The mystery of Potential Energy wells

Brian Strom.
email: brianstrom999@aol.com
https://www.facebook.com/brian.strom.750
blog: https://edisconstant.wordpress.com/

Abstract:

Einstein's General Theory of Relativity proposes the distortion of the fabric of space by an object, creating a Potential Energy well. But how and why does this happen? In this paper we question some aspects of PE wells. For a spaceship orbiting a PE well, how can the energy, speed and direction of the spaceship change when there appears to be no force acting on it? Would Newton have viewed the Earth's PE well differently if he had observed a water-filled balloon falling from a tree instead of an apple? Would he have written "energy" equations instead of "force" equations? Perhaps the understanding of the mysterious nature of Potential Energy wells could be one of the "keys to the universe".

1. Introduction:

Einstein's General Theory of Relativity proposes the distortion of the fabric of space by "matter", creating Potential Energy wells. Figure 1 shows a two-dimensional representation *(though, in reality, the effect is three-dimensional)*.

We observe that movement through space is affected by these Potential Energy wells such that most motion in the solar system appears to be orbital, with most objects orbiting some other object.

Only in "empty" outer space, can an object move in a straight line, if it is not influenced by the Potential Energy well of any other object.

Whilst the principles of orbital motion make sense in space, the observations of orbital motion on Earth are often mis-interpreted in "force" equations as gravity, mass and weight.

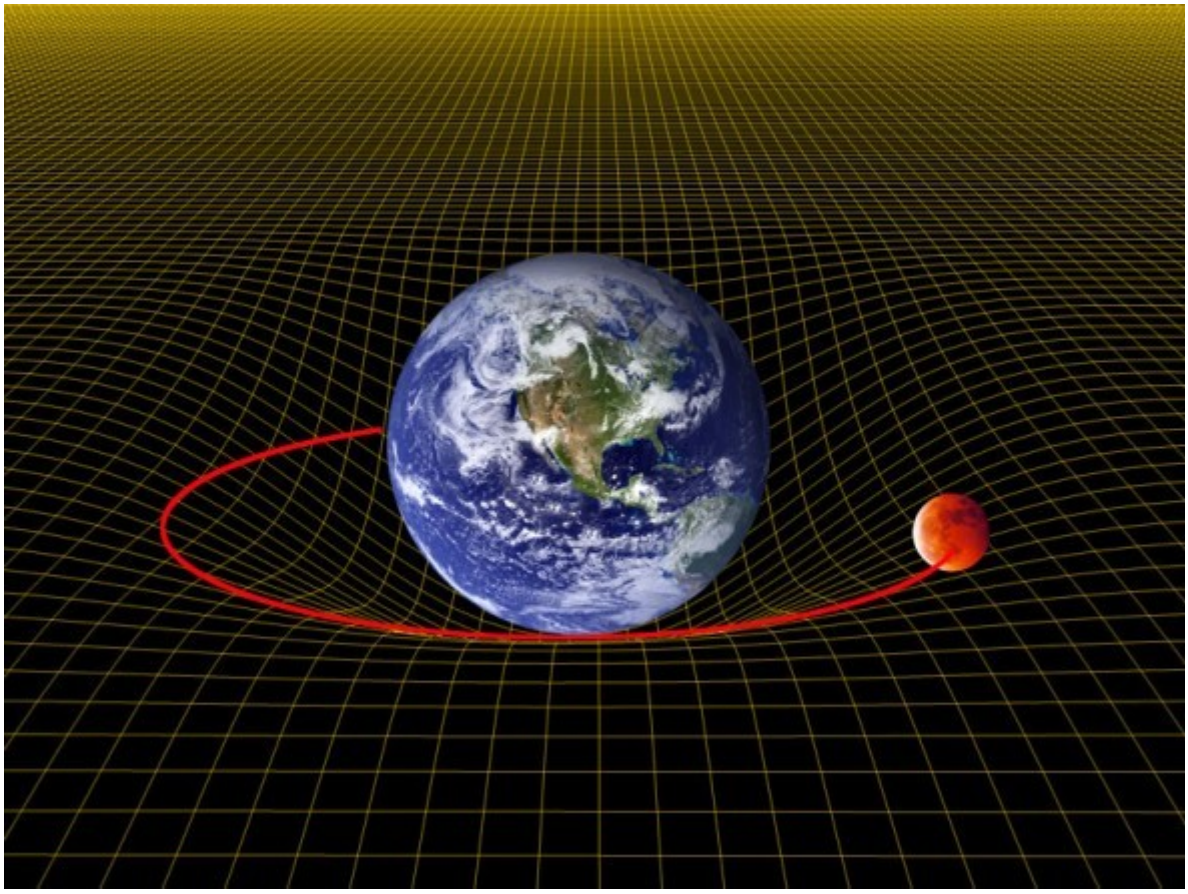

Figure 1. Potential Energy well of the Earth. *Diagram by Rogelio-Bernal-Andreo.*

2. Orbital motion and Energy:

From our observations, we believe that Energy cannot be created or destroyed, and that Energy can only be transposed from one form into another.

During elliptical orbital motion, Potential Energy - *energy of position* - is transposed into Kinetic Energy - *energy of motion* - and back again, on a cyclical basis. However, the Total Energy remains constant – see Figure 2:

(In reality, each object orbits the other, but for simplicity we show the motion from the larger object's frame of reference, as though the larger object is stationary.)

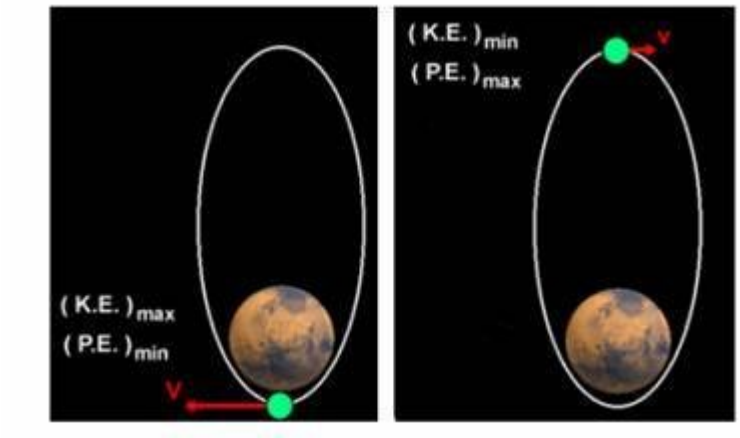

Figure 2. Orbital motion of PE wells. *Diagram by Steve Mitchell.*

3. Here's the conundrum:

An astronaut in a spaceship seems to feel no force when in free orbital motion. Yet the spaceship changes velocity (direction and speed) as it moves around the orbit.

Is there really a force in this scenario? If an accelerometer was attached to the astronaut, would it show positive and negative accelerations during the orbital movement?

From our basic laws of physics, we believe there must be a FORCE on the spaceship if it accelerates, and that a force produces WORK which causes a change in the spaceship's ENERGY.

But where would this energy come from?

We believe the additional Kinetic Energy comes from - *and returns to* - the Potential Energy Well during the orbit, and that the TOTAL energy of the system remains constant at all times.

How can we explain these magical properties of the Potential Energy well?

4. The Earth and orbital motion:

Imagine an asteroid in orbit around the Sun. Its orbit brings it too close to the Earth and it falls into the influence of the Earth's Potential well. Its orbit around the Sun will be changed.

It could go into orbit around the Earth. Alternatively, it could collide with the Earth and, upon impact, give up its Kinetic Energy to the Earth. In this case it will be held in a stationary position of constant Potential Energy at the Earth's surface. The asteroid has simply been stopped in its "orbital" path.

This is where Newton looked at the local Earth environment and thought of mass, weight and gravity etc. In fact, the asteroid is held at the Earth's surface by an upward force that prevents it from continuing its path towards the centre of the Potential Energy well (of the Earth). Remove the constraint, and the asteroid will resume its journey in orbit around the Earth's centre.

The principle can be represented by a thought experiment whereby an object "falls" through a trap-door into a mine-shaft through the centre of the Earth. The object will follow a simple sinusoidal motion – see Figure 3:

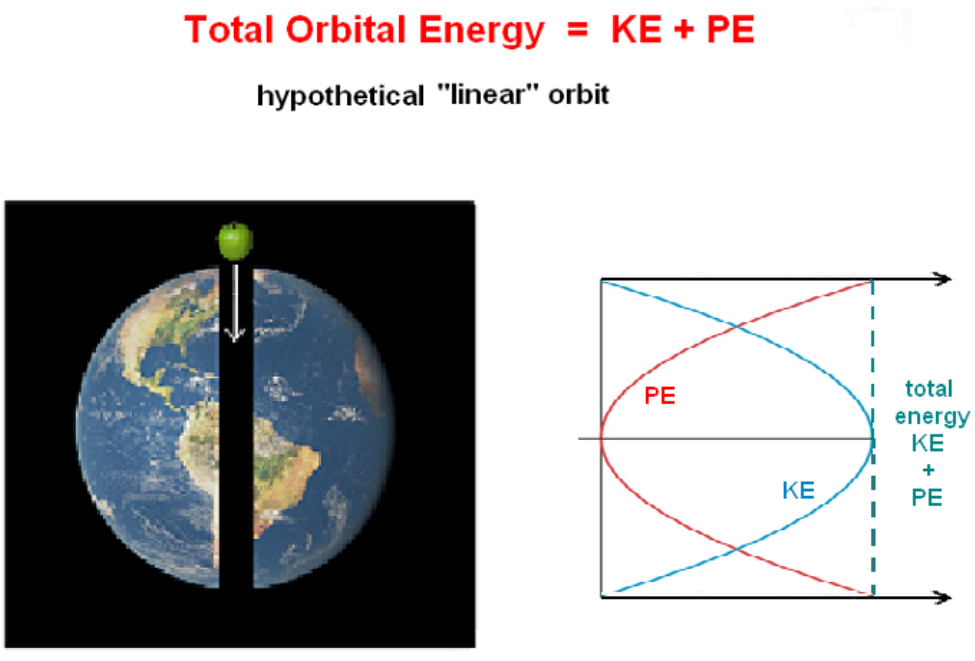

Figure 3. Hypothetical "linear" orbit through the Earth.

5. Newton's Apple Tree:

Newton is said to have observed an apple falling from a tree.

From Newton's frame of reference, sitting beneath the tree, the falling apple is acted upon by a force (gravity) and accelerates, gaining Kinetic Energy. When the apple hits the ground, an upwards force on the apple stops it from moving, and it's Kinetic Energy is transferred to the Earth, mainly as heat energy.

From the Apple's frame of reference, the force holding the apple to the tree is suddenly removed. The tree accelerates away and the apple feels itself "floating" in space. The apple feels weightless, and there is no force acting on it. Then the Earth crashes into it and changes the apple's velocity.

How can we explain both viewpoints?

Imagine a different scenario where Newton ties a water-filled balloon to the branch of a tree. He would have noticed that the balloon was not spherical, but elongated. He might have concluded that a force was stretching the balloon out of its natural, spherical shape.

When the balloon is released from the tree it begins to fall, and the balloon becomes approximately spherical (*allowing for wind-resistance etc*). In this scenario, Newton might have concluded that a force held the balloon to the tree, and that the force was removed when the balloon was released.

As the balloon falls towards the ground, it begins a linear orbit through the centre of the Earth.

If Newton had used energy equations to describe the balloon's motion, he might have concluded that its Potential Energy begins to convert into Kinetic Energy. And, reciprocally, the Earth falls towards the balloon - just a little – so the Earth's Potential Energy begins to convert to Kinetic Energy. The total orbital energy (KE + PE) remains constant. Upon impact, the Kinetic Energies of the two objects are transposed into Heat Energy, and the total Potential Energy is permanently reduced.

With the water-filled balloon scenario, Newton might have written energy equations for the motion of the balloon, and he might never have used force equations - or invented the magical force "gravity".

So, is there really a force on the balloon that causes acceleration, or are we mistaken? Should we consider using only Energy equations to describe the laws of motion in the universe?

6. Other questions on Potential Energy wells:

There are other fundamental questions on Potential Energy wells:

For instance, how does “matter” create Potential Energy Wells?

Others have proposed a “zero energy universe”, where matter is positive energy and the Potential Energy well is negative energy. Einstein considered, and rejected, this theory.

Or, perhaps there is “negative” energy somewhere in the universe, creating negative Potential Energy wells?

These questions remain unanswered.

7. Summary and Conclusions:

On Earth, a water-filled balloon falls and appears to accelerate downwards - but it also becomes spherical as though there is no force acting on it.

In Space, a satellite in an elliptical orbit changes velocity (speed and direction) - but there seems to be no force on it.

Are our “force” equations wrong?

We believe that for an object moving under the influence of a Potential Energy well, there is a transposition of energy between Kinetic and Potential, but the total energy remains constant. How can we explain this transposition of energy if there are no forces acting?

Should we stop using “force” equations to describe motion on Earth and use “energy” equations instead? Can all motion be described by “energy” equations?

Is the understanding of the mysterious nature of Potential Energy wells one of the "keys to the universe"?

Further information on the Blog: https://edisconstant.wordpress.com/

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