27th Feb 2014

Course: Biophysics

Problem Set: 3

Due: 6th March 2014

4.5 *Perrin's experiment*

Figure 4.17 shows some experimental data on Brownian motion taken by Jean Perrin. Perrin took colloidal particles of gutta-percha (natural rubber), with radius 0.37 μm. He watched their projections into the xy plane, so the two-dimensional random walk should describe their motions. Following a suggestion of his colleague P. Langevin, Perrin observed the location of a particle, waited 30 s, then observed again and plotted the net displacement in that time interval. He collected 508 data points in this way and calculated the root-mean-square displacement to be $d = 7.84\ \mu$m. The concentric circles drawn on the figure have radii $d/4$, $2d/4$, $3d/4$, ...

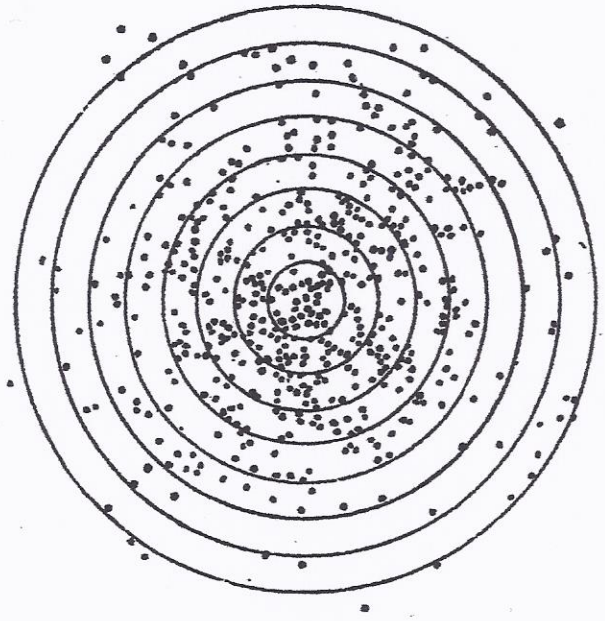

Figure 4.17: (Experimental data.) See Problem 4.5. [From Perrin, 1948.]

a. Find the expected coefficient of friction for a sphere of radius 0.37 μm, using the Stokes formula (Equation 4.14). Then work out the predicted value of d, using the Einstein relation (Equation 4.16) and compare with the measured value.

b. T_2 How many dots do you expect to find in each of the rings? How do your expectations compare with the actual numbers?