Mathematical modelling of Drude model using biased random walk

By Sayantan Mondal

#Mathematical modelling of Drude model by 1D random walk between two end points A (left) and B (right), separated by N steps.

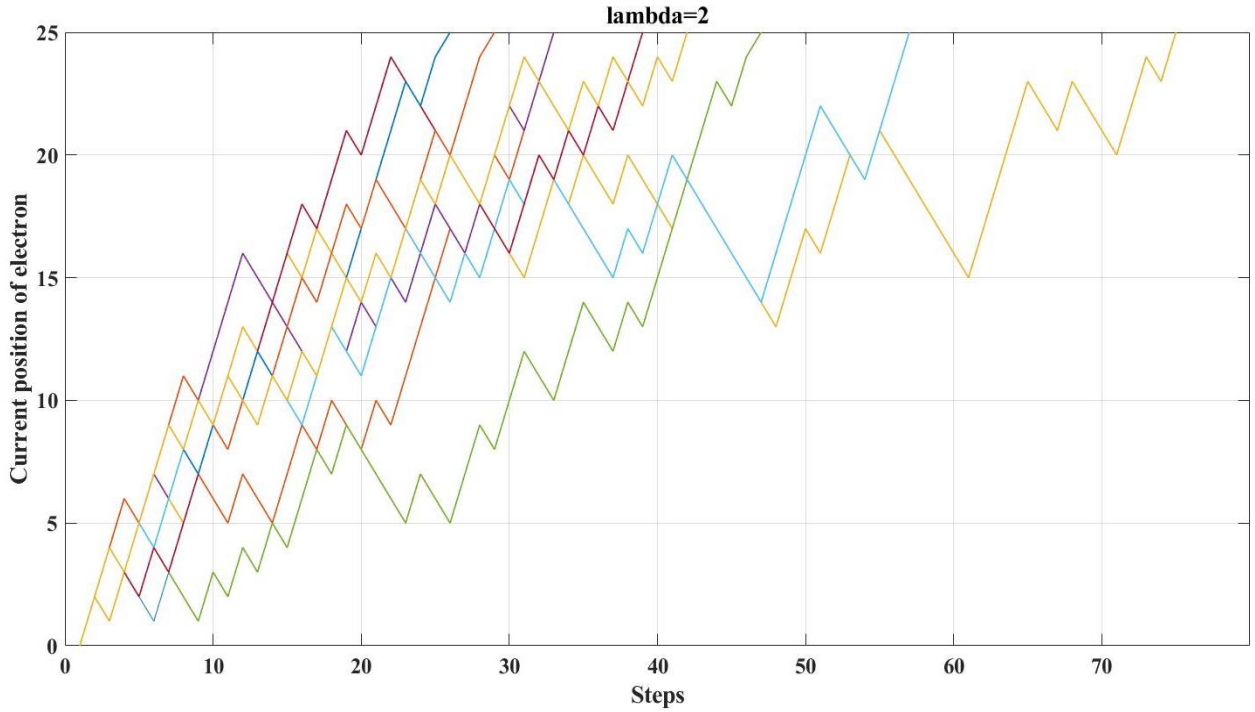
#Finite probability for the electron to go the left is (pl), and that to right is (pr) such that pr + pl = 1 and pr/pl = λ, where λ is greater than 1 as it is a biased random walk**.**

#Under normal condition number of steps taken by an electron to go from A to B is N and post biased walk let the number of steps taken be N'.

Below is the plots obtained for various random walk simulations and the possible trajectory that can be followed for 10 different iteration in random. The value of N is fixed to 25 in the first case and varied by fixing λ in the second case.

a)

For λ=2, we have-



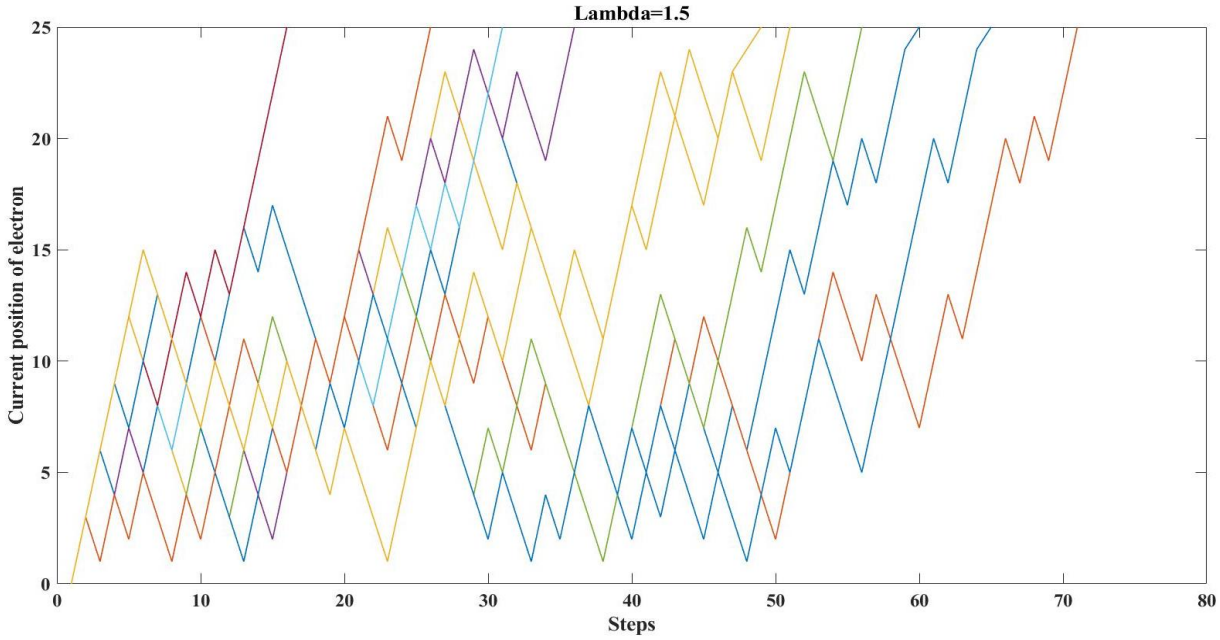
No of steps after each simulation for value of N'

43	51	47	51	71	83	59	43	47	63

Average value of N'=55.8≈56;

Standard deviation= 13.1724;

For λ=1.5 we have-



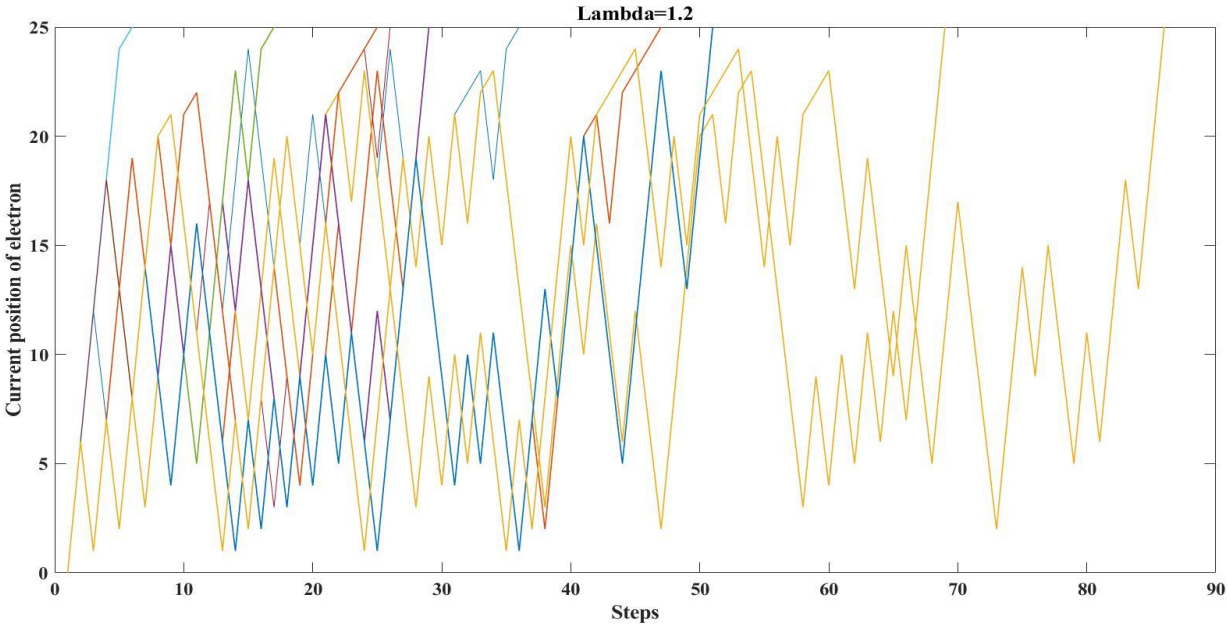
No of steps after each simulation for value of N'

149	173	125	89	137	77	41	161	65	125

Average value of N'=114.2≈114;

Standard deviation= 43.9818;

For λ=1.2 we have –



No of steps after each simulation for value of N'

215	375	395	155	95	35	150	275	155	515

Average value of N'=236.5≈237;

Standard deviation=150.9976;

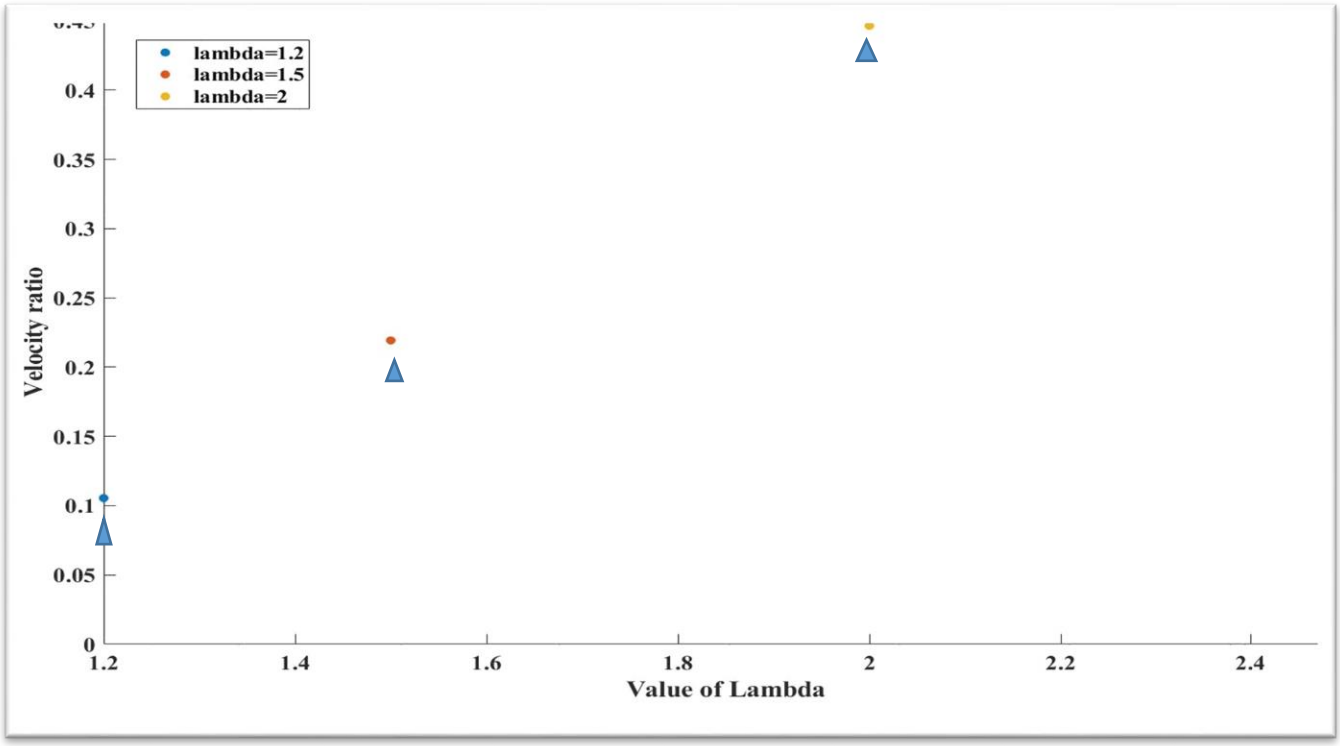
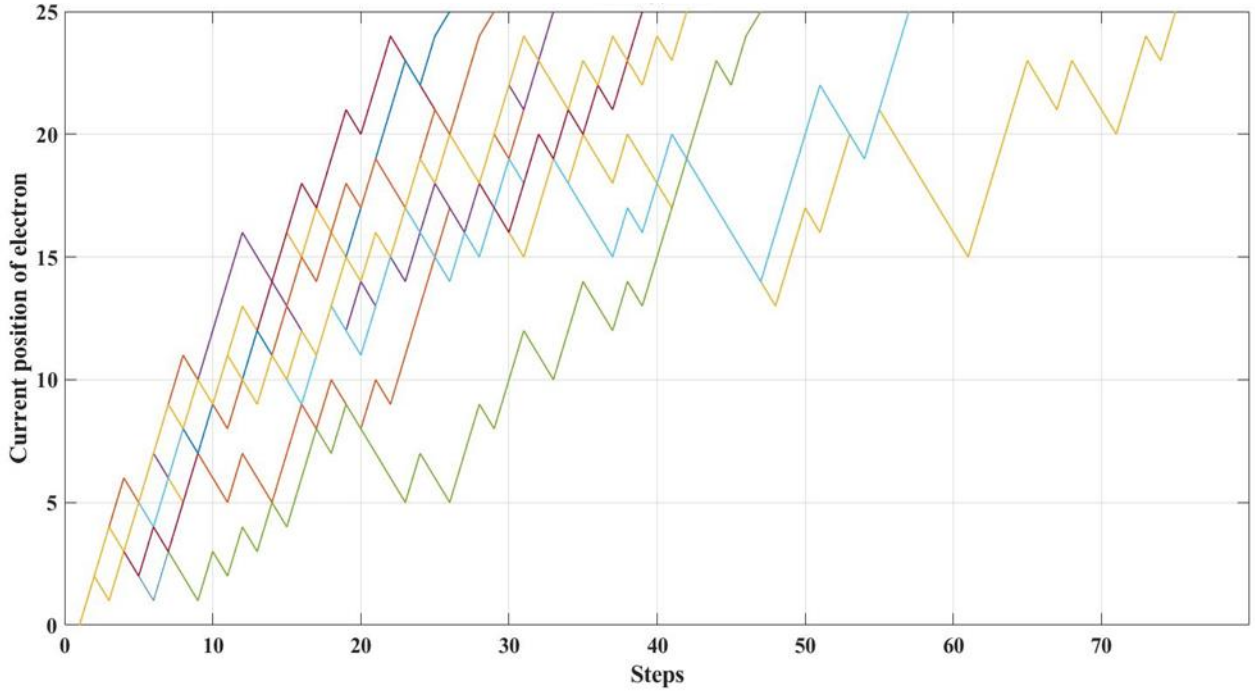


Fig.3 Shows the variation of velocity ratio with lambda

Conclusion: Hence the velocity ratio increases with value of λ, as can be seen from the above graph.

Taking a constant value of λ =2 and varying value of N we have.

For λ =2 and N=25;



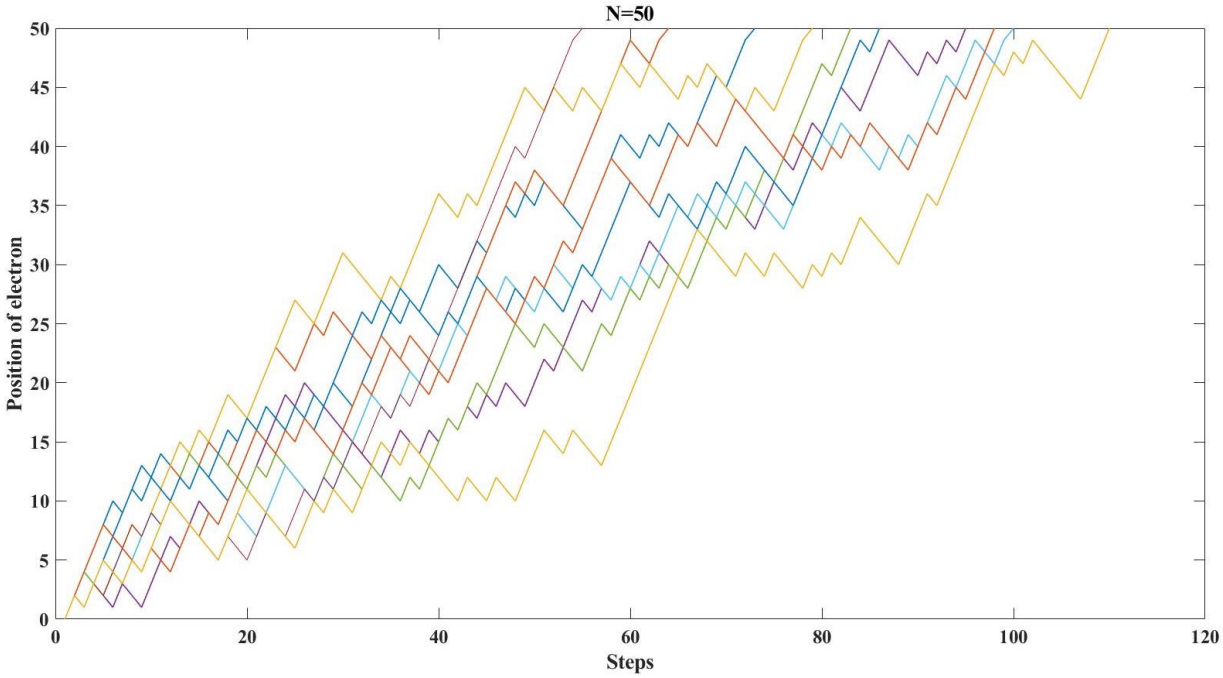
No of steps after each simulation for value of N'

43	51	47	51	71	83	59	43	47	63

Average value of N'=55.8≈56

Standard deviation=13.1724

For λ=2 and N=50;



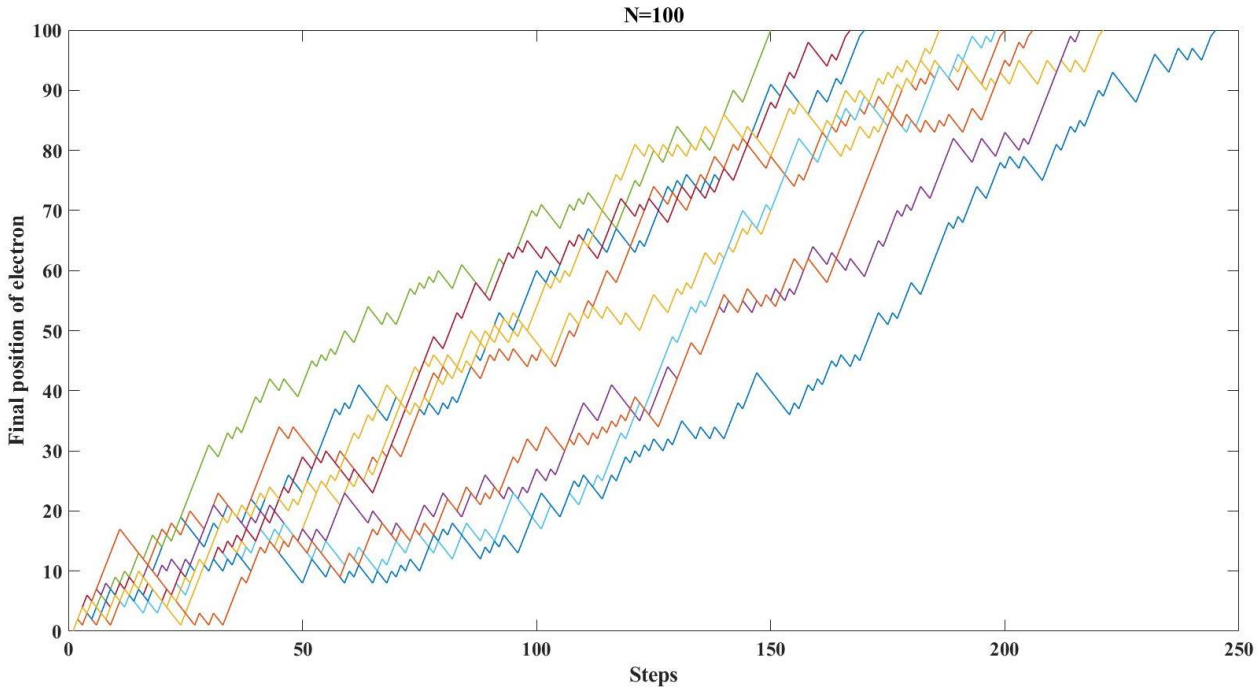
No of steps after each simulation for value of N'

114	102	122	142	126	150	90	130	146	163

Average value of N'=128.5≈129

Standard deviation= 22.5746

For λ=2 and N=100;



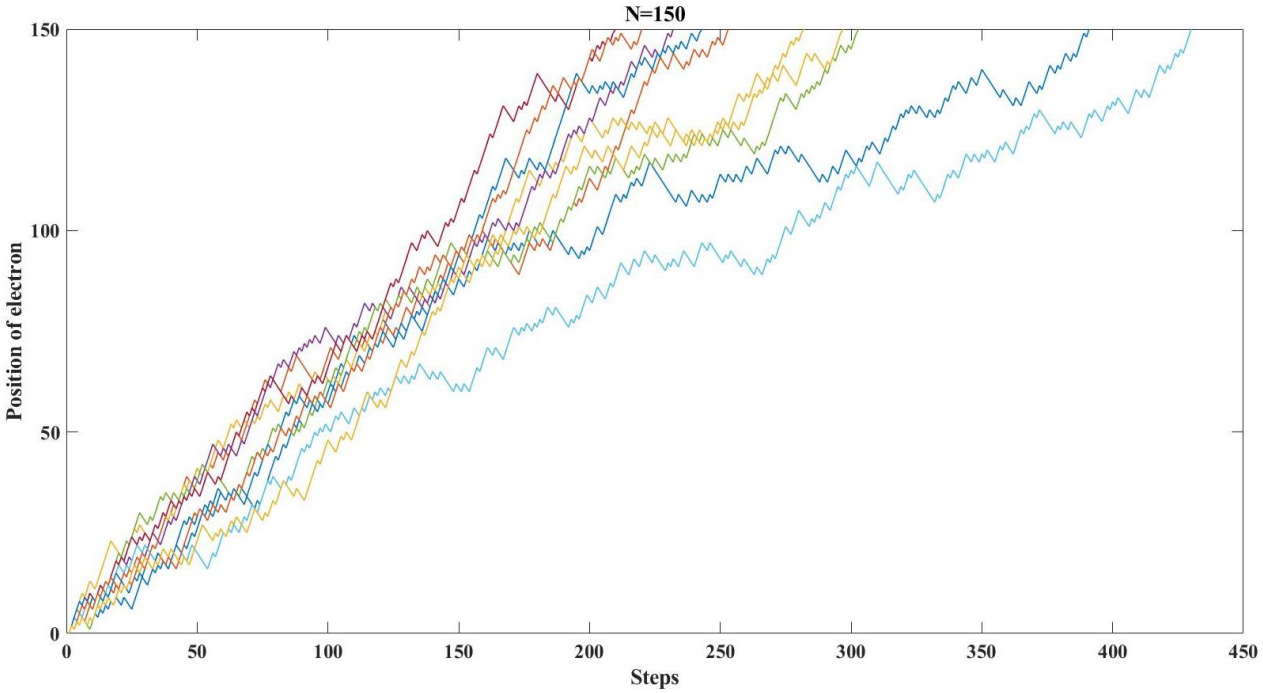
No of steps after each simulation for value of N'

260	300	328	320	232	296	256	360	308	280

Average value of N'=294

Standard deviation= 38.0993

For λ=2 and N=150;



No of steps after each simulation for value of N'

570	386	426	358	454	622	330	374	342	446

Average value of N'=430.8≈431

Standard deviation= 97.3571

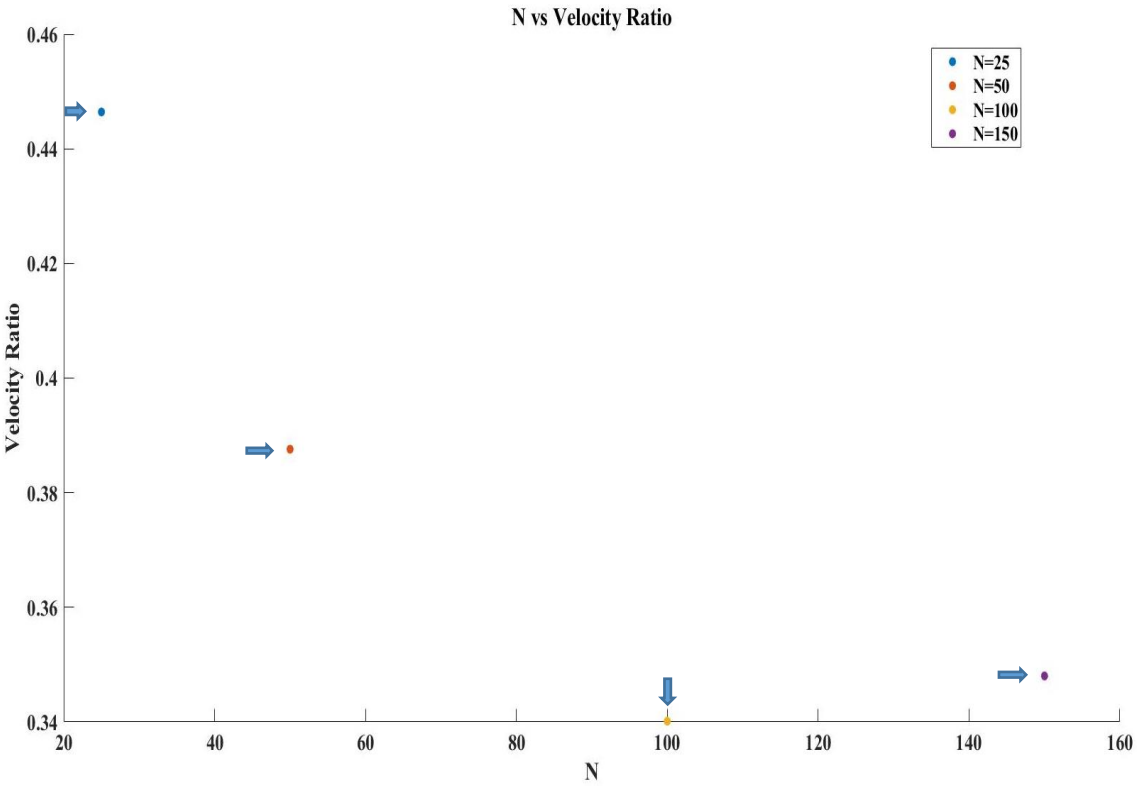


Fig 4. - Velocity ratio vs. N