RANDOM WALKS AND FLIGHTS

Due Date: 1/23/2014 @ 8:00 am

Random walk is a type of motion where directions and sizes of consecutive steps are drawn from a random distribution. Various random walks are applicable to diverse topics in astronomy, biology, and social sciences, among others. The usual example of a random walk is Brownian motion, a random motion of particles floating in fluid and colliding with fluid's molecules. A very localized distribution of die in a form of a tiny droplet floating in water will diffuse with time. Lengths of random walk steps of die particles are distributed according to the normal distribution, and dispersion of particles is proportional to the square root of time ($\sigma^2(t) \propto t$). There are other types of diffusion, sometimes called anomalous diffusion, where distribution of step lengths is not normal, but follows an inverse power law:

$$p(d) \propto d^{-\mu},$$

where $1 < \mu < 3$. Because of the nature of the power law very large steps (called Lévy flights) are not uncommon. Dispersion in these cases has a time dependant form of $\sigma^2(t) \propto t^{\gamma}$, where γ depends on parameter μ.

The goal of this exercise is to study different kinds of random walks and determine different types of diffusion processes.

- Write a single function that will accept all necessary parameters and will be able to simulate various random walks (Brownian motion and walks where the distribution of steps follows an inverse power law). Submit a copy of this function with your report.
- For normal and anomalous diffusion with different values of μ create plots for several walks after N steps. Pay attention to very large steps when analysing anomalous diffusion.
- For a few selected values of μ determine the time dependence parameter γ.
- Discuss all results!