Newton's laws in Brownian motion (submitted to Nature Communications 21/07/17)

The zigzag motion of microscopic organic and inorganic particles, described by botanist Robert Brown (1828) [1], has been attributed to an effect of random collisions with kinetic water molecules, a proposal that disregards the mass discrepancy between the colliding objects [2].

Discussion

Since 1905, collisions with randomly moving water molecules represented the accepted cause of Brownian particle motion. However, there is an extreme weight difference between a Brownian particle and a water molecule. Compare a Brownian particle 2.79 microns in diameter (0.00279 mm) to a water molecule (d = 0.000000279 mm). The particle is 0.00279 / 0.000000279 (i.e., 10,000) times the diameter of a water molecule. Since mass varies directly with volume (a cubic function of the radius), the particle weighs in the order of $10{,}000^3$ (one trillion) times a water molecule's mass.

In gravity-free outer space, if a motionless polyethylene ball were struck by a similar ball, moving at velocity, v, the collision would impart some of the moving ball's momentum to the stationary ball. Since the balls have identical S.G., the velocity gained by the stationary ball would equal the velocity lost by the striking ball – which is axiomatic, using the Law of Conservation of Momentum (directly related to Newton's Laws of Motion) [3].

If the motionless ball were struck similarly by a polyethylene ball $1/100^{th}$ its weight, the transfer of velocity from the collision to the larger ball would be $1/100^{th}$ the velocity gained by a collision of two balls of the same size. If the weight of the striking ball were one trillionth the mass of the stationary ball, there would be no visually discernable motion imparted to the stationary ball. In outer space, any velocity gained by the motionless ball would not be affected by the mass and viscosity of any surrounding fluid, such as water in an Earth setting.

Now consider a polyethylene ball of colloidal size, not suspended in outer space, but which is suspended in water as a Brownian particle. Suppose it were struck by a water molecule one trillionth its mass. No microscopically visible motion would be imparted to the sol particle by this collision, regardless of the water molecule velocity. Furthermore, with water molecule collisions occurring randomly on all Brownian particle surfaces from all directions, statistical randomness precludes visible zigzag Brownian particle motion through the mass and viscosity of water; there must be a statistical evenness of pressure on all sides of the particle.

Any logical explanation for Brownian motion must adhere to the principle of conservation of momentum as dictated by Newton's laws of motion. For example, in laboratory Brownian motion microscope set-ups, there has always been significant environmental sound of varying amplitude, frequency and direction; a sound wave transfers microscopically demonstrable vibratory action to anything in its path, such as the tympanum of a human, or of a hummingbird, or the tympanal organ of insects [4] – or a Brownian particle. A sound wave, with a wavelength of one centimeter would have a wave front made up of a mass of an infinitely large number of water molecules that would strike the Brownian particle at the speed of sound. Sound waves propel a particle away from the sound source [5].

Conclusion

It is untenable that Brownian motion is caused by random collisions between Brownian particles and water molecules.

[1] Brown, R., A brief account of microscopical observations made in the months of June, July, and August, 1827, on the particles contained in the pollen of plants; and on the general existence of active molecules in organic and inorganic bodies. Edinburgh New Philos. J. 5, 358–371 (1828)

[2] Einstein, A. Über die von der molekularkinetischen Theorie der Wärme geforderte Bewegung von in ruhenden Flüssigkeiten suspendierten Teilchen. Annalen der Physik, 322 (8): 549–560 1905

[3] Newton, I., Philosophiae Naturalis Principia Mathematica (1687)

[4] Hoy, R.R. and Robert, D., Tympanal hearing in insects. Annual Rev Entomol, 41:433-50 (1996)

[5] Liebermann, L.N., The second viscosity of liquids. Physical Review. *75: 1415-1422 (1949)*