Quantum Gravity and Magnetism

Physicists in Australia have made a high-precision sensor that can measure gravitational and magnetic fields at the same time. The device uses an atom interferometer to track the motion of a Bose–Einstein condensate (BEC) in free fall and the researchers say it could improve the search for iron ore, hydrocarbons, diamonds and other minerals. [5]

The curved space-time around current loops and solenoids carrying arbitrarily large steady electric currents is obtained from the numerical resolution of the coupled Einstein-Maxwell equations in cylindrical symmetry. The artificial gravitational field associated to the generation of a magnetic field produces gravitational redshift of photons and deviation of light. Null geodesics in the curved space-time of current loops and solenoids are also presented. We finally propose an experimental setup, achievable with current technology of superconducting coils, that produces a phase shift of light of the same order of magnitude than astrophysical signals in ground-based gravitational wave observatories. [4]

The changing acceleration of the electrons explains the created negative electric field of the magnetic induction, the electromagnetic inertia, the changing relativistic mass and the Gravitational Force, giving a Unified Theory of the physical forces. Taking into account the Planck Distribution Law of the electromagnetic oscillators also, we can explain the electron/proton mass rate and the Weak and Strong Interactions.

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Preface

Today the most popular enigma is the gravitational force after founding the Higgs boson experimentally. Although the graviton until now is a theoretical particle, its existence is a necessary basis of the Quantum Gravitation and the Theory of Everything.

The electromagnetic origin of mass gives an explanation of the inertia, the relativistic change of mass and also the gravitational force.

Quantum sensor targets gravity and magnetism

Physicists in Australia have made a high-precision sensor that can measure gravitational and magnetic fields at the same time. The device uses an atom interferometer to track the motion of a Bose–Einstein condensate (BEC) in free fall and the researchers say it could improve the search for iron ore, hydrocarbons, diamonds and other minerals.

Geological exploration often involves making local measurements of the Earth's gravitational field. In a classical sensor, this involves dropping a mirror a certain distance and using light-based interferometry to measure its height at several points during its fall. However, because this approach involves many moving parts it is not well suited to vibrational, noisy environments.

Quantum sensors, on the other hand, use atom interferometry to measure the free fall of cold atoms. Developed over the past decade and now sold commercially, these devices have surpassed the sensitivity of their classical counterparts. However, like classical sensors, they are at the mercy of ambient noise – and particularly stray magnetic fields. According to Nicholas Robins of the Australian National University (ANU) in Canberra, scientists go to great lengths to shield these devices from stray magnetism in order to minimize noise levels.

Two in one

In the latest work, Robins and colleagues at the ANU have made this magnetic sensitivity a virtue and created a quantum sensor that can measure changes in both accelerations due to gravity and those due to magnetic fields. Not only does this provide accurate gravitational data, they say, but it also yields magnetic data that could be very useful for mineral prospecting.

The new technique involves cooling a sample of rubidium-87 atoms to just a few billionths of a degree above absolute zero in order to turn them into a BEC – a state of matter in which all constituent particles share the same quantum state. The BEC cloud of atoms is then placed in a quantum superposition of three magnetic spin states and allowed to fall under the effect of gravity for several metres. During that time, the height of the cloud is measured three times using an atom interferometer, a device that exploits the wave nature of matter to make extremely precise measurements on atoms.

The advantage of using a BEC, explains Robins' colleague Kyle Hardman, is that the waves of the constituent atoms remain coherent across the full width of the cloud, which is several millimetres across. This makes it easier to achieve the overlap needed between the two paths of the interferometer to achieve a given sensitivity – thereby allowing the device to work in noisier environments.

Spin superposition

However, Hardman says, the device's real novelty lies in the spin superposition. Because the three spin states are sensitive to magnetic fields in different directions, the BEC cloud will tend to split into three components as it falls. One state feels magnetic fields pointing upwards, causing it to lag behind during free fall, another is immune to magnetic fields, while the third is subject to downward pointing fields, which boosts it acceleration towards the Earth. The relative size of these three components at the interferometer's output therefore reveals the magnitude and orientation of local magnetic fields.

To put their device to the test, the Australian group's researchers created a BEC of two million atoms and ran the interferometer continuously for eight hours, dropping a new BEC every 13 seconds. They looked to see whether they could accurately monitor the varying gravitational acceleration of solid Earth tides – the deformation of the Earth's crust by the tug of the Moon and the Sun. They also varied the height of their interferometer during the measurement period in order to map variations in the ambient magnetic field. The results of those tests, says Hardman, show their sensor to be "a state-of-the-art gravimeter and state-of-the-art magnetic gradiometer". Indeed, it is able to measure variations in the acceleration due to Earth's gravity (g) of one part in a billion.

Elegant extension

Florian Schreck of the University of Amsterdam praises the Australian group for its "interesting and significant" research, which, he says, "elegantly extends the capability of atom interferometers to disentangle the influence of gravity, magnetic field strength and magnetic field gradient". He believes that a portable version of the new sensor "will be interesting for geology and the prospecting of resources".

That kind of mineral exploration involves loading an accelerometer on to an aircraft or helicopter and then monitoring the tiny changes in gravitational field that occur as the instrument passes over regions of the Earth. Hardman says that adding magnetic measurements into the mix would yield more detailed crustal maps, but maintains that this can only be done properly if a single device measures both the gravitational and magnetic fields. "If you fly two separate machines it is difficult to merge the information," he says.

Hardman adds that the team hopes to commercialize the technology, but cautions that they must first overcome a significant technical hurdle: how to reduce the time needed to prepare BECs. Currently standing at around 10 seconds, this limits the rate at which they can make measurements and with it the resolution of their mapping. However, he believes they can do better than the roughly 30 years he says it has taken the mining company Rio Tinto to make classical gravimeters operational. "Cold-atom technology is developing very rapidly," he says.

The research is described in Physical Review Letters. [5]

How Current Loops and Solenoids Curve Space-time

The generation of artificial gravitational fields with electric currents could be in principle detected through the induced change in space-time geometry that results in a purely classical deflexion of light by magnetic fields. This effect does not invoke any new physics, as it is a consequence of the equivalence principle. Although very weak, we have shown that this effect could be detectable by a twofold experimental setup. On one hand, it includes stacked large superconducting Helmholtz coils for the generation of the artificial gravitational field. On the other hand, the detection would be achieved by highly sensitive Michelson interferometers whose arms contain Fabry-Perot cavities to store light into the generated gravitational field. In an appropriate experimental setup, the amplitude of the phase shift accumulated during the bouncing of light in the curved space-time generated by the magnetic field would reach in a few months the level of an astrophysical source of gravitational wave passing through ground-based GW observatories.

We claim that such detection would open new eras in experimental gravity and laboratory tests of general relativity and the equivalence principle. These tests, although concerning the weak field regime, will have the particularity of focusing exclusively on the coupling between gravitation and electromagnetism. Future theoretical works should focus on extending the present study to alternative theories of gravity to explore how far they would depart from general relativity.

Such a detection of the space-time curvature generated by a magnetic field in laboratory would constitute a major step in physics: the ability to produce, detect, and ultimately control artificial gravitational fields. And would this technology be developed, it could lead to amazing applications like the controlled emission of gravitational waves with large alternative electric currents. Gravity would then cease to be the last of the four fundamental forces not under control by human beings. [4]

Electromagnetic inertia and mass

Electromagnetic Induction

Since the magnetic induction creates a negative electric field as a result of the changing acceleration, it works as an electromagnetic inertia, causing an electromagnetic mass. [1]

Relativistic change of mass

The increasing mass of the electric charges the result of the increasing inductive electric force acting against the accelerating force. The decreasing mass of the decreasing acceleration is the result of the

inductive electric force acting against the decreasing force. This is the relativistic mass change explanation, especially importantly explaining the mass reduction in case of velocity decrease.

The frequency dependence of mass

Since $E = h\nu$ and $E = mc^2$, $m = h\nu / c^2$ that is the m depends only on the ν frequency. It means that the mass of the proton and electron are electromagnetic and the result of the electromagnetic induction, caused by the changing acceleration of the spinning and moving charge! It could be that the m_o inertial mass is the result of the spin, since this is the only accelerating motion of the electric charge. Since the accelerating motion has different frequency for the electron in the atom and the proton, they masses are different, also as the wavelengths on both sides of the diffraction pattern, giving equal intensity of radiation.

If the mass is electromagnetic, then the gravitation is also electromagnetic effect caused by the accelerating Universe! The same charges would attract each other if they are moving parallel by the magnetic effect.

Electron – Proton mass rate

The Planck distribution law explains the different frequencies of the proton and electron, giving equal intensity to different lambda wavelengths! Also since the particles are diffraction patterns they have some closeness to each other – can be seen as a gravitational force. [2]

The Gravitational force

The gravitational attractive force is basically a magnetic force.

The same electric charges can attract one another by the magnetic force if they are moving parallel in the same direction. Since the electrically neutral matter is composed of negative and positive charges they need 2 photons to mediate this attractive force, one per charges. The Bing Bang caused parallel moving of the matter gives this magnetic force, experienced as gravitational force.

Since graviton is a tensor field, it has spin = 2, could be 2 photons with spin = 1 together.

You can think about photons as virtual electron – positron pairs, obtaining the necessary virtual mass for gravity.

The mass as seen before a result of the diffraction, for example the proton – electron mass rate Mp=1840 Me. In order to move one of these diffraction maximum (electron or proton) we need to intervene into the diffraction pattern with a force appropriate to the intensity of this diffraction maximum, means its intensity or mass.

The Big Bang caused acceleration created radial currents of the matter, and since the matter is composed of negative and positive charges, these currents are creating magnetic field and attracting forces between the parallel moving electric currents. This is the gravitational force experienced by the matter, and also the mass is result of the electromagnetic forces between the charged particles. The positive and negative charged currents attracts each other or by the magnetic forces or by the much stronger electrostatic forces!?

The gravitational force attracting the matter, causing concentration of the matter in a small space and leaving much space with low matter concentration: dark matter and energy.

There is an asymmetry between the mass of the electric charges, for example proton and electron, can understood by the asymmetrical Planck Distribution Law. This temperature dependent energy distribution is asymmetric around the maximum intensity, where the annihilation of matter and antimatter is a high probability event. The asymmetric sides are creating different frequencies of electromagnetic radiations being in the same intensity level and compensating each other. One of these compensating ratios is the electron – proton mass ratio. The lower energy side has no compensating intensity level, it is the dark energy and the corresponding matter is the dark matter.

The Graviton

In physics, the graviton is a hypothetical elementary particle that mediates the force of gravitation in the framework of quantum field theory. If it exists, the graviton is expected to be massless (because the gravitational force appears to have unlimited range) and must be a spin-2 boson. The spin follows from the fact that the source of gravitation is the stress-energy tensor, a second-rank tensor (compared to electromagnetism's spin-1 photon, the source of which is the four-current, a first-rank tensor). Additionally, it can be shown that any massless spin-2 field would give rise to a force indistinguishable from gravitation, because a massless spin-2 field must couple to (interact with) the stress-energy tensor in the same way that the gravitational field does. This result suggests that, if a massless spin-2 particle is discovered, it must be the graviton, so that the only experimental verification needed for the graviton may simply be the discovery of a massless spin-2 particle. [3]

The Higgs boson

By March 2013, the particle had been proven to behave, interact and decay in many of the expected ways predicted by the Standard Model, and was also tentatively confirmed to have + parity and zero spin, two fundamental criteria of a Higgs boson, making it also the first known scalar particle to be discovered in nature, although a number of other properties were not fully proven and some partial results do not yet precisely match those expected; in some cases data is also still awaited or being analyzed.

In my opinion, the best explanation of the Higgs mechanism for a lay audience is the one invented by David Miller. You can find it here: http://www.strings.ph.qmul.ac.uk/~jmc/epp/higgs3.html .
The field must come first. The boson is an excitation of the field. So no field, no excitation. On the other hand in quantum field theory it is difficult to separate the field and the excitations.
The Higgs field is what gives particles their mass.
There is a video that gives an idea as to the Higgs field and the boson. It is here:
http://www.youtube.com/watch?v=RIg1Vh7uPyw . Note that this analogy isn't as good as the Miller one, but as is usually the case, if you look at all the analogies you'll get the best understanding of the situation.

Since the Higgs boson is necessary to the W and Z bosons, the dipole change of the Weak interaction and the change in the magnetic effect caused gravitation must be conducted. The Wien law is also important to explain the Weak interaction, since it describes the T_{max} change and the diffraction patterns change. [2]

Higgs mechanism

The magnetic induction creates a negative electric field, causing an electromagnetic inertia. Probably it is the mysterious Higgs field giving mass to the charged particles? We can think about the photon as an electron-positron pair, they have mass. The neutral particles are built from negative and positive charges, for example the neutron, decaying to proton and electron. The wave – particle duality makes sure that the particles are oscillating and creating magnetic induction as an inertial mass, explaining also the relativistic mass change. Higher frequency creates stronger magnetic induction, smaller frequency results lesser magnetic induction. It seems to me that the magnetic induction is the secret of the Higgs field.

In particle physics, the Higgs mechanism is a kind of mass generation mechanism, a process that gives mass to elementary particles. According to this theory, particles gain mass by interacting with the Higgs field that permeates all space. More precisely, the Higgs mechanism endows gauge bosons in a gauge theory with mass through absorption of Nambu–Goldstone bosons arising in spontaneous symmetry breaking.

The simplest implementation of the mechanism adds an extra Higgs field to the gauge theory. The spontaneous symmetry breaking of the underlying local symmetry triggers conversion of components of this Higgs field to Goldstone bosons which interact with (at least some of) the other fields in the theory, so as to produce mass terms for (at least some of) the gauge bosons. This mechanism may also leave behind elementary scalar (spin-0) particles, known as Higgs bosons.

In the Standard Model, the phrase "Higgs mechanism" refers specifically to the generation of masses for the $W^{\pm}$, and Z weak gauge bosons through electroweak symmetry breaking. The Large Hadron Collider at CERN announced results consistent with the Higgs particle on July 4, 2012 but stressed that further testing is needed to confirm the Standard Model.

What is the Spin?

So we know already that the new particle has spin zero or spin two and we could tell which one if we could detect the polarizations of the photons produced. Unfortunately this is difficult and neither ATLAS nor CMS are able to measure polarizations. The only direct and sure way to confirm that the particle is indeed a scalar is to plot the angular distribution of the photons in the rest frame of the centre of mass. A spin zero particles like the Higgs carries no directional information away from the original collision so the distribution will be even in all directions. This test will be possible when a much larger number of events have been observed. In the mean time we can settle for less certain indirect indicators.

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