BROWNIAN MOVEMENTS

According to 'MATTER (Re-examined)'

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Abstract: Currently, analyses of 'Brownian motion' are limited to its relevance to other scientific phenomena. Observed motion of a microscopic solid particle, suspended in a liquid, is attributed to assumed random motion of liquid molecules, which is one of many assumptions of 'kinetic theory'. There is neither a logical cause nor a mechanism nor a known mover, acting on liquid molecules. Hence, root cause of Brownian motion remains a mystery. Aim of this article is to explain a logical mechanism for random motion of molecules of liquid macro body, based on structural behaviour of its matter-particles, rather than to analyse observed motion and its significance to other phenomena.

Keywords: Brownian motion, Gravitational pressure, Kinetic theory of gas, Primary matter-particles.

Introduction:

The idea that molecules of a gas are constantly in motion, colliding with each other and bouncing back and forth, is a prominent part of 'kinetic (molecular) theory of gases'. Kinetic theory of gas was originally developed to explain macroscopic properties of (ideal) gas. Although this theory is based on numerous assumptions, it gives no reason for physical movements of molecules in a gaseous macro body. One of the assumptions simply states that *'molecules (of a gaseous macro body) are in constant, random, and rapid motion and these rapidly moving molecules constantly collide with the walls of the container and with each other'*. Speed of motion is further assumed proportional to temperature of the gas. Assumed collisions with container wall and with each other, presumably explains internal pressure and increase in internal pressure during heating of the gaseous macro body.

In due course of time, liquids were also included in the purview of kinetic theory. Currently all explanations on Brownian motion are based on these assumptions, which give no reasons for random motions of molecules in a liquid macro body. Instead, these theories analyse observed displacements of suspended microscopic solid particles in a liquid macro body. As long as reasons for basic random motion of molecules are not explained, such theories remain theoretical exercises on random motions only. They explain nature of Brownian movements under an assumed condition rather than its real causes and mechanism. Although reasons for random motion are not given, mathematical treatments on observed random motions give accurate analysis for many similar events.

Compression of macro body:

External pressure on a macro body, compresses it. Compression is nothing but inward efforts, acting at macro body's surface, towards a common centre. Force is the rate of work, introduced into universal medium about a macro body, by external effort. Work, in and about a macro body, is in the form of distortions in universal medium. Distortions in universal medium about a macro body determine macro body's current state (of motion). External effort on a macro body acts against reactions from structure of universal medium within the macro body's border.

Constituent 3D matter-particles of a macro body are held together by compression due to gravitational attraction and interactive field-efforts, between them. Gravitational attractions between 3D matter-particles tend to move them towards each other. 3D matter-particles are prevented from colliding into each other by interactive (repulsive) field-efforts about them. During compression, a macro body's 3D matter-particles are pushed towards a common centre and nearer to each other. In most cases, this can be seen by a reduction in size of the macro body. Reduction in distances between macro body's 3D matter-particles increases repulsion between them. Changes in interactive field-efforts are due to changes in distortion-density of universal medium in the region. Reactive component of repulsion provides external compression on primary matter-particles in fundamental particles of macro body. Work done, due to compression of macro body, is stored in the form of additional distortions in universal medium about it. Increased distortion-density compresses primary matter-particles in the macro body. As primary 3D matter-particles are compressed, they expand in size and lower their matter and energy contents. Matter-content, lost from primary matter-particles, if in sufficient quantity, form photons and radiate away in the form of heat or light. This phenomenon heats gas under compression and produces radiations of various frequencies from very large macro bodies.

Actions on a macro body, during compression and heating are similar. Heating is a process of reducing matter and energy contents of a macro body by enhancing surrounding pressure. Reduction in matter-content of primary matter-particles under compression lowers matter-contents (mass) of corresponding atoms/molecules of macro body. At the same time, primary matter-particles expand in size, causing expansion of atoms/molecules. These actions, together, reduce matter-density of constituent atoms and the macro body, as a whole.

Expansion of macro body, as a whole, may be compensated (up to an extent) by reduction in its volume due to external compression, by moving its atoms towards each other. Application of external pressure on a macro body reduces macro body's volume by bringing its constituent atoms/molecules nearer, against interactive repulsions, which are keeping them away from each other. This may affect change in matter-density of the macro body, as a whole, but leaves matter-density of constituent atoms/molecules, unaffected. Variations in matter-density of primary matter-particles are by changes in their matter-contents. Expansion of primary matter-particles in a macro body increases size of a heated macro body, which is under no external compression. Applying external pressure on a macro body compels it to lose its matter and energy contents.

Constituent 3D matter-particles (atoms/molecules) of a macro body are held together, to maintain integrity of the macro body, by mutual gravitational attraction and other interactive field-efforts between its constituent 3D matter-particles. In any macro body, inner most atom/molecule is under highest pressure due to gravitation. Higher external pressure on this atom/molecule reduces its matter-density by a larger magnitude compared to reduction in matter-density of atoms in other locations within the macro body. If a macro body is located in free space (where there is no other external effort/pressure on it), atom at its centre has least matter-density. Matter-density of atoms in the macro body gradually increases as their locations approach towards surface. If there are other macro bodies, nearby, location of atom/molecule with least matter-density may differ from centre of the macro body.

Brownian motion:

A microscopic solid matter-particle, suspended in a liquid, is observed to have random displacements within the liquid. This phenomenon is known as 'Brownian motion'. It is named after Robert Brown, who first (in modern times) observed random movement of particles suspended in a fluid, when he examined pollen grains in water. Analysis of random nature of movements in this phenomenon has developed into many concepts related to probability and fluctuations. Mathematical model of Brownian motion has several real-world applications, related to data-fluctuations. Mathematical model describing such random movements is often related to 'particle theory'.

As there was no logical reason for the observed random movements of microscopic solid matter-particles suspended in a fluid, cause of such motion was attributed to an assumption in 'kinetic

(molecular) theory' of liquid [similar to and derived from kinetic (molecular) theory of gas] and the same is used in explanations that confirmed existence of atoms and molecules. Einstein suggested that random movements of suspended solid matter-particles in a liquid as being a result of random thermal agitation of molecules, which compose surrounding liquid. Later on, calculations based on Brownian motions helped to determine sizes of liquid's atoms. All these and similar conclusions are true only if there is a logical explanations to random thermal agitation of a liquid macro body's molecules. Since the assumption of random motion of matter-particles in 'kinetic theory' of liquid, itself has no logical basis, an alternative explanation (based on an alternative concept, presented in 'MATTER (Re-examined)', is given below.

Constituent 3D matter-particles in any macro body have definite relative positions. In atoms, adhesion of primary matter-particles and fundamental particles are very strong. They can resist all reasonable efforts to change their relative positions. Atoms in molecules are also strongly bonded. Usually they may change their relative positions only under very strong influences, produced during chemical interactions. Each type of atom has unique nature of its distortion-field. Complimentary atoms, guided by their distortion-fields, join in definite pattern to form a molecule. By completing the structure of a molecule, constituent atoms locate themselves in relation to the structure so that resultant distortion-field about the molecule is electrically and magnetically neutral.

There are no rigid bonds between atoms or molecules in a macro body. It is the gravitational attractions that hold them together to form an integral macro body. Repulsion between their distortion-fields keeps neighboring molecules apart, irrespective of gravitational attraction between them. Depending on their matter and energy contents and natures of their distortion-fields, strengths of bonds between neighboring atoms/molecules vary. It is the strength of inter-atomic/molecular bonds in a macro body that determines its physical state. In solid macro bodies, inter-molecular bonds are very strong and therefore, usually, no relative displacements of constituent atoms/molecules are allowed.

Constituent atoms/molecules of a fluid macro body are not held rigidly. At the same time, they do not have independent free relative movements. Degree of floppiness is expressed in terms of fluid's viscosity. Depending on viscosity of a fluid macro body, its molecules have certain degree of restricted freedom to move about each other, in groups, within the limitations imposed by their molecular formations. Such motions help to form convection and other types of currents in fluid macro bodies.

If a fluid macro body is situated on or near the surface of a large macro body, each of its atoms/molecules is gravitationally attracted towards the large macro body. Denser atoms/molecules of fluid macro body tend to move towards large macro body, under greater gravitational attraction. Disregarding actions of external pressure on primary matter-particles, the fluid macro body achieves a stable state with its denser atoms/molecules at the bottom (towards the large macro body) and lighter atoms at the top.

Within the fluid macro body, its atoms/molecules are also gravitationally attracted towards each other. Inter-atomic attraction due to field-efforts, in association with gravitational attraction towards the large macro body, applies higher external pressure on the atom/molecule, which is at the bottom-centre of fluid macro body. This atom has least matter-density, compared to all other atoms/molecules in the fluid macro body. Due to its lowest matter-density, magnitude of gravitational attraction on it towards large macro body is least, compared to magnitudes of gravitational attractions on other atoms and molecules. Other atoms/molecules, on which magnitudes of gravitational attraction towards large macro body are higher (due to their higher matter-density), tend to move towards the large macro body – that is, to the bottom of fluid macro body. Atom/molecule, which is at the bottom–centre and least dense will be replaced by another atom/molecule, which is denser. Displaced atom should move slowly upwards to the top of fluid macro body. As denser atom/molecule reaches bottom-center position in fluid macro body, due to higher external pressure on it, it will discard part of its matter-content, corresponding to increased external pressure and thereby lowers its matter-density. Now, this atom/molecule becomes least dense in the fluid macro body, to be replaced another denser atom/molecule.

In the mean time, atoms/molecules, rising to the top, are relieved of excess external pressure. They absorb matter-content from surrounding universal medium, to compensate the loss suffered. Depending on rate of absorption of matter-content by atoms/molecules, their upward movements to surface are restricted by viscosity of fluid macro body. Gravitational actions, external pressure and rate of absorption of matter-content by their primary 3D matter-particles, produce certain randomness in their possible movements. It tends to initiate random convection current within the fluid macro body. This tendency of convectional motion, amplified by characteristic properties of fluid macro body's material, affects very small solid particles suspended in the liquid macro body.

Possible convectional motions, initiated by atom/molecule located at bottom-centre of fluid macro body (near a larger macro body), are as described above. Atoms/molecules in other locations, throughout the fluid macro body, depending on their relative matter-density and magnitudes of gravitational attraction towards large macro body, also tend to undergo similar convectional motions. Unless additional impetus is provided (like heating) inter-atomic/inter-molecular attractions are sufficient to restrict free convectional current within liquid macro body.

In any macro body, constituent molecules are arranged in definite pattern, determined by the distribution of their resultant distortion-fields. A molecule or atom, moving from its current location in a macro body, can settle only in a different location that has similar configuration of (neighbouring) distortion-fields, as available at the location of its present existence. Field-efforts, holding a molecule or atom in its current location prevent or impede external efforts that are trying to dislodge it from the place of its present existence. As and when external efforts overcome retaining field-efforts, molecule or atom may be dislodged from its present location. But it can be accommodated only in another location with similar configuration of distortion-fields. If there are suitable locations nearby, the molecule/atom will immediately occupy one of them. If suitable locations are not available, the molecule/atom will slip back into or remain in its original location. However, relocation of the molecule/atom takes place very fast. Speed of molecules during relocation is determined by molecular field-efforts rather than speed of possible conviction motion in fluid macro body. Hence, a molecule or atom, dislodged from its present location is propelled very rapidly to its new location in fluid macro body.

A molecule moving under this effect moves with small but quick jerky motions from one location to another. Although these movements are initiated by variations in matter-density of molecules, movements and re-location of molecules are governed by configuration of their distortion fields. A molecule, ejected from its location finds another location with identical configuration of distortion-fields. During its stabilisation at new location, the molecule may twist or turn to conform to local configuration of distortion-fields. Departure of molecule from one place and its arrival at another location produce corresponding movements of all molecules around it.

Moving atoms/molecules do not directly collide with other atoms/molecules on their path. Instead, their distortion-fields come within interacting distances to transfer momentum of moving atom/molecule (in part or full) to distortion-fields of atoms/molecules on their paths. Momenta of high-speed movements of these molecules may be transferred to any (sufficiently small) suspended solid particles in fluid macro body as small kicks. Hence, motion of suspended solid particles is not smooth, but appears in random directions or erratic and jerky in fashion. This phenomenon produces 'Brownian motion'. Average movements of suspended solid particles are calculated by using probability principles.

All constituent atoms of a macro body have mutual gravitational attraction. This provides macro body with its viscosity. In solid macro bodies, viscosity is very high and its constituent atoms cannot have relative motion. In fluid macro bodies, viscosity is low enough that its constituent atoms/molecules may have limited motion relative to each other. As temperature of a fluid macro body is raised, its viscosity reduces and magnitude of external effort, required to move its molecules (relative to each other) decreases. Molecules/atoms of the fluid macro body move more freely. If temperature of a fluid macro body is raised, without creating convectional currents of its own, magnitude of Brownian motion of a suspended solid particle in it, increases.

Power of tendency to form convectional current (other than by heating) in the liquid macro body depends on magnitudes of: (1). Mutual gravitational attractions between 3D matter-particles of liquid macro body and (2). Gravitational attractions between very large macro body (on which liquid macro body is situated) and 3D matter-particles of liquid macro body. Therefore, magnitude of Brownian motion increases as matter-content (mass) of very large macro body (on which the liquid macro body is situated) becomes greater. Magnitude of Brownian motion is greater on or near surface of larger celestial bodies.

Brownian motion of suspended solid particles in fluid macro body continues as long as fluid macro body is within gravitational (attractive) sphere of a larger macro body. In the absence of a larger macro body in the vicinity (in free space) of fluid macro body, Brownian movements cannot take place in it. Least dense atom/molecule settles at its centre and fluid macro body attains stable spherical shape. In this state, all atoms of liquid macro body are held at their relative positions within its border by gravitational attraction and field-efforts. Irrespective of differences in their matter (energy) content levels, they can have no relative motion without help from external efforts. Convectional currents, during heating of a fluid macro body is also be absent in free space.

Conclusion:

In a macro body, whichever physical state it may be, there is a definite pattern of arrangement for its constituent atoms/molecules. Unless affected by external efforts, they cannot have relative motion between them. Bonds between atoms/molecules may be very strong as in solids or weak as in fluids. But it will not permit relative motion between constituent atoms/molecules of a macro body, unless affected by external influences. Hence, 'kinetic theory of gas', which presumes relative motion of atoms in gaseous (or liquid) macro body's in proportion to their 'energy level', without appropriate external efforts, is illogical. An explanation to phenomenon of Brownian motion needs not have random motion of a liquid macro body's atoms/molecules. Effects of external pressure on matter-contents of 3D matter-particles in a liquid macro body and their compulsion to settle in locations with similar configuration of distortion-fields produce jerky movements of constituent molecules. Moving molecules collide with microscopic solid particles, suspended in liquid macro body and cause their erratic motion in random directions. Brownian movements in fluid macro bodies can take place only within gravitational sphere (immediate neighbourhood) of another large macro body. Higher the magnitude of gravitational attraction, more energetic the Brownian movements are.

References:

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