

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. The observed motion of a microscopic solid particle, suspended in a liquid, is attributed to the assumed random motion of liquid molecules, which is one of many assumptions of the 'kinetic theory'. There is neither a logical cause nor a mechanism nor a known mover acting on liquid molecules. Hence, the root cause of Brownian motion remains a mystery. The aim of this article is to explain a logical mechanism for random motion of molecules of a liquid macrobody, based on structural behaviour of its 3D 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 the molecules of a gas are constantly in motion, colliding with each other and bouncing back and forth, is a prominent part of the 'kinetic (molecular) theory of gases'. The 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 macrobody. One of the assumptions simply states that '*molecules (of a gaseous macrobody) 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 to be proportional to temperature of the gas. Assumed collisions with the container wall and with each other presumably explain internal pressure and an increase in internal pressure during heating of the gaseous macrobody.

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

Compression of a macrobody:

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

Constituent 3D matter-particles of a macrobody 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 macrobody'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 the size of the macrobody. Reduction in the distances between the macrobody's 3D matter-particles increases repulsion between them. Changes in the interactive field-efforts are due to changes in the distortion-density of the universal medium in the region. Reactive component of repulsion provides external compression on primary matter-particles in the fundamental particles of the macrobody. Work done, due to the compression of the macrobody, is stored in the form of additional structural distortions in the universal medium about it. Increased distortion-density compresses primary matter-particles in the macrobody. As the primary 3D matter-particles are compressed, they expand in size and lower their 3D matter and energy contents. 3D matter-content, lost from the primary matter-particles, if in sufficient quantity, forms photons and radiate away in the form of heat or light. This phenomenon heats a gaseous body under compression and produces radiation of various frequencies from very large macrobodies.

Actions on a macrobody, during compression and heating, are similar. Heating is a process of reducing 3D matter and energy contents of a macrobody by enhancing surrounding pressure. Reduction in 3D matter-content of primary matter-particles under compression lowers 3D matter-contents (mass) of corresponding atoms/molecules of the macrobody. At the same time, primary matter-particles expand in size, causing expansion of the atoms/molecules. These actions, together, reduce 3D matter-density of constituent atoms and the macrobody, as a whole.

Expansion of the macrobody, as a whole, may be compensated (up to an extent) by a reduction in its volume due to external compression, by moving its atoms towards each other. Application of external pressure on a macrobody reduces its volume by bringing its constituent atoms/molecules nearer, against interactive repulsions, which are keeping them away from each other. This may affect a change in 3D matter-density of the macrobody, as a whole, but leaves the 3D matter-density of constituent atoms/molecules unaffected. Variations in 3D matter-density of primary matter-particles are by changes in their 3D matter-contents. Expansion of primary matter-particles in a macrobody increases the size of a heated macrobody, which is under no external compression. Applying external pressure on a macrobody compels it to lose its 3D matter and energy contents.

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

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 the random movement of particles suspended in a fluid when he examined pollen grains in water. Analysis of the random nature of movements in this phenomenon has developed into many concepts related to probability and fluctuations. The mathematical model of Brownian motion has several real-world applications related to data fluctuations. A 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, the cause of such motion was attributed to an assumption in the 'kinetic (molecular) theory' of liquid [similar to and derived from the kinetic (molecular) theory of gas], and the same is used in explanations that confirmed the existence of atoms and molecules. Einstein suggested that the random movements of suspended solid matter-particles in a liquid are a result of random thermal agitation of molecules which compose the surrounding liquid. Later on, calculations based on Brownian motions helped to determine the sizes of liquid atoms. All these and similar conclusions are true only if there is a logical explanation for the random thermal agitation of a liquid macrobody's molecules. Since the assumption of random motion of matter-particles in the 'kinetic theory' of liquid itself has no logical basis, an alternative explanation (based on an alternative concept, presented in the book 'MATTER (Re-examined)', is given below.

Constituent 3D matter-particles in any macrobody have definite relative positions. In atoms, the adhesion of primary matter-particles and fundamental particles is 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 a unique nature of its distortion-field. Complementary atoms, guided by their distortion-fields, join in a definite pattern to form a molecule. By completing the structure of a molecule, constituent atoms locate themselves in relation to the structure so that the resultant distortion-field about the molecule is electrically and magnetically neutral.

There are no rigid bonds between atoms or molecules in a macrobody. It is the gravitational attractions that hold them together to form an integral macrobody. Repulsion between their distortion-fields keeps neighbouring molecules apart, irrespective of gravitational attraction between them. Depending on their 3D matter and energy contents and natures of their distortion-fields, the strengths of bonds between neighbouring atoms/molecules vary. It is the strength of inter-atomic/molecular bonds in a macrobody that determines its physical state. In solid macrobodies, intermolecular bonds are very strong and, therefore, usually, no relative displacements of constituent atoms/molecules are allowed.

Constituent atoms/molecules of a fluid macrobody are not held rigidly. At the same time, they do not have independent free relative movements. The degree of floppiness is expressed in terms of the fluid's viscosity. Depending on the viscosity of a fluid macrobody, its molecules have a 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 macrobodies.

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

Within the fluid macrobody, 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 macrobody, applies higher external pressure on the atom/molecule, which is at the bottom-centre of the fluid macrobody. This atom has the least 3D matter-density, compared to all other atoms/molecules in the fluid macrobody. Due to its lowest 3D matter-density, the magnitude of gravitational attraction on it towards the large macrobody is the least, compared to the magnitudes of gravitational attractions on other atoms and molecules. Other atoms/molecules, on which the magnitudes of gravitational attraction towards the large macrobody are higher (due to their higher 3D matter-density), tend to move towards the large macrobody – that is, to the bottom of the fluid macrobody. The atom/molecule, which is at the bottom centre and least dense, will be replaced by another atom/molecule, which is denser. The displaced atom should move slowly upwards to the top

of the fluid macrobody. As a denser atom/molecule reaches the bottom-centre position in the fluid macrobody, due to higher external pressure on it, it will discard part of its 3D matter-content, corresponding to the increased external pressure and thereby lowers its 3D matter-density. Now, this atom/molecule becomes the least dense one in the fluid macrobody, to be replaced by another denser atom/molecule.

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

Possible convectational motions, initiated by an atom/molecule located at the bottom-centre of a fluid macrobody (near a larger macrobody), are as described above. Atoms/molecules in other locations, throughout the fluid macrobody, depending on their relative 3D matter-density and magnitudes of gravitational attraction towards the large macrobody, also tend to undergo similar convectational motions. Unless additional impetus is provided (like heating), inter-atomic/inter-molecular attractions are sufficient to restrict free convectational current within the liquid macrobody.

In any macrobody, constituent molecules are arranged in a definite pattern, determined by the distribution of their resultant distortion-fields. A molecule or atom, moving from its current location in a macrobody, can settle only in a different location that has a similar configuration of (neighbouring) distortion-fields, as available at its current location. 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 the retaining field-efforts, the molecule or atom may be dislodged from its present location. But it can be accommodated only in another location with a 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. The speed of molecules during relocation is determined by the molecular field-efforts rather than the speed of possible convection motion in the fluid macrobody. Hence, a molecule or atom, dislodged from its present location, is propelled very rapidly to its new location in the fluid macrobody.

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 3D matter-density of molecules, movements and relocation of the molecules are governed by the configuration of their distortion-fields. A molecule, ejected from its location, finds another location with an identical configuration of distortion-fields. During its stabilisation at the new location, the molecule may twist or turn to conform to the local configuration of distortion-fields. The departure of a 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 the moving atom/molecule (in part or in full) to the 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 a fluid macrobody as small kicks. Hence, the 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 macrobody have mutual gravitational attraction. This provides the macrobody with its viscosity. In solid macrobodies, viscosity is very high, and the constituent atoms cannot have relative motion. In fluid macrobodies, viscosity is low enough that their constituent atoms/molecules may have limited motion relative to each other. As the temperature of a fluid macrobody is raised, its viscosity reduces, and the magnitude of external effort required to move its molecules (relative to each other) decreases. Molecules/atoms of the fluid macrobody move more freely. If the temperature of a fluid macrobody is raised, without creating convection currents of its own, the magnitude of Brownian motion of a suspended solid particle in it increases.

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

Brownian motion of suspended solid particles in a fluid macrobody continues as long as the fluid macrobody is within the gravitational (attractive) sphere of a larger macrobody. In the absence of a larger macrobody in the vicinity (in free space) of a fluid macrobody, Brownian movements cannot take place in it. The least dense atom/molecule settles at its centre, and the fluid macrobody attains a stable spherical shape. In this state, all atoms of the liquid macrobody are held at their relative positions within its border by gravitational attraction and field-efforts. Irrespective of differences in their 3D matter (energy) content levels, they can have no relative motion without help from external efforts. Convection currents, during the heating of a fluid macrobody, are also absent in free space.

Conclusion:

In a macrobody, 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 macrobody, unless affected by external influences. Hence, the 'kinetic theory of gas', which presumes relative motion of atoms in gaseous (or liquid) macrobodies in proportion to their 'energy level', without appropriate external efforts, is illogical. An explanation of the phenomenon of Brownian motion does not need to have the random motion of a liquid macrobody's atoms/molecules. Effects of external pressure on 3D matter-contents of 3D matter-particles in a liquid macrobody and their compulsion to settle in locations with a similar configuration of distortion-fields produce jerky movements of constituent molecules. Moving molecules collide with microscopic solid particles, suspended in a liquid macrobody, and cause their erratic motion in random directions. Brownian movements in fluid macrobodies can take place only within the gravitational sphere (immediate neighbourhood) of another large macrobody. The higher the magnitude of gravitational attraction, the more energetic the Brownian movements are.

References:

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