

Brownian Movement ^[1]

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Brownian movement, or motion, is a process familiar to many of us and is named after the great Scottish scientist, Robert Brown.

This visionary worked during the fascinating era of rapid scientific discovery and advancement of the 1800's. A major contributor to scientific knowledge, Brown was a contemporary of such giants of science as Darwin and Rutherford.

Although his study of Brownian motion is a foundation stone of modern physics, he was better known as a botanist and biologist. His main research area was collecting and documenting animal and plant samples from the recently explored Australia.

The discovery of Brownian movement ^[3] was one of those accidents that happens in science, and leads to groundbreaking theories.

The discovery of penicillin ^[4], by Fleming, was another famous example of a 'happy accident' in science. These accidents still require a sharp mind and the intuition to recognize that something unusual is happening.

Brown's Accidental Discovery

Whilst looking within the vacuoles of the pollen grains suspended in water under a microscope he discovered something that appeared to wobble and move almost randomly around the medium.

Whilst not completely appreciated at the time, this motion was to lead to speculation about atoms and molecules long before they could be seen.

Whilst Robert Brown was not the first to postulate that atoms might be the cause, with the Roman Lucretius (c60 BC) and Ingenhousz (1785) studying the irregular movements of fine dust in the air and liquid, it was Brown who first began to study the significance.

What is Brownian Movement

What Brown observed was that the motion within pollen grains (suspended in water) seemed to move around the liquid seemingly at random. This intrigued him and he began to study why this was happening, and tried to establish what force was driving these random fluctuations

and changes in direction.

He was not sure what was causing the motion, so set about to rule out other possible causes. The main input of Brown was that he proved that the movement was not due to the live pollen propelling itself, by scrutinizing dead pollen grains and rock dust. He also noted that these smaller particles underwent a larger amount of vigorous movement and fluctuations.

Contrary to popular belief, although Brown was the first to observe and document the phenomenon, he was unsure as to why it was happening. Later studies began to uncover that the Brownian movement was due to buffeting by individual molecules in the water.

Although pollen grains are 10 000 times larger than the water molecules, the cumulative effect of all that buffeting is strong enough to move the grains around. This is what results in the jerky and unpredictable movement within pollen grains.

Whilst, instinctively, you would think that random movement within pollen grains would act equally in all directions and that the molecules would cancel each other out, that is impossible, and there will always be a slightly stronger push one way than another.

Further Research

Brownian motion is one of the fundamental studies in physics, and has had far-reaching consequences.

Later physicists, such as Einstein and Smoluchowski used it to prove the existence and movement of atoms and molecules.

Beyond physics, there has been a large impact, with economists realizing that fluctuations in the stock market followed similar rules. Modern chaos theory, trying to understand the processes behind seemingly random fluctuations, has its roots in Brownian motion.

There is some debate about whether true Chaos Theory can be applied directly to Brownian movement. Despite this, this discovery was one of the catalysts that led to modern theories about random fluctuations and behavior.

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[2] <https://staging.explorables.com/en>

[3] <http://www.brianjford.com/wbbrowna.htm>

[4] <https://staging.explorables.com/history-of-antibiotics>