Further thoughts after replying to comments on

The Anatomy of Explosion: A Paper by A C Sturt

by A C Sturt

The comment was made that the orbits of electrons in atoms do not vibrate. In fact they must distort on impact in order to provide the force of restitution, like any two billiard balls. So as far as weight is concerned, if there is no distortion, there is no resistance to the force of gravitational attraction by the Earth, and there can be no possibility of attaining equilibrium at rest, which is clearly at odds with observation. The arguments and some practical measurements are given below, not as theories but by direct measurements of the diameters of atoms with a metre rule, a bit like Langmuir's trough experiment, though it must be admitted that the metre rule is of the latest technology. The aim is to illustrate the difference between quantum leaps and the reality on the ground. Literally!

A. Description

i. Take a bar of length *l*, width *w* and depth *d* such that all corners are orthogonal.
ii. Make it of regularly close-packed atoms like crystals, so that the length of each side and any orthogonal section can be expressed in terms of a whole number of atomic diameters.
iii. Measure *l, w* and *d* out of contact with any other body and free from acceleration.
iv. Then put the bar down on the Earth with the long side vertical.
v. The proposition here is that the bar's weight causes it to shrink in length.
vi. However, the mass of the bar has not changed, nor has the number of atoms.
vii. It is reasonable to infer that the volume of the bar is unchanged by its shrinkage in length, now height, in the same way that liquids are incompressible. This can be confirmed by measurement if necessary. Archimedes?
viii. Thus when the bar shrinks because it is compressed by the force of gravity, its width and depth increase to maintain the volume.
ix. The reason for doing the first part of the experiment out of contact with another body i.e. the Earth is to preclude the possibility of distortion of electron shells by exogenous forces. Out of contact does not mean out of the Earth's gravitational field, but far enough away to avoid interaction of electron shells.

B. Postulated mechanism of distortion

First consider the bar of material as such. The bar which is long in space becomes shorter, wider and deeper when it rests the surface of the Earth, because of interaction of electrons shells (Figure 1).

Shrinkage occurs because of changes at the level of the individual atom (Figure 2). The reasoning is as follows:

i. Most of the mass of the atom is in the nucleus.
ii. Thus the nucleus experiences greater force of gravitational attraction to the Earth.
iii. The electron shell is repelled by electron shells of the atom at the surface of the Earth.

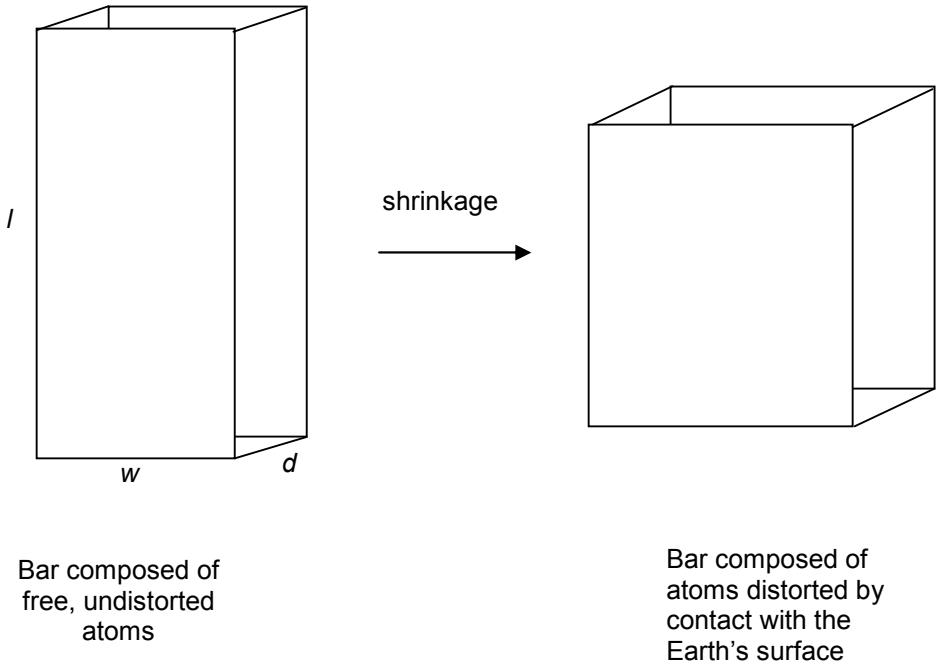


Figure 1

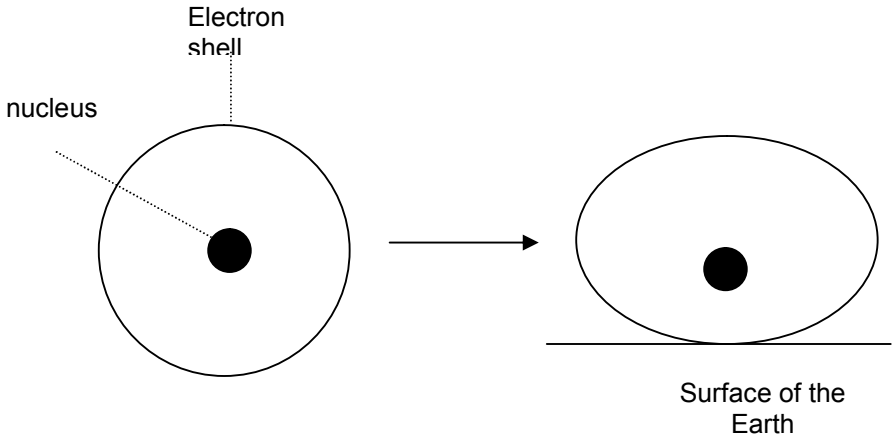


Figure 2

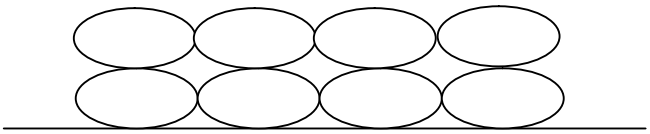
iv. The nucleus is not repelled by Earth's electron shells, if anything quite the opposite, partly because of its charge, partly because it is much further away (by the radius of the atom).
v. The result is that the nucleus is pulled down closer to its electron shell on the Earth-side of the atom.
vi. The diameters of the atom which are parallel to the Earth's surface increase to maintain the atom's volume.
vii. The result is an atom in the shape of an ellipse with the nucleus at one focus, rotated about the shortest diameter.

All of which is to say that the atom spreads out under the force of gravitational attraction to the Earth i.e. under its own weight.

The same happens to every atom on the base of the bar in contact with the Earth because everything is symmetrical and regular.

The same happens to every layer of atoms above the base. The reasoning is as follows:

i. The nucleus of the next higher atom has the same mass.
ii. The force of gravitational attraction between this nucleus and the Earth is reduced by its increased distance from the centre of gravity of the Earth, but this is vanishingly small by definition, because the term 'weight' is used only for a small body in contact with a very much larger one i.e. one whose centre of gravity is much further away from its surface.
iii. The distorted electron shell of the first layer of atoms has exactly the same effect on the next layer as the Earth had on the first shell i.e.



Earth

Figure 3

The same reasoning applies throughout the bar's length (now height).

The net result is that the bar standing on end on Earth is shorter and fatter as a result of its contact with Earth. This would be true even if the separation had been only a small number of atomic diameters i.e. enough to prevent interaction of their electron shells.

The new equilibrium position of the nucleus in the flattened atom is determined by the balance of forces of:

- Gravitational attraction between the nucleus and the Earth.

- Attraction of electric charges between the nucleus and the electron shell on the Earth-side.
- Attraction of electric charges between the nucleus and the electron shell on the opposite side.
- Attraction of electric charges between the nucleus and the electron shell at the bulge.

See Figure 4 below.

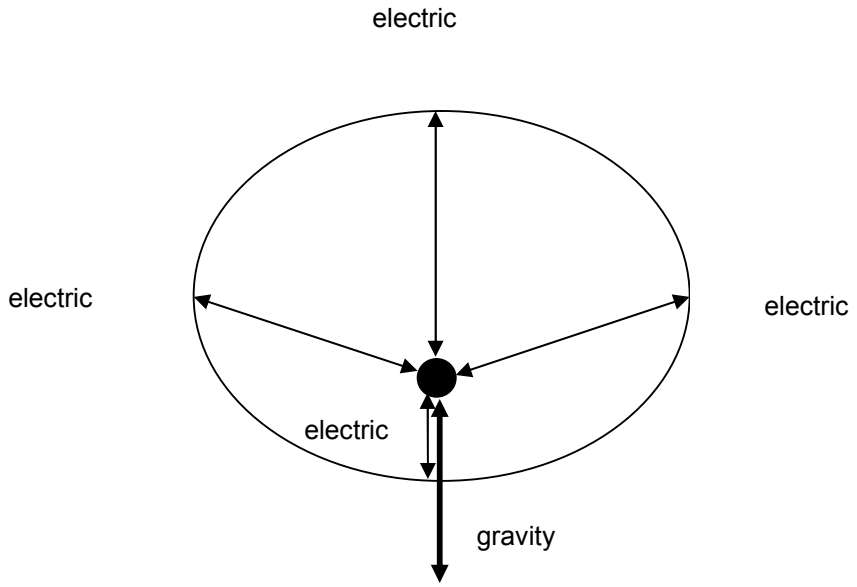


Figure 4

There is nothing extraordinary in the proposal of this mechanism; it is the sort of test on materials which is carried out every day to determine the compression strength of materials using e.g. Instron test machines, when the force is applied by squeezing the test sample between plates. The difference here is that the force is the attraction of gravity and the bar sags under its own weight, like the spread of a jelly when it is tipped out of its mould.

C. The dynamics of settling on the surface

In achieving the equilibrium position when the bar is placed on the surface of the Earth, the nucleus will overshoot as part of the process of moving towards the Earth and losing its momentum in that direction. The electron shell will do the same on coming into contact with the electron shell of the atom at the surface of the Earth. The overshoots will

correct themselves in a damped oscillation before settling down to equilibrium position. In other words they will vibrate.

D. Estimates of atomic diameters.

In this model atomic diameters can be calculated from the number of layers of atoms in the perfectly arranged structure of the bar. A bar of manageable size might contain 10^{10} layers of atoms. The diameter of an atom in such a bar when floating freely is then the length of the side in metres divided by the number of layers. The accuracy of the estimate of the atomic diameter in the bar depends on the precision with which the dimensions can be measured and the number of layers counted. This is not beyond the bounds of possibility using new techniques, such as zone refining, large crystal growth, lasers, diffraction, some sort of Michelson-Morley type of arrangement etc.

When the bar is placed on the surface of the Earth, the decrease of height and increase of width can be measured with great precision by such methods. Mechanical measurements are a problem, because callipers, for instance, are subject to the same distortions as the bar itself. Electromagnetic methods seem simpler, but they are not without their problems, because wavelengths are not reliably unchanged in space. The distortion of electron orbits results only from contact with the Earth, and so in principle the measurements can be made at any height above the Earth greater than a few atomic diameters, but in practice it would be simplest to make them in geostationary orbit in some form of 'weightless' laboratory. Suspending the bar would not be a substitute, because tension introduces distortions of its own.

E. Electromagnetic emissions

There is a final twist, if it were possible to arrange. According to the analysis, the distortion of electron orbits occurs as soon as the bar rests its weight on the surface of the Earth. During the instant of accommodation to their new configuration the orbits change from (near) circular to more pronounced elliptical, and the orbiting electrons must accelerate as they come into their new position closer to the nucleus and decelerate on the side on which they are further away. This applies to the orbits of electrons in the whole body, not just the surface layers.

If my previous analysis of the atom is correct, deceleration of electrons causes no emissions, and so can be disregarded. However, acceleration during the very short period of transition to the new orbit ought to cause the emission of electromagnetic radiation which is characteristic of the transition. In other words, if you drop the weight there may just be a flash of light! Whether it could be seen is a matter of conjecture, but of course there ought to a matching flash of light on impact from the atoms of the Earth's surface i.e. action and reaction.

F. Conclusions

This experiment amounts to measuring the dimensions of a bar of material with a very sophisticated metre rule under two conditions: floating freely and sitting on the Earth's surface. It may all have been done before by material scientists, though it is doubtful whether anyone would have taken the trouble to make the measurements in space.

However, if it is shown that atoms flatten under the proposed conditions of contact with the surface of the Earth, it will be quite clear that the electron orbits of atoms can and must be deformed in materials. It will be similarly clear that they must undergo damped oscillation in the transition from free space to resting on the surface of the Earth, the condition in which weight manifest itself. If by chance it is possible to detect electromagnetic emissions on impact, it will confirm the predicted damped oscillation and the nature of the transition.

A C Sturt
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