# 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 ‘kinetic theory’. There is neither a logical cause nor a mechanism nor a known mover acting on the 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 in a liquid macrobody based on the 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 the ‘kinetic (molecular) theory of gases’. The kinetic theory of gas was originally developed to explain the macroscopic properties of (ideal) gas. Although this theory is based on numerous assumptions, it gives no cause or reason for the 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’*. The speed of motion is further assumed to be proportional to the temperature of the gas. Assumed collisions with the container wall and with each other presumably explain the internal pressure and its increase during the heating of the gaseous macrobody.

In due course, liquids were also included in the purview of kinetic theory. Currently, all explanations of Brownian motion are based on these assumptions, which give no reason for random motions of molecules in a liquid macrobody. Instead, these theories analyse the observed displacements of suspended microscopic solid particles in a liquid macrobody. As long as the 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 mechanisms. Although reasons for random motion are not given, mathematical treatments of the observed random motions give accurate analysis for many similar events.

## Compression of macro body:

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 in and about a macrobody by an external effort. Work, in and about a macro body, is in the form of structural distortions in the universal medium. Structural distortions in the universal medium in and about a macrobody determine the macrobody’s current state (of motion). External effort on a macrobody acts against the 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 with each other by interactive (repulsive) field efforts. During compression, a macrobody's 3D matter particles are pushed towards a common centre and closer to each other. In most cases, this can be seen by a reduction in the size of the macrobody. A reduction in distances between macrobodies' 3D matter particles increases repulsion between them. Changes in interactive field efforts are due to changes in the distortion-density of the universal medium in the region. The reactive component of repulsion provides external compression on primary 3D matter particles in the fundamental particles of the macrobody. Work done due to compression of the macrobody is stored in the form of additional structural distortions in the universal medium about it. Increased distortion-density compresses the primary matter particles in the macrobody. As primary 3D matter particles are compressed, they expand in size and lower their 3D matter and associated energy contents. 3D matter content, lost from the primary 3D matter particles, if available in sufficient quantity, forms photons and radiates 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.

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

The 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 the macrobody's volume by bringing its constituent atoms and molecules closer together against interactive repulsions, which are keeping them away from each other. This may affect a change in the 3D matter-density of the macrobody as a whole, but it leaves the 3D matter-density of constituent atoms and molecules unaffected. Variations in the 3D matter-density of primary matter particles are caused by changes in their 3D matter-contents. Expansion of primary 3D matter particles in a macro body increases the size of a heated macro body, which is under no external compression. Applying external pressure to a macrobody compels it to lose its 3D matter and associated energy contents.

Constituent 3D matter particles (atoms or molecules) of a macro body are held together to maintain the integrity of the macro body by mutual gravitational attraction and other interactive field-efforts between its constituent 3D matter particles. In any macrobody, the innermost atom or molecule is under the highest pressure due to gravitation. Higher external pressure on this atom or molecule reduces its 3D matter-density by a larger magnitude compared to the reduction in the 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 or pressure on it), the atom at its centre has the least 3D matter-density. The 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 the atom or 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. The 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 the '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 was 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 the result of the random thermal agitation of molecules that compose the surrounding liquid. Later on, calculations based on Brownian motions helped determine the size of the liquid's atoms. All these and similar conclusions are true only if there are logical explanations for the random thermal agitation of a liquid macrobody's molecules. Since the assumption of random motion of matter particles in 'kinetic theory' of liquids 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 3D 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 in its distortion-field (structural distortions in the surrounding universal medium). Complimentary 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 the 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 the neighbouring molecules apart, irrespective of the gravitational attraction between them. Depending on their 3D matter and associated energy contents and the nature of their distortion-fields, the strengths of bonds between neighbouring atoms or molecules vary. It is the strength of inter-atomic and molecular bonds in a macrobody that determines its physical state. In solid macrobodies, inter-molecular bonds are very strong, and therefore, usually, no relative displacements of constituent atoms or molecules are allowed.

The constituent atoms or 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 form convection and other types of currents in fluid macrobodies.

If a fluid macro body is situated on or near the surface of a large macro body, each of its atoms or molecules is gravitationally attracted towards the large macro body. Denser atoms and molecules of the fluid macrobody tend to move towards the large macrobody under greater gravitational attraction. Disregarding the actions of external pressure on primary 3D matter particles, the fluid macro body achieves a stable state with its denser atoms and molecules at the bottom (towards the large macro body) and lighter atoms at the top.

Within the fluid macrobody, its atoms and molecules are also gravitationally attracted to each other. Inter-atomic attraction due to field-efforts, in association with gravitational attraction towards the large macro body, applies higher external pressure to the atom or molecule, which is at the bottom-center of the fluid macro body. This atom has the lowest 3D matter-density, compared to all other atoms and 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 attraction on other atoms and molecules. Other atoms and molecules, whose magnitudes of gravitational attraction towards the large macro body are higher (due to their higher 3D matter-density), tend to move towards the large macro body—that is, to the bottom of the fluid macro body. The atom or molecule that is at the bottom-center and least dense will be replaced by another atom or molecule that is denser. A displaced atom should move slowly upwards to the top of the fluid macrobody. As another denser atom or molecule reaches the bottom-center 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 lower its 3D matter-density. Now, this atom or molecule becomes the least dense in the fluid macrobody, to be replaced by another denser atom/molecule.

In the meantime, atoms and molecules rising to the surface 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 or molecules, their upward movements to the surface are restricted by the viscosity of the fluid macrobody. Gravitational actions, the 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 a random convection current within the fluid macrobody. This tendency toward convectional motion, amplified by the characteristic properties of the fluid macrobody's material, affects very small solid particles suspended in the liquid macrobody.

Possible convectional motions, initiated by an atom or molecule located at the bottom-center of the fluid macrobody (near a larger macrobody), are as described above. Atoms and molecules in other locations throughout the fluid macrobody, depending on their relative 3D matter density and magnitudes of gravitational attraction towards the macrobody, also tend to undergo similar convectional motions. Unless additional impetus is provided (like heating), inter-atomic or inter-molecular attractions are sufficient to restrict free convectional 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 (neighboring) 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 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 atomic or molecular distortion-fields. If there are suitable locations nearby, the molecule or atom will immediately occupy one of them. If suitable locations are not available, the molecule or atom will slip back into or remain in its original location. However, as and when a suitable location becomes available, the relocation of the molecule or atom takes place very quickly. The speed of molecules during relocation is determined by molecular field-efforts rather than the speed of possible conviction 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 the 3D matter-density of the molecules, the movements and re-location of the molecules are governed by the configuration of their distortion-fields. A molecule or an atom ejected from its location finds another location with an identical configuration of distortion-fields. During its stabilization at the new location, the molecule may twist or turn to conform to the local configuration of distortion-fields. The departure of an atom or a molecule from one place and its arrival at another location produce corresponding movements of all molecules around it.

Moving atoms or molecules do not directly collide with other atoms or molecules on their path. Instead, their distortion-fields come within interacting distances to transfer the momentum of moving atoms or molecules (in part or in full) to the distortion-fields of atoms or molecules on their paths. Momenta of high-speed movements of these atoms or molecules may be transferred to any (sufficiently small) suspended solid particles in the fluid macrobody as small kicks. Hence, the motion of suspended solid particles is not smooth but appears in random directions or is erratic and jerky in fashion. This phenomenon produces the 'Brownian motion'. Average movements of suspended solid particles are calculated 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 its constituent atoms cannot have relative motion. In fluid macrobodies, viscosity is low enough that its constituent atoms or 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 and atoms in the fluid macrobody move more freely. If the temperature of a fluid macrobody is raised without creating convectional currents of its own, the magnitude of the Brownian motion of a suspended solid particle in it increases.

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

The Brownian motion of suspended solid particles in the fluid macro body continues as long as the fluid macro body is within the gravitational (attractive) influence of a larger macro body. In the absence of a larger macro body in the vicinity (in free space) of the fluid macro body, Brownian movements cannot take place in it. The least dense atom or molecule settles at its center, 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 (and associated energy) content levels, they can have no relative motion without the help of external efforts. Convectional currents, during the heating of a fluid macrobody, are also absent in free space.

## Conclusion:

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

## References:

[1] Nainan K. Varghese, '*MATTER (Re-examined)',* https://www.matterdoc.info/

[2] Wikipedia, *Brownian motion*, http://en.wikipedia.org/wiki/Brownian_motion

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