Anomalous Brownian Motion is Expected

Classical Brownian theory describes uncharged particles

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Anomalous Brownian motion is an important subject attracting much recent attention.(*1*, *2*) I write to point out that apparent anomalies are expected because of a longstanding oversimplification(3) in the theory of Brownian motion that makes problematic its description of particles with electric charge. Most atoms, molecules, and particles found in water solutions, or biological cells, carry significant charge (as did the colloidal particles studied by Robert Brown in the first place), yet traditional Brownian motion theory ignores the charge of particles. Traditional theory yields concentrations of solutes that fluctuate dramatically with time, yet it does not deal with the fluctuating electric field that must result if the solutes are charged, according to the (well established) laws of the electric field. Simple estimates suggest that the fluctuations in electric forces will be large, often producing flows and effects larger than the diffusive forces themselves. Treatments of Brownian motion that compute the fluctuating electric field—by solving Poisson's equation and boundary conditions along with equations of Brownian motion or its equivalent—have been used in computational electronics for many years.(*4*, *5*) These consistent treatments of fluctuating concentrations and fluctuating electric fields need to be extended to Brownian motion in water solutions and biological cells, in my view, before one can understand the source and significance of anomalous behavior, before one can understand the source and significance of super and subdiffusion so interestingly reported and studied by Abbott, (*2*) and Turiv et al (*1*).

References

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