The gravitational force quanta. An alternative definition of the kilogram.

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The model of gravity based on the nuclear kinetic dipole states that each atomic nucleus constantly generates a pushing force which imparts a linear momentum to the atom. The direction of that force can be changed through gravitational polarization, a macroscopic body being pushed from within in the direction of surrounding bodies by the cumulative force of its nuclei.
The pushing force of a single nucleon is thought to be the gravitational force quanta, its value being derived from the Avogadro program for a new definition of the kilogram. The gravitational force quanta is found to be $\approx 2 \times 10^{-19}$ a.u. (atomic unit of force) which could be confirmed through a proposed experiment.
An alternative definition of the kilogram is also proposed, along with multiple possibilities to build kilogram etalons. Particularly, subdivisions of the kilogram (e.g. gram, milligram, microgram) can be accurately reproduced onsite through nano-3D printing for the purpose of calibrating high-precision scales and balances.

The model of gravity based on the nuclear kinetic dipole [1-6] states that each atomic nucleus constantly generates a pushing force which imparts a linear momentum to the atom. The direction of that force can be changed through gravitational polarization, a macroscopic body being pushed from within in the direction of surrounding bodies by the cumulative force of its nuclei. The source of said force is believed to be an asymmetric vibration of quarks and gluons in each nucleon, their spin being aligned in the direction of the push. The resultant force of the nucleons in an atom is the force of its nuclear kinetic dipole (NKD).

Therefore, gravity can be quantized by calculating the push of a single nucleon called gravitational force quanta (GFQ).

A solid body is considered to have a fixed number of atoms. A new definition of the kilogram will be rightfully related to a precise number of atoms of pure ^{28}Si contained in a highly finished sphere. Other proposed material is ^{12}C [8].

The Avogadro project [7] redefines the etalon of the kilogram in terms of the number of atoms contained in a sphere of pure ^{28}Si. That number is 2.1525387×10^{25} atoms.
Using the conventional standard value of **g** (9.80665 m/s^2), the force with which said silicon sphere is pushing itself against the Earth is equal with:

$F_g = 1 \text{ kg} \times 1 \, \mathbf{g} = 9.80665 \text{ N}$ (1)

Dividing this force by the number of atoms in the silicon sphere, we find the approximate value of the nuclear kinetic dipole of ^{28}Si:

$F_{NKD} = 9.80665 \text{ N} / 2.1525387 \times 10^{25} \text{ atoms} = 4.555853 \text{ X } 10^{-25} \text{ N /atom of } ^{28}Si$ (2)

The isotope ^{28}Si has a nucleus formed of 14 neutrons and 14 protons. Assuming all 28 nucleons have their momentum aligned in one direction, we can divide the nucleus' push by 28 and find the pushing force of one nucleon:

$GFQ = 4.555853 \text{ X } 10^{-25} \text{ N} /28 = 1.62709035 \times 10^{-26} \text{ N}$ (3)

It was assumed that all kinetic dipoles were oriented in the direction of the center of the Earth, as shown in Fig. 3.

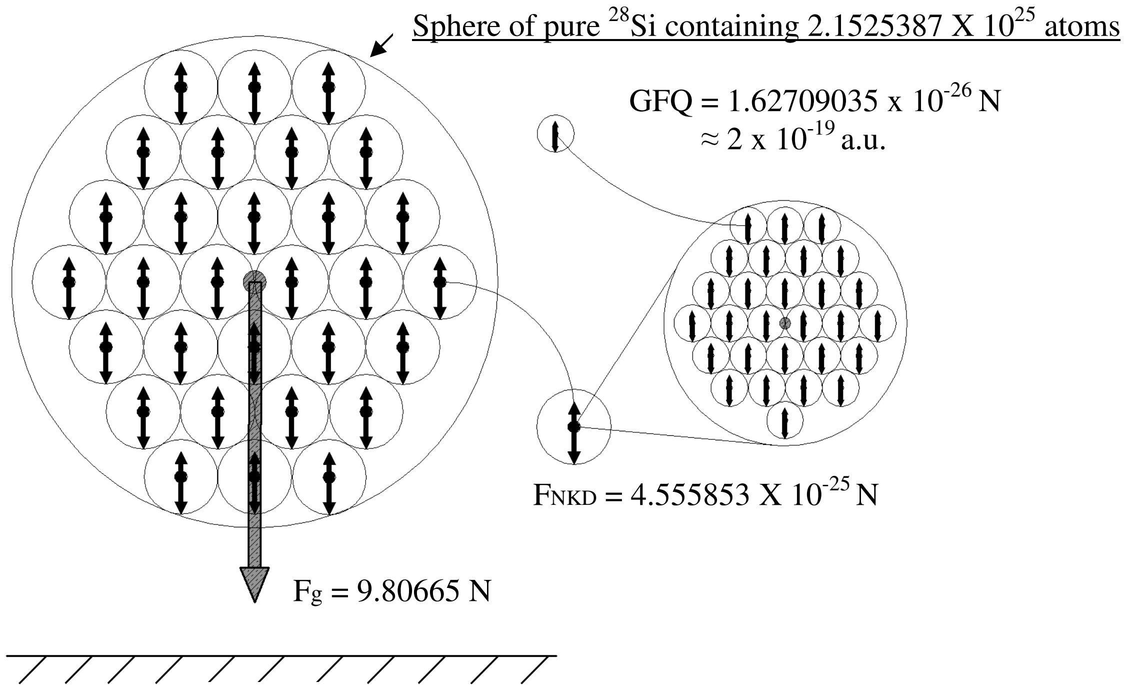

Fig. 4

The NKD push of each element "i" and its isotopes in the periodic table can be calculated by multiplying the respective atomic mass number A_i with GFQ:

$F_{NKDi} = A_i \times GFQ$ (4)

Now it is more clear why each atomic species has a unique gravitational signature, as discussed in [3].

Further, using the 2014-CODATA internationally recommended value of the atomic unit of force 8.23872336 X 10^{-8} N [9], we find:

$$GFQ = 1.62709035 \times 10^{-26} \text{ N} / 8.23872336 \times 10^{-8} \text{ N} = 1.9749301 \times 10^{-19} \approx 2 \times 10^{-19} \text{ a.u.} \quad (5)$$

Consequently, the push of the kinetic dipole of the nucleus of element "i" in the periodic table can be expressed in Hartree units:

$$F_{NKDi} = 2A_i \times 10^{-19} \text{ a.u.} \quad (6)$$

where A_i is the specific atomic number of element "i".

Another proposal for the definition of kilogram is a cube containing 1000/12 moles of ^{12}C, an isotope of carbon having 12 nucleons [8]. The number of nucleons in this etalon is:

$$1000/12 \times N_A = 1000/12 \times 6.022140857 \times 10^{23} = 6.0221408 \times 10^{26} \text{ nucleons/kg} \quad (7)$$

where $N_A = 6.022140857 \times 10^{23}$ is the Avogadro constant according to 2014-CODATA internationally recommended value [9].

In the Avogadro project [7], the sphere of ^{28}Si contains a number of nucleons equal to:

$$2.1525387 \times 10^{25} \text{ atoms} \times 28 \text{ nucleons} = 6.0271083 \times 10^{26} \text{ nucleons/kg} \quad (8)$$

It can be seen from (7) and (8) that the number of nucleons is practically the same in both cases, i.e. $\approx 6 \times 10^{26}$. Therefore, dividing the weight $F_g = 9.80665$ N of the etalon of kilogram by the number of nucleons it contains, leads to the above gravitational force quanta (GFQ) value, regardless the material. GFQ is considered to be the self-generated pushing force of one proton or neutron which can impart a linear momentum to each atomic nucleus, acting like a kinetic dipole.

It has to be noted that the above calculation assumed an average mass of a nucleon. We know that the mass of a neutron is slightly higher than that of a proton, but since both isotopes of silicon and carbon have an equal number of protons and neutrons, the average nucleon mass is implied.

It could be argued that the above calculation of the gravitational force quanta is based on the surface gravity on Earth and therefore it may not be a universal constant. However, it is interesting to notice that, at least in the solar system, all planets and their satellites have much lower surface gravity compared to Earth, except Neptune (1.14 **g**) and Saturn (1.07 **g**) which have surprisingly close surface gravity to Earth's despite their huge relative masses (i.e. Neptune mass = 17.147 and Saturn mass = 95.159 Earth masses). Based on this observation, it may be assumed that a surface gravity of 1 **g** is sufficient for orienting all kinetic dipoles in a test body close to a planet's surface in the direction of the center of the planet. In terms of polarization of kinetic dipoles, it seems that at 1 **g** a test body reaches saturation. This is the key assumption on which the above calculation is based on.

So far, we calculated the gravitational force quanta based on the average mass of a nucleon deducted from a macroscopic kilogram etalon, i.e. a top-down approach.

It is useful to also try a bottom-up approach by using the mass of nucleons provided by nuclear physics, the internationally recommended values [9] being:

proton mass = $1.672621898 \times 10^{-27}$ kg
neutron mass = $1.674927471 \times 10^{-27}$ kg
average nucleon mass = $1.673774685 \times 10^{-27}$ kg (9)

with the relative standard uncertainty of 1.2×10^{-8}

Multiplying the average nucleon mass (9) by the conventional standard value of **g** (9.80665 m/s^2 as per [9]), we find:

$$\text{GFQ} = 1.673774685 \times 10^{-27} \text{ kg} \times 9.80665 \text{ m/s}^2 = 1.6414122 \times 10^{-26} \text{ N} \quad (10)$$

which expressed in Hartree units is:

$$\text{GFQ} = 1.64141339 \times 10^{-26} \text{ N} / 8.23872336 \times 10^{-8} \text{ N} = 1.9923138 \times 10^{-19} \text{ a.u.} \quad (11)$$

which confirm equation (5). Hence, it appears that it is safe to use the value of GFQ = 2×10^{-19} a.u. in further calculations.

A proposed way to measure the GFQ of the proton

Doing a practical measurement of GFQ of the proton could be in the grasp of physicists at CERN and other particle accelerators operators, as first proposed in [3] where it was called the proton gravitational constant (PGC).

The primary operation of the LHC is proton-proton collision. If we could elastically collide head-on just two protons and accurately measure their acceleration in a well specified time frame before collision, we can accurately deduct the proton's GFQ.

Considering the two protons "falling" on each other with known initial velocity and subtracting the Coulomb force repelling each other, we get the gravitational force pushing the two protons towards each other. The trajectories of the colliding protons should be perfectly aligned and their speed should be accurately measured "stroboscopically" before collision.

Unlike most experiments at CERN, this one would not involve high energy. On the contrary, the lower the energy, the slower the protons, and the higher precision of measuring their speed. Non-relativistic speed should be preferred.

I believe a soft head-on elastic collision would be the best condition for the experiment, without disintegrating the protons. Detectors and the source of single protons could be a challenge.

The advantage of the proposed method is that is "**g**-free". Applying a Coulomb or Lorentz force to a proton results in changing the direction of its kinetic dipole in the direction of the force. If said force is horizontal, the proton's kinetic dipole cannot be simultaneously directed to a vertical direction, freeing the result from the influence of the Earth's gravity. The orientation of the kinetic dipoles in the direction of the external force was explained in [6].

It is also possible that the above concept may be embodied in a table-top experiment.

An alternative definition of the kilogram

Calculations (7) and (8) suggest one kilogram contains 6×10^{26} nucleons, regardless the material of which the etalon is made. This could actually be an alternative definition of the kilogram:

$$1 \text{ kg} = \text{the mass of } 6 \times 10^{26} \text{ nucleons} \tag{12}$$

To be more precise, we can "re-engineer" the kilogram using the average nucleon mass as per (9) and calculating how many times it fits into it:

$$1/\ 1.673774685 \times 10^{-27} \text{ kg} = 5.9745198 \times 10^{26} \text{ nucleons in 1 kg}$$

$$1 \text{ kg} = \text{the mass of } 5.9745198 \times 10^{26} \text{ nucleons} \tag{13}$$

The above definition of the kilogram also supports the concept of defining the gravitational force quanta as the gravitational force of a single nucleon acting like a kinetic dipole, since the SI unit of mass is measured indirectly, through its gravitational force at 1 **g**.

The above definition of the kilogram would free the building of etalons from materials, usually precious metals, with very high purity. It could be possible to build kilogram etalons out of composite materials, even organic compounds, through nanotechnology or biotechnology, as long as the number of nucleons can be controlled. Imagine the DNA of a virus could be engineered to multiply a bio-structure with a known number of nucleons a certain number of times and then stop.

This concept could be particularly useful in the "democratization" of etalons, especially for the subdivisions of the kilogram (e.g. gram, milligram, microgram) which can be accurately reproduced onsite through nano-3D printing for the purpose of calibrating high-precision scales and balances.

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