Fundamentals of Gravity

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This paper makes one basic assumption and then, by defining the terms and making some simple observations, provides conclusions concerning what gravity does. Included are Newton's three principles, the causality principle and the conservation laws. Based on this assumption, definitions and conclusions, several principles are developed and predictions made. This is not a document that explains what gravity is, but only what gravity does. A specific mechanism for gravity is not included.

1. Basic Assumption

The universe contains objects that move.

1. **Object.** An object is what we hear, see, taste, feel, or smell. It is also what instruments generate and detect. Some examples are planets, space-dust, light, gravity, and radio waves. There are many more that can be listed. To restate this assumption: "The universe is the sum of all objects".
2. **Motion.** Motion occurs when an object's position in space changes from one instant of time to another.

2. Definitions

1. **Space.** *Space is a manmade idea for locating objects.*
   To locate an object, a co-ordinate system is developed using an origin, axes, and length. Also space is a volume in which an object exists**.**

   Length is measured in meters.

   a. A point in space has zero volume.
   b. A physical point is a space with a very small volume.
   c. Length is the distance between two physical points.
2. **Time.** *Time is a manmade idea for measuring motion.*

   Time is measured in seconds.

   a. A point in time is zero seconds.
   b. An instant in time has a very small duration.
   c. An interval of time is the duration between two instants of time.
3. **Measurement.** Velocity and acceleration are measured using length and time and have units of meters per second and meters per second squared respectively. A body at rest is only considered at rest if its position in space does not change relative to a specified co-ordinate system.

The National Institute of Science and Technology (NIST) defines the meter and the second.

3. Principles

Principles describe something that is fundamentally true. The statement or observation must be so clear that it is true beyond a reasonable doubt. Unfortunately, what is reasonable to one person may not be reasonable to another. The following statements are considered principles by the author.

1. **Causality Principle.** *For every effect there is a cause. The cause comes first then the effect.*
   One could ask the question, what causes objects to exist? Or what causes the objects to move? What causes objects to exist is not included in this paper. However, Newton's three principles of motion are included.
   One application of the causality principle is in the evaluation of equations. An empirical equation is based on data and has no cause. An equation based on a theory that has parameters related to that theory will be expressed in terms of cause on one side of the equation and effect on the other.
2. **Newton's First Principle.** *Every body will remain in the state of uniform motion unless acted on by an external force.*
   This characteristic of objects is easily observed. But the cause is not easy to understand. An object at rest remains at rest if no other force is used. But how does an object in motion stay in motion?
3. **Newton's Second Principle.** *The acceleration of a particle is directly proportional to the resultant force applied and inversely proportional to the mass of the particle and has the same direction as the resultant force.*
   The definition of acceleration was described above. Newton's second principle describes the cause (external force) of an objects' acceleration (effect). Acceleration equals force divided by mass. (a = F/m). Here Newton actually introduces the idea of mass. In fact this is a defining equation. The NIST defines the meter, the second, the kilogram, and the force of one Newton. All based on Newton's second principle.
4. **Newton's Third Principle.** *To every action there is an equal and opposite reaction.*
   This principle is difficult because action and reaction is not defined. It implies a very large range of activity. However in the preceding paragraphs the phrase 'equal and opposite' have been used several times and therefore this principle has been included but for the specific cases described.

4. Three Simple Observations

Listed below are three observations that should be obvious to everyone, but there will be those who disagree.

1. **Gravity passes through objects.** There is gravity in my office as I type this sentence. It gets here by passing though the roof, the walls and the floor.
2. **As gravity passes through an object it causes the object to move.** If gravity does not cause the object to move then, there must be another force that does.
3. **Gravity is omnidirectional.** The force of gravity always causes the object to move to the center of the earth. So no matter where you are on the earth, gravity moves objects toward the center. Hence it is omnidirectional.

Based on these observations, Newton's first principle can be restated as:

> *Every object will remain in the state of uniform motion as long as all the external forces are equal and opposite in all directions.*

Newton assumes that there is something innate to the object causing it to move and he calls this inertia. This revised statement indicates that gravity is acting on an object whether it is at rest, moving with constant velocity, or accelerating and could be the cause of inertia. The word force is defined in Newton's second principle.

Prediction: *The instantaneous force of gravity F_i causes Inertia.*

Gravity is omnidirectional which means it comes from all directions. If we select an instant of time that is small enough then it is possible that only one force of gravity F_i occurs in one direction. This force that occurs in one instant of time is called the instantaneous force of gravity. However an object will not move in a straight line or at constant velocity unless **all** the forces are equal and opposite in all directions.

5. Types of Motion

5.1. Moving in a Straight Line

The figure below shows the instantaneous forces of gravity F_i in the horizontal and vertical directions. We pick an instant of time small enough that only one Fi happens in one direction. The object is pushed left then right, and up then down. These forces over a longer interval of time make it appear that the object is moving in a straight line. If a film could be made of the motion of an object in very small instants of time, it would have jitter.

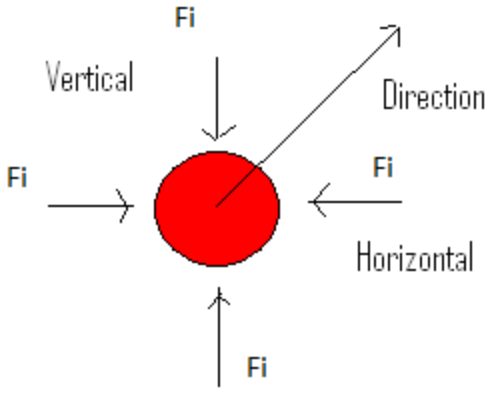

Fig. 1. Caption

5.2. Moving at a Uniform Velocity

The figure below shows an object moving to the right. The instantaneous force of gravity from the left causes acceleration, while the forces from the right cause deceleration. These forces over a longer interval of time make it appear that the object is moving with constant velocity. However, if a film could be made of the motion of an object in very small instants of time, it would have jitter.

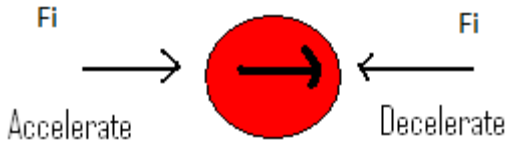

Fig. 2. Caption

5.3. Moving with Uniform Spin

Spin is defined as the rotation of an object around its axis. An object in uniform motion can also appear to have uniform spin. In the figure below there are four selected parts. Each part has an instantaneous velocity. Inertia will try to keep that part in a straight line and in uniform motion, but cohesion (a strong force at the atomic level) will keep all parts together. Hence each part will continue in uniform spin due to the force of inertia and the force of cohesion.

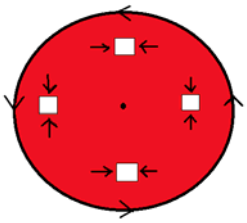

Fig. 3. Caption

6. Force and Mass

6.1. Force

Forces come in many forms. There is mechanical, gravitational, electromagnetic, electrostatic, chemical, nuclear, and even cohesive force. Only when all forces are equal and in opposite in all directions will there be uniform motion.

Cohesive force is at the microscopic or atomic level and is not part of this document. The cohesive force of objects is very strong. Only when the cohesive force is weak relative to an external force can we see the shape of the object change.

6.2. Mass

> *Mass is an assigned value that is used to describe motion.*
> *Also the measure of resistance that an object gives to a specific force.*

The National Institute of Science and Technology defines the value of mass. They select a specific object and assign it a value of 1 kg. This is totally arbitrary. The object could be made from anything and could have been called 1 egg. In terms of motion, mass is not the sum of all molecules, and atoms, and particles. Mass of any arbitrary object is compared to this defined kg and is used to describe motion.

Rest mass and gravitational mass are two typical phrases using the word mass. The mass of an object can be measured using

the force of gravity and hence it is a measure of its gravitational mass. But if a mass is at rest then its value cannot be determined because there is no acceleration. Mass can be measured using any convenient force. Hence, there can be mechanical mass, gravitational mass and magnetic mass. The values of these masses are not necessarily the same.

6.3. Conservation Laws

There are several conservation laws that might apply to gravity. Three of these are conservation of force, mass, and momentum.

7. The Three Principles of Gravity

1. *The force that keeps a planet in orbit is the same force that causes the apple to move toward the center of the earth.*

   The first Principle of gravity is based on Newton's observation concerning the orbits of planets and the falling of the apple. This principle was stated over 350 years ago and has not been proven wrong.

2. *As gravity passes through an object, a small portion of gravity causes the object to move, resulting in a reduction of the force of gravity as it leaves the object.*

   The second principle of gravity is based on the 'Three Simple Observations' and conservation of force. Corollary:

   When gravity passes through two objects, there is a force imposed on the first object resulting in a reduction of force towards the second object. This reduced force is reduced again after it passes through the second object. This results in a double reduction of force.

3. *When two objects are placed near each other in a gravitational field, gravity will impose a larger force on a larger mass and a smaller force on a smaller mass resulting in the same rate of acceleration.*

This statement is in agreement with Newton's second principle. What if there are two objects in the path of gravity?

This idea was stated 250 years ago by Georges L. Le Sage and has not yet been proved. Yet it seems so fundamentally true, that it is being called a principle of gravity.

7.1. From Inertia to Gravity

When a comet is in space with no imbalance of force, it continues in uniform motion. The instantaneous forces of gravity are the cause. When the comet comes close to a large mass, the force of gravity is reduced in the direction towards the large mass. The result is a net force of gravity that causes the comet to move in the direction of the large mass. This net force is what we call gravity.

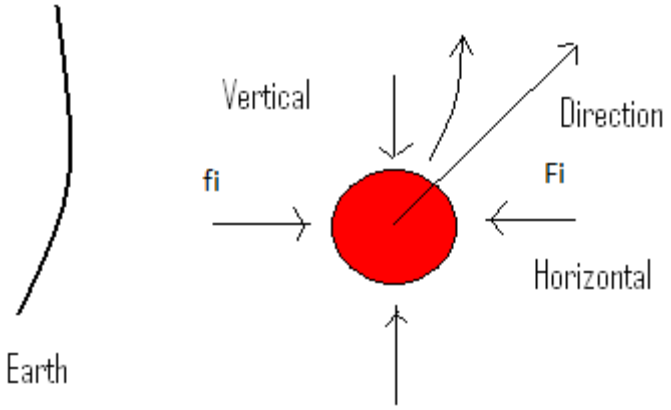

Fig. 4. Caption

Inertia and gravity do not exist as separate entities. What exists are the instantaneous forces of gravity that can explain inertia if all forces are equal and opposite and can explain gravity when the forces are not equal and opposite. But in fact some of the instantaneous forces can be equal and opposite while at the same time others are not. This indicates that gravity and inertia can coexist as partial effects of the instantaneous force of gravity.

Double reduction is not included in traditionally used theories. It is this double reduction that can help explain various anomalies. However, there are no anomalies in nature. There are only discrepancies between calculations and measurements.

Prediction: *Double reduction will help explain the discrepancies.*

Galileo Galilei predicted and astronaut David Scott demonstrated that two objects of different mass will accelerate at the same rate when placed close to each other in a field of gravity. David Scott, while on the moon, dropped a hammer and a feather at the same time. They both hit the ground at the same time. Based on this observation, the following principle is established.

References

[1] Matthew Edwards, Ed., **Pushing Gravity** (Apeiron, 2002).
[2] Author?, **Elements of Physics**, 2nd Ed. (Prentice-Hall, 1953, 1955).
[3] Glenn Borchardt, **The Scientific World View** (iUniverse, 2007).
[4] Robert de Hilster, David de Hilster, and Geoff Hunter, "Gravity Experiment 1", *Proceedings of the NPA* **4** (1): 51-57 (2007).
[5] Robert de Hilster, "The Graviton Equations", presented at NPA-15 (Albuquerque, NM, Apr 2008).
[6] Robert de Hilster, ""An Equation for *G*", presented at NPA-15 (Albuquerque, NM, Apr 2008).
[7] Robert de Hilster, "Majorana's Experiments and the New Equation for Gravity", presented at the NPA-16 (Storrs, CT, May, 2009).