THE DISCOVERY OF SELF-MOTION, OR NATURAL-MECHANICAL-QUANTUM-MOTION

Submitted to the Physical Review Letters
November 23, 1997

by

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Self-motion denotes the natural motions that bodies and particles produce from within themselves. The author produced self-motion in lifeless bodies by dynamic coupling of orthogonal mechanical oscillations in the bodies or their parts. An extensive experimental program, which led to the discovery, revealed that self-motion obeys quantum rules. The discovery of self-motion is a radical step, which clarifies great difficulties encountered in classical, quantum and electromagnetic physics, as well as the other sciences and their derivatives. This paper describes the discovery of self-motion, the equations of self-motion and some implications of the discovery.

In the 1950s and 60s, the author found the explanation that walking results from the forward push by the ground on the sole of our feet to be implausible. It seemed to the author that walking defied the laws of classical mechanics. Moving a wheeled-chair by throwing one's body on it without pushing against the floor seemed to defy Newton's first law of motion and the conservation of linear momentum. Here, motion is produced from where there was none. Such thoughts hinted that self-motion was not understood and that motion could be produced in lifeless mechanical bodies by proper application of inertial effects. An extensive experimental program was undertaken to achieve the seemingly impossible goal of self-motion or internally induced motion. The experimental program evolved in three phases.

Phase I: Gyroscopic effects are effective sources of inertial forces and many combinations of these produced interesting results. After thousands of tests using the inertial effects, a sample of one hundred tests showed that in 5 out of 100 tests, the models moved alone. It was not obvious how or why the models moved, as there were no external forces acting on the models. In 95 out of 100 tests, the models moved on the strange condition of being held with the hands. Opposing the latter motion with pressure from the hands indicated the presence of "*a motive force*," which was as puzzling as the motion induced in some models.

Further testing led to a peculiar observation: The vertical force, or thrust, on the ground had more to do with forward motion than the backward push against the floor. For example, running is accomplished by raising the center of gravity of the moving body, which increases the downward thrust on the ground. The Apollo astronauts moved with ease on the Moon by hopping which increased the downward thrust by the dynamic overshoot effect of bouncing. The greater downward thrust seemed to facilitate the astronauts' forward motion. Such observations led to a tentative model of motion that greatly differed from previous ones. Whereas all previous motion models considered a body to move in the direction of the externally applied force (Fig. 1a), the new model consisted of a vertical force, somehow, producing motion in a perpendicular direction (Fig. 1b).

Interestingly, Aristotle noted that a man and a mouse could not run on a pile of wheat. This is similar to the astronauts marching in place in microgravity environment. In these cases, the absence of the downward force vector deprived the movers from moving forward.

Modifying the inertial models by adding the vertical force component produced peculiar behaviors. In particular, most models moved in circles.

Phase II: A thorough review of the theories of flight of birds and insects and more experiments indicated that the force model in Fig. 1b was inadequate. Studying millions of video frames of the motions of athletes and animals at varying stages of motion led to the modification shown in Fig. 1c. It now seemed that the action responsible for the motion was the up-down oscillating vector shown in the Figure. After thousands of tests with the new configuration, a notable improvement was achieved. In about 20 tests out of the typical100-tests sample, the models moved alone; and in some 80, out of 100, tests, the models required the mysterious holding with the hands to move.

Phase III: The results in Phase 2 were encouraging, but something major was missing from the model in Fig. 1c. Further reviews of the theories of motion and previous inventions did not lead anywhere. Looking to nature for help, a potential solution appeared in the motion of the electromagnetic waves. Here, an electric charge oscillates in one direction, a magnetic wave oscillates in a perpendicular direction, and the combined electromagnetic wave moves in the third orthogonal direction. This behavior was a central problem for modern physics early in the twentieth century.

Applying two orthogonal mechanical oscillations (Fig. 1d) to the lifeless models led to dramatic results. After thousands of tests, the typical 100-tests sample showed the following: In 95 out of 100 tests, the models moved alone without externally applied forces, and in about 5 out of 100 tests, the models required the touch action to move. Also, many *gaits* were observed and recorded. Self-motion was finally at hand.

The following Table summarizes the evolution of the discovery.

Evolution of the Discovery of Self-Motion		
A typical 100-test sample	No. of models moved alone	Models moved held with hands
Inertial effects	5	95
Up-down Oscillations	20	80
2 orthogonal oscillations	95	5

With further refinement, it was possible to move the lifeless models forward, backward and in any direction, and up inclined surfaces. Eventually, the experimental program concentrated on two central problems: (1) Develop the mathematical expression(s) that govern self-motion, and (2) Explain the requirement for holding the models with the hands to induce motion. The second problem led to the construction of the first mechanical neuronmotor-muscle model that moved alone. This is described in another paper.

Finding the equations that governed self-motion was as daunting as the invention itself. Because the models ranged in mass from a few grams to several kilograms and because the motion ranged from mm/sec to many cm/sec, it seemed logical to try to fit the motions into Newton's second law of motion; i.e., F=d(mv)/dt, or F=ma, where the mass of the models was always constant.

It took many tests to determine with certainty that self-motion did not follow Newton's equations. In all cases of self-motion by mechanical oscillations, the models reached maximum, or terminal, speed nearly instantaneously, Fig. 2a. Moving the models on polished wood, glass, polished chromium, and on teflon surfaces, and using different lubricants to minimize the effects of friction did not alter the nature of the motion: In all cases, the models reached terminal speed nearly instantaneously.

By varying the exciting frequencies that were driving the models, the speed changed: The speed (s) increased when the frequency (*f*) was increased and the speed decreased when the frequency was lowered, Fig.

2a. The following relationship was then established:

$$s \propto F(f) \qquad (1)$$

Experiments to study the effect of mass on self-motion gave a distinct inverse relationship, or,

$$s \propto \frac{1}{F(m)} \qquad (2)$$

Combining the above functional relationships, the following was obtained, where A is proportionality constant:

$$s = A\frac{F(f)}{F(m)} \qquad (3)$$

Eventually, it became evident that self-motion is actually quantum in nature. Consider the basic quantum equation E=*h*ν or E=*hf*, where ν or *f* is the frequency of light waves in the photoelectric effect, E is the kinetic energy (or $\frac{1}{2} mv^2$) of the electrons ejected in the process, and *h* is Planck's constant. Solving for the velocity, v, of the electrons, we obtain:

$$v = C\frac{F(f)}{F(m)} \qquad (4)$$

Where C is a constant. Notice that our Equation (3) for speed, which was derived from thousands of tests with self-motion macro models, is identical to the velocity Equation (4), which was introduced by Einstein to describe the photoelectric effect and which has been repeatedly verified in the twentieth century for quantum effects.

The following observations were also made from experiments; (1) there is a lower frequency f_{min} below which the self-motion models do not move. This is reminiscent of the cutoff frequency in the photoelectric effect. (2) As the exciting frequency is increased above f_{min}, the self-motion models moved in discrete steps, Fig. 2b. When the exciting frequency was increased, the amplitude and frequency of the motion steps increased and the wavelengths became smaller, as shown in the Figure. The seemingly continuous motion in many earlier models was the result of operation at high frequencies. Another way to produce continuous motion was by higher-order coupling of added mechanical oscillations in the models. (3) Acceleration (a), or the rate of change of velocity (v) with respect to time (t), is a function of the rate of change of frequency (f) with respect to time:

$$a = \frac{dv}{dt} \propto \frac{df}{dt} \qquad (5)$$

The author evaluated the effects of geometry, materials of construction and interface conditions on self-motion. These variables produced variety of effects unknown before in classical or quantum mechanics. Self-motion cannot be analyzed by modeling the moving body as a point, i.e., *the center of gravity*.

The Discovery of self-motion will have profound impact on all the sciences, especially physics, and their derivatives. Tens of thousands of tests led to a better picture of the nature of physical reality than has ever been described before.

Consider the wave-particle duality. Thinking strictly in classical mechanics terms, the founders of modern physics looked in vain for particle-like entities that imparted momentum and energy to the electrons by impact or collision in quantum effects. *Waves* of light were envisioned to be particles, photons, to explain the motion of the electrons in the photoelectric effect. The self-motion models clearly demonstrate how altering the oscillations of bodies or particles can set the bodies in linear or rotary motions. No collisions are necessary; only changes in oscillations. The speed or velocity of a body on the left sides in Equations 3 and 4 (a particle property) is no longer at odds with the frequency (a wave property) in the right side of the equations. Self-motion gives simple explanations to the black body radiation problem, the photoelectric effect, the Compton effect (see Fig. 2b), the tunneling effect and other hitherto puzzling effects in physics.

When two self-motion models were aimed at each other, the two bodies bonded together, as if by glue. Self-motion gives better insight into the bonding mechanisms in chemical and other processes.

In jointed-models, the author produced motions similar to those of the arm and its parts by coupled-mechanical-oscillations. Also, the author induced artificial motions in his fingers, hands and arms by physically attaching self-motion models to those parts. Recognizing the mechanism responsible for living motions gives a deeper understanding of biological systems.

Natural motions can be produced in artificial limbs by simple mechanical pulse trains. Also, recognizing the mechanism of living motion can lead to revolutionary techniques to fight germs in the human body; e.g., viruses may be frozen in place or driven in desired directions by proper mechanical oscillations. When some self-motion models were attached to the author's arm, the exciting oscillations produced tremors of the arm; and it may be that the opposite effect can be used to cure motor-diseases, such as, Parkinson disease. Other revolutionary treatments can be found in medical research.

The only robot that moves nearly naturally is the *passive dynamic walker,* a two-legged robot that moves human-like down shallow slopes. This robot moves naturally because it is acted on by forward force vectors at all vertical levels, as shown in Fig. 3a. The main reason that no one has been able to construct walking robots before is because, on a horizontal surface, no one knew how to produce the small forward force vectors at all levels of the robotic structure, Fig. 3a. The author simulated natural robotic motions by stacking self-motion models as in Fig. 3b. Other applications in transportation, electronics, and other engineering areas are revolutionary.

Placing self-motion models with appropriate inertia and frequency against his torso, the author induced forward motion of his whole body without command from his mind. This was a unique experience, as the onset of motion was not recognized by the author's mind. After the motion began, the author's mind concentrated on ordering the lifting of the legs one at a time to avoid falling down. Fearing adverse effects from feedback into the nervous system, these experiments were terminated. But the effect was distinct and repeatable. Experts and students of psychology will find these experiments useful in studying the mind-body interactions.

Aristotle noted that if we did not understand motion, we would not understand nature. Our research shows that motion has not been clearly understood before. Theories of cosmology, philosophy and education at every level will be greatly impacted by the discovery of self-motion. The requirement for the external forces of pushing and pulling to induce motion must now be supplemented by the recognition that suitable and opportune local oscillations can produce a variety of linear and rotary motions. Physicists who have taken the lead to explain physical reality throughout history must lead again. Many concepts must change, but the changes must be thoughtful and careful.

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Herndon, VA, USA and Amman, JORDAN – November 1997

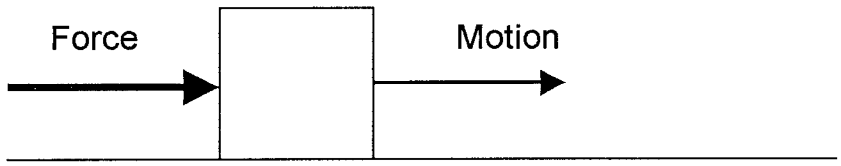

FIG. 1a Prevailing view: Motion occurs in the direction of the applied Force

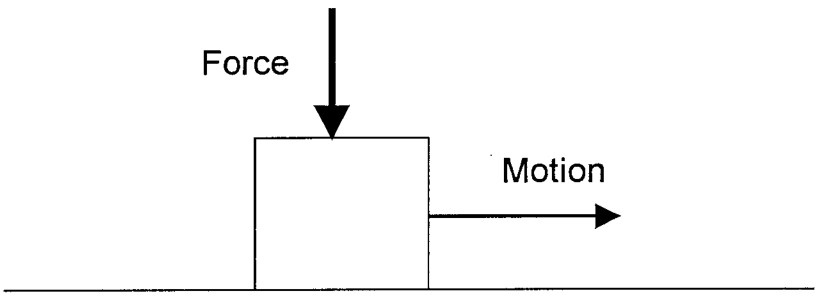

FIG. 1b A major departure in thinking about motion - **Phase I**

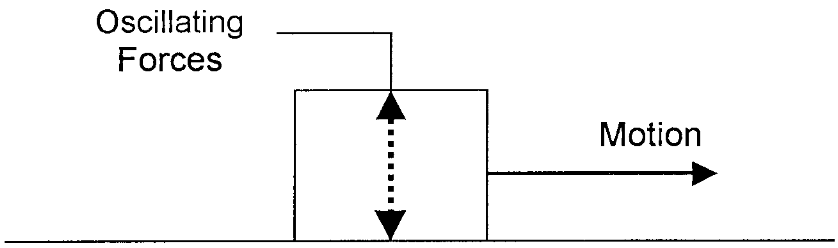

FIG. 1c Up-down oscillations improved ratio of moving models – **Phase II**

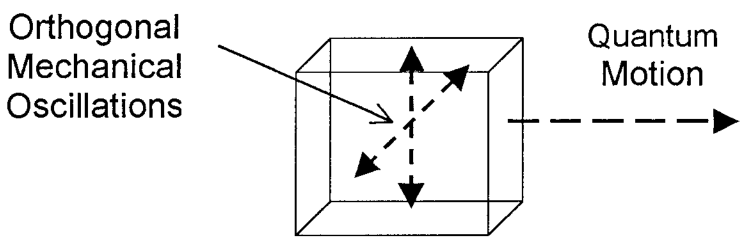

FIG. 1d Orthogonal mechanical oscillations produce linear motion - **Phase III**

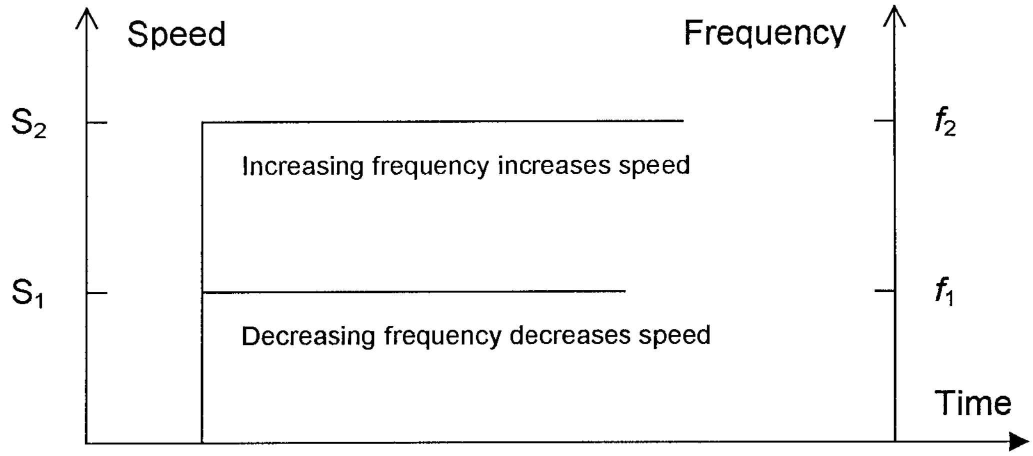

FIG. 2a Self-motion models reach terminal speed nearly instantaneously

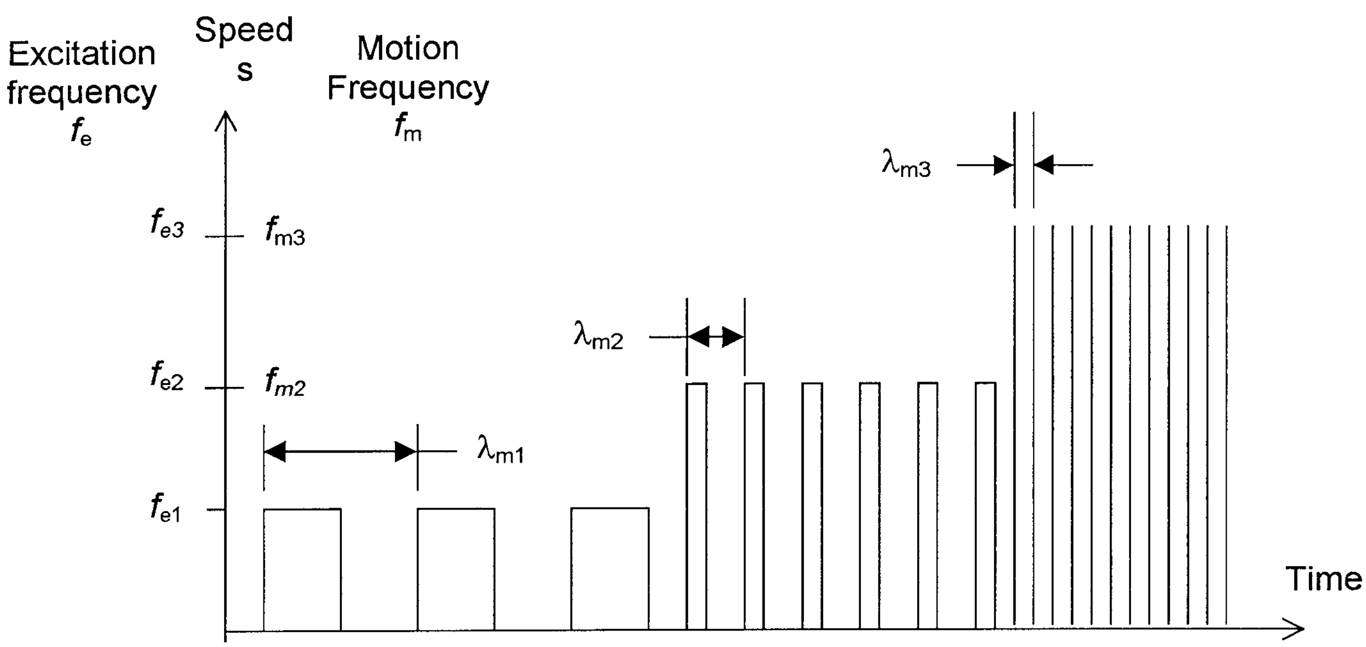

FIG. 2b Self-motion explains quantum effects. Notice the two distinct frequencies and the two distinct wavelengths; (1) the excitation frequency f_e which causes the motion and (2) the motion frequency f_m which results from the discrete motion.

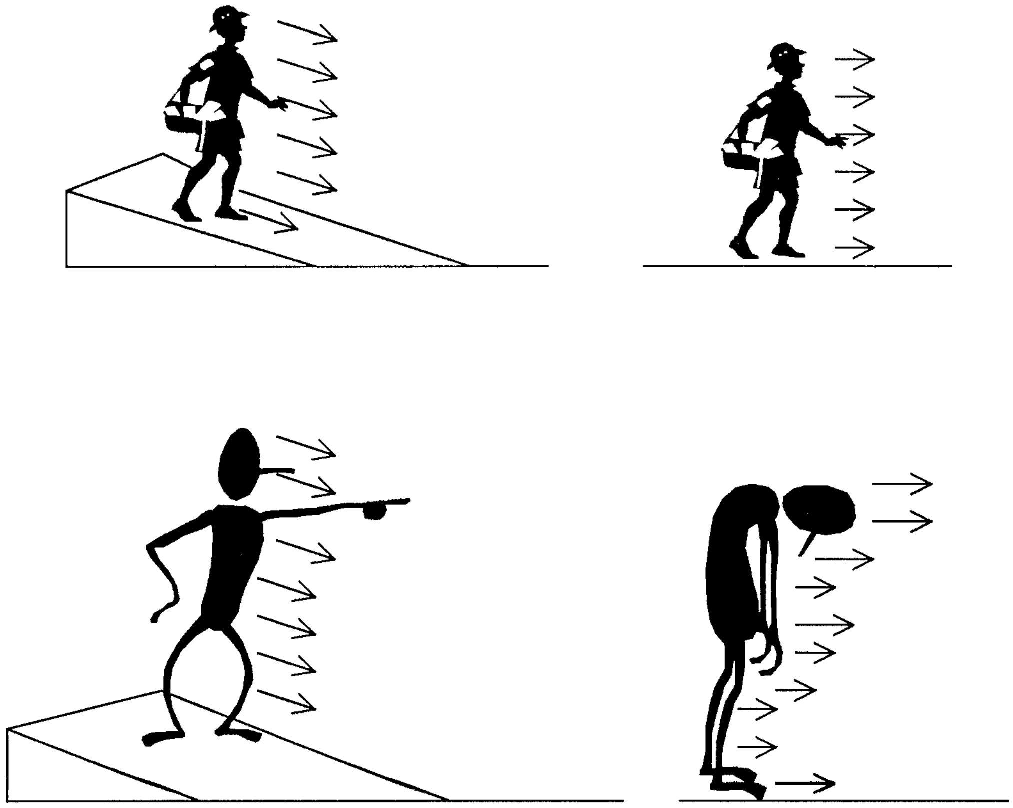

FIG. 3a *Passive Dynamic Walker* moves human-like down shallow slopes as result of forward gravitational components. To move forward on horizontal surfaces, PDW and other robots must be given forward force vectors at all vertical levels.

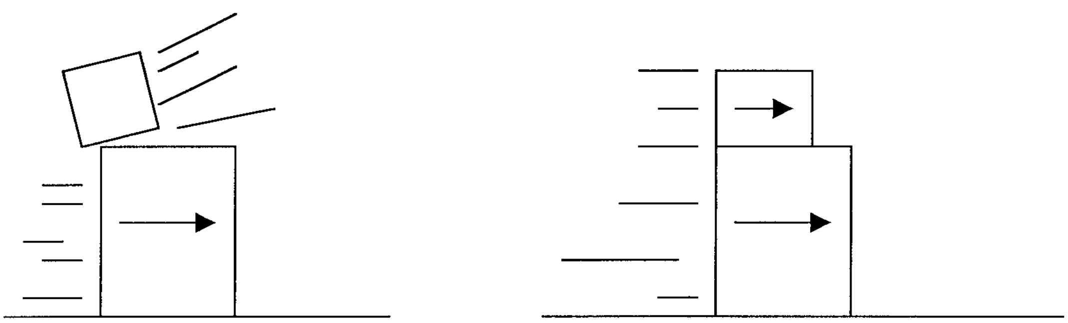

FIG. 3b When the upper self-motion model is inactive, it slips and falls. When both models are active, the bodies simulate natural forward motion.