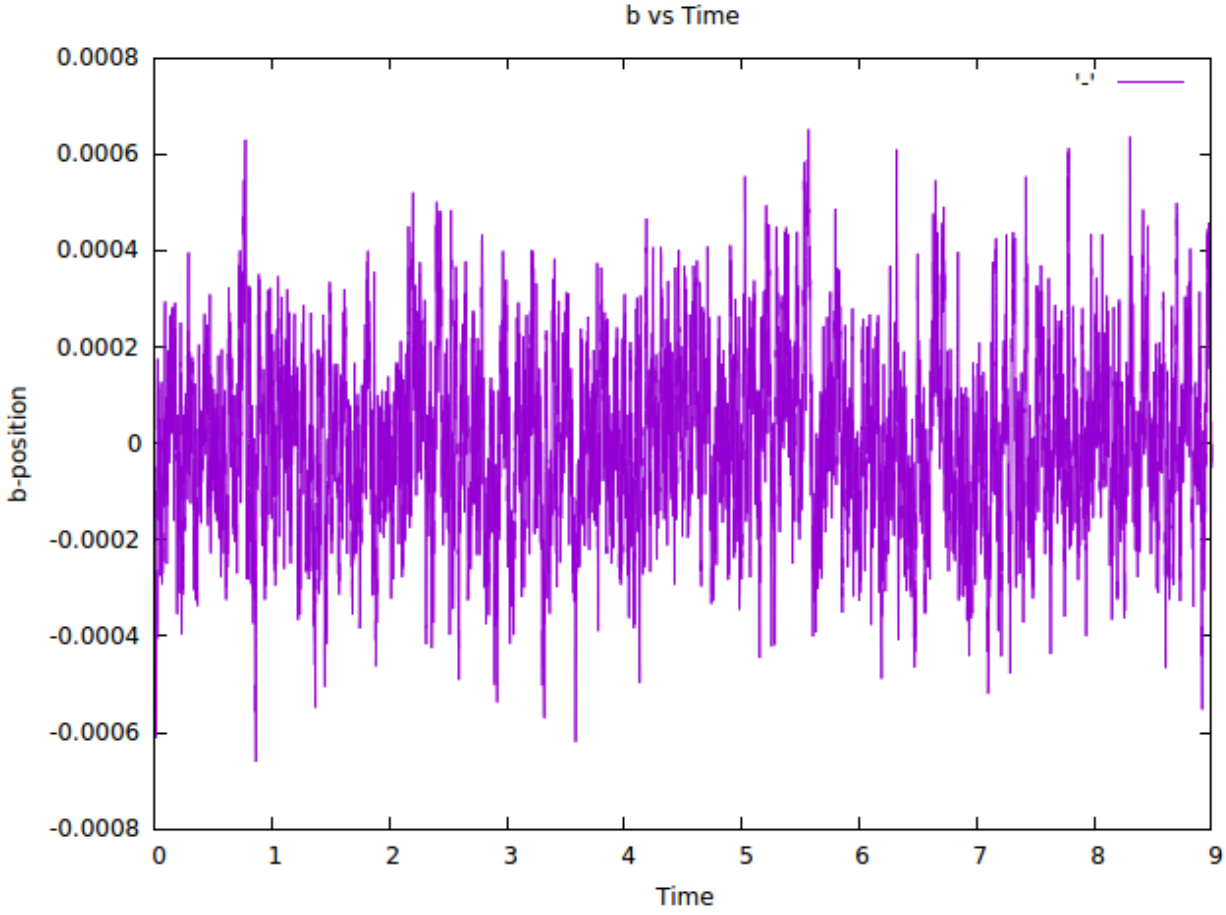
- We had solved the differential equation of b(position of the particle) by the Runge-Kutta 4th order method.
- The thermal forces are randomized by the F function such that they vary from $-2k_B\gamma T$ to $2k_B\gamma T$.
- Thus we obtain different values of force for different values of time and thus different values of b (position of the particle).
- Now we put the values of time (through timestep) and corresponding b values into a file and thus plot it through gnuplot (We take temperature to be the starting temperature which is taken from the user).
- Now, we find the RMS values of b for values of temperatures starting from the starting temperature which is input by the user. The final temperature is also input form the user.
- Now,we put the values of RMS of b and temperatures into a file and thus plot it using gnuplot.

OBSERVATIONS:

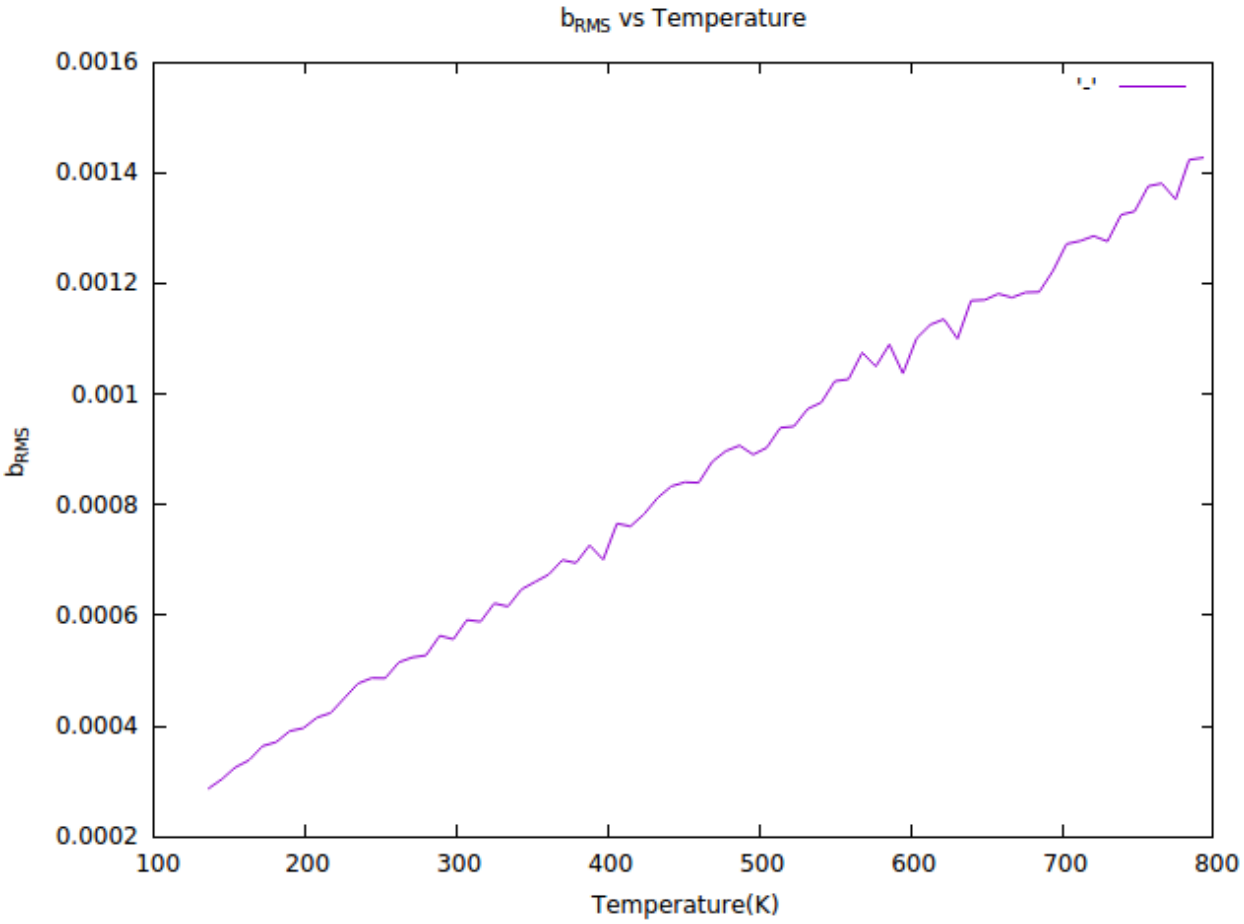
We obtain a graph of b vs time for a smaller number of iterations so as to observe the nature of its displacements over time. This graph shows this:



But to find appropriate RMS values, we take it over a much longer time to obtain this saturated graph:



So finally, we obtain a striking observation- Brms has a linear relation with temperature!!!



CONCLUSION:

The value of the root mean square of position over a large period of time is linearly related to temperature

Thank You!