Unusual Origins of High-Energy Electrons

High above the surface, Earth's magnetic field constantly deflects incoming supersonic particles from the sun. These particles are disturbed in regions just outside of Earth's magnetic field - and some are reflected into a turbulent region called the foreshock. New observations from NASA's THEMIS mission show that this turbulent region can accelerate electrons up to speeds approaching the speed of light. Such extremely fast particles have been observed in near-Earth space and many other places in the universe, but the mechanisms that accelerate them have not yet been concretely understood. [8]

The scientists analyze the magnetic field strengths and show that, even in the least massive fragment the field is not strong enough to inhibit gravitational collapse. In fact, they find indications that gravity, as it pulls material inward, drags the magnetic field lines along. [7]

Astronomers have shed new light on the rarest and brightest exploding stars ever discovered in the universe. Their research proposes that the brightest exploding stars, called super-luminous supernovae, are powered by magnetars -- small and incredibly dense neutron stars, with gigantic magnetic fields, that spin hundreds of times a second. [6]

This paper explains the Accelerating Universe, the Special and General Relativity from the observed effects of the accelerating electrons, causing naturally the experienced changes of the electric field potential along the moving electric charges. The accelerating electrons explain not only the Maxwell Equations and the Special Relativity, but the Heisenberg Uncertainty Relation, the wave particle duality and the electron's spin also, building the bridge between the Classical and Relativistic Quantum Theories.

The Big Bang caused acceleration created the radial currents of the matter and since the matter 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.

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NASA finds unusual origins of high-energy electrons

High above the surface, Earth's magnetic field constantly deflects incoming supersonic particles from the sun. These particles are disturbed in regions just outside of Earth's magnetic field - and some are reflected into a turbulent region called the foreshock. New observations from NASA's THEMIS mission show that this turbulent region can accelerate electrons up to speeds approaching the speed of light. Such extremely fast particles have been observed in near-Earth space and many other places in the universe, but the mechanisms that accelerate them have not yet been concretely understood.

The new results provide the first steps towards an answer, while opening up more questions. The research finds electrons can be accelerated to extremely high speeds in a region farther from Earth than previously thought possible - leading to new inquiries about what causes the acceleration. These findings may change the accepted theories on how electrons can be accelerated not only in shocks near Earth, but also throughout the universe. Having a better understanding of how particles are energized will help scientists and engineers better equip spacecraft and astronauts to deal with these particles, which can cause equipment to malfunction and affect space travelers.

"This affects pretty much every field that deals with high-energy particles, from studies of cosmic rays to solar flares and coronal mass ejections, which have the potential to damage satellites and affect astronauts on expeditions to Mars," said Lynn Wilson, lead author of the paper on these results at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

The results, published in Physical Review Letters on Nov. 14, 2016, describe how such particles may get accelerated in specific regions just beyond Earth's magnetic field. Typically, a particle streaming toward Earth first encounters a boundary region known as the bow shock, which forms a protective barrier between the sun and Earth. The magnetic field in the bow shock slows the particles, causing most to be deflected away from Earth, though some are reflected back towards the sun. These reflected particles form a region of electrons and ions called the foreshock region.

Some of those particles in the foreshock region are highly energetic, fast moving electrons and ions. Historically, scientists have thought one way these particles get to such high energies is by bouncing back and forth across the bow shock, gaining a little extra energy from each collision. However, the new observations suggest the particles can also gain energy through electromagnetic activity in the foreshock region itself.

The observations that led to this discovery were taken from one of the THEMIS - short for Time History of Events and Macroscale Interactions during Substorms - mission satellites. The five THEMIS satellites circled Earth to study how the planet's magnetosphere captured and released solar wind energy, in order to understand what initiates the geomagnetic substorms that cause aurora. The THEMIS orbits took the spacecraft across the foreshock boundary regions. The primary THEMIS mission concluded successfully in 2010 and now two of the satellites collect data in orbit around the moon.

This visualization represents one of the traditional proposed mechanisms for accelerating particles across a shock, called a shock drift acceleration. The electrons (yellow) and protons (blue) can be seen moving in the collision area where two hot …more

Operating between the sun and Earth, the spacecraft found electrons accelerated to extremely high energies. The accelerated observations lasted less than a minute, but were much higher than the average energy of particles in the region, and much higher than can be explained by collisions alone. Simultaneous observations from the Wind and STEREO spacecraft showed no solar radio bursts or interplanetary shocks, so the high-energy electrons did not originate from solar activity.

"This is a puzzling case because we're seeing energetic electrons where we don't think they should be, and no model fits them," said David Sibeck, co-author and THEMIS project scientist at NASA Goddard. "There is a gap in our knowledge, something basic is missing."

The electrons also could not have originated from the bow shock, as had been previously thought. If the electrons were accelerated in the bow shock, they would have a preferred movement direction and location - in line with the magnetic field and moving away from the bow shock in a small, specific region. However, the observed electrons were moving in all directions, not just along magnetic field lines. Additionally, the bow shock can only produce energies at roughly one tenth of the observed electrons' energies. Instead, the cause of the electrons' acceleration was found to be within the foreshock region itself.

"It seems to suggest that incredibly small scale things are doing this because the large scale stuff can't explain it," Wilson said.

High-energy particles have been observed in the foreshock region for more than 50 years, but until now, no one had seen the high-energy electrons originate from within the foreshock region. This is partially due to the short timescale on which the electrons are accelerated, as previous observations had averaged over several minutes, which may have hidden any event. THEMIS gathers observations much more quickly, making it uniquely able to see the particles.

Next, the researchers intend to gather more observations from THEMIS to determine the specific mechanism behind the electrons' acceleration. [8]

The role of magnetic fields in star formation

The star forming molecular clump W43-MM1 is very massive and dense, containing about 2100 solar masses of material in a region only one-third of a light year across (for comparison, the nearest star to the Sun is a bit over four light years away).

Previous observations of this clump found evidence for infalling motions (signaling that material is still accumulating onto a new star) and weak magnetic fields.

These fields are detected by looking for polarized light, which is produced when radiation scatters off of elongated dust grains aligned by magnetic fields. The Submillimeter Array recently probed this source with high spatial resolutions and found evidence for even stronger magnetic fields in places. One of the outstanding issues in star formation is the extent to which magnetic fields inhibit the collapse of material onto stars, and this source seems to offer a particularly useful example.

CfA astronomers Josep Girart and TK Sridharan and their colleagues have used the ALMA submillimeter facility to obtain images with spatial scales as small as 0.03 light years. Their detailed polarization maps show that the magnetic field is well ordered all across the clump, which itself is actually fifteen smaller fragments, one of which (at 312 solar masses) appears to be the most massive fragment known.

The scientists analyze the magnetic field strengths and show that, even in the least massive fragment the field is not strong enough to inhibit gravitational collapse. In fact, they find indications that gravity, as it pulls material inward, drags the magnetic field lines along. They are, however, unable to rule out possible further fragmentation. The research is the most precise study of magnetic fields in star forming massive clumps yet undertaken, and provides a new reference point for theoretical models. [7]

New light on star death: Super-luminous supernovae may be powered by magnetars

The research is published Oct. 17 in Nature. It proposes that the brightest exploding stars, called super-luminous supernovae, are powered by magnetars -- small and incredibly dense neutron stars, with gigantic magnetic fields, that spin hundreds of times a second.

Scientists at Queen's Astrophysics Research Centre observed two super-luminous supernovae -- two of the Universe's brightest exploding stars -- for more than a year. Contrary to existing theories, which suggested that the brightest supernovae are caused by super-massive stars exploding, their findings suggest that their origins may be better explained by a type of explosion within the star's core which creates a smaller but extremely dense and rapidly spinning magnetic star.

Matt Nicholl, a research student at the Astrophysics Research Centre at Queen's School of Mathematics and Physics, is lead author of the study. He said: "Supernovae are several billions of times brighter than the Sun, and in fact are so bright that amateur astronomers regularly search for new ones in nearby galaxies. It has been known for decades that the heat and light from these supernovae come from powerful blast-waves and radioactive material.

"But recently some very unusual supernovae have been found, which are too bright to be explained in this way. They are hundreds of times brighter than those found over the last fifty years and the origin of their extreme properties is quite mysterious.

"Some theoretical physicists predicted these types of explosions came from the biggest stars in the universe destroying themselves in a manner quite like a giant thermonuclear bomb. But our data doesn't match up with this theory.

"In a supernova explosion, the star's outer layers are violently ejected, while its core collapses to form an extremely dense neutron star -- weighing as much as the Sun but only tens of kilometers across. We think that, in a small number of cases, the neutron star has a very strong magnetic field, and spins incredibly quickly -- about 300 times a second. As it slows down, it could transmit the spin energy into the supernova, via magnetism, making it much brighter than normal. The data we have seems to match that prediction almost exactly."

Queen's astronomers led an international team of scientists on the study, using some of the world's most powerful telescopes. Much of the data was collected using Pan-STARRS -- the Panoramic Survey Telescope and Rapid Response System. Based on Mount Haleakala in Hawaii, Pan-STARRS boasts the world's largest digital camera, and can cover an area 40 times the size of the full moon in one shot.

The study is one of the projects funded by a €2.3million grant from the European Research Council. The grant was awarded to Professor Stephen Smartt, Director of Queen's Astrophysics Research Centre, in 2012 to lead an international study to hunt for the Universe's earliest supernovae.

Professor Smartt said: "These are really special supernovae. Because they are so bright, we can use them as torches in the very distant Universe. Light travels through space at a fixed speed, as we look further away, we see snapshots of the increasingly distant past. By understanding the processes that result in these dazzling explosions, we can probe the Universe as it was shortly after its birth. Our goal is to find these supernovae in the early Universe, detecting some of the first stars ever to form and watch them produce the first chemical elements created in the Universe." [6]

The Big Bang

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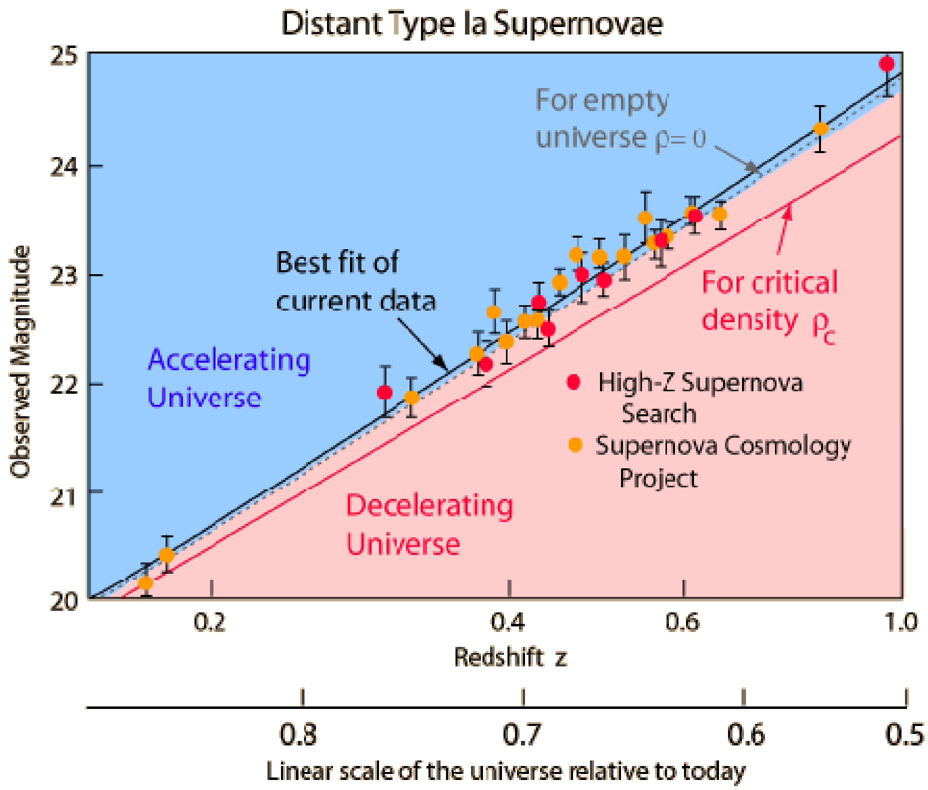
The positive and negative charged currents attracts each other or by the magnetic forces or by the much stronger electrostatic forces!?
The gravitational force attracting the matter, causing concentration of the matter in a small space and leaving much space with low matter concentration: dark matter 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.

Evidence for an accelerating universe

One of the observational foundations for the big bang model of cosmology was the observed expansion of the universe. [4] Measurement of the expansion rate is a critical part of the study, and it has been found that the expansion rate is very nearly "flat". That is, the universe is very close to the critical density, above which it would slow down and collapse inward toward a future "big crunch". One of the great challenges of astronomy and astrophysics is distance measurement over the vast distances of the universe. Since the 1990s it has become apparent that type Ia supernovae offer a unique opportunity for the consistent measurement of distance out to perhaps 1000 Mpc. Measurement at these great distances provided the first data to suggest that the expansion rate of the universe is actually accelerating. That acceleration implies an energy density that acts in opposition to gravity which would cause the expansion to accelerate. This is an energy density which we have not directly detected observationally and it has been given the name "dark energy".

The type Ia supernova evidence for an accelerated universe has been discussed by Perlmutter and the diagram below follows his illustration in Physics Today.



The data summarized in the illustration above involve the measurement of the redshifts of the distant supernovae. The observed magnitudes are plotted against the redshift parameter z. Note that there are a number of Type 1a supernovae around z=.6, which with a Hubble constant of 71 km/s/mpc is a distance of about 5 billion light years.

Equation

The cosmological constant Λ appears in Einstein's field equation [5] in the form of

$$R_{\mu\nu} - \frac{1}{2}R\,g_{\mu\nu} + \Lambda\,g_{\mu\nu} = \frac{8\pi G}{c^4}T_{\mu\nu}\,,$$

where *R* and *g* describe the structure of spacetime, *T* pertains to matter and energy affecting that structure, and *G* and *c* are conversion factors that arise from using traditional units of measurement. When Λ is zero, this reduces to the original field equation of general relativity. When *T* is zero, the field equation describes empty space (the vacuum).

The cosmological constant has the same effect as an intrinsic energy density of the vacuum, ρ_{vac} (and an associated pressure). In this context it is commonly moved onto the right-hand side of the equation, and defined with a proportionality factor of 8π: $\Lambda = 8\pi\rho_{vac}$, where unit conventions of general relativity are used (otherwise factors of *G* and *c* would also appear). It is common to quote values of energy density directly, though still using the name "cosmological constant".

A positive vacuum energy density resulting from a cosmological constant implies a negative pressure, and vice versa. If the energy density is positive, the associated negative pressure will drive an accelerated expansion of the universe, as observed. (See dark energy and cosmic inflation for details.)

Explanatory models

Models attempting to explain accelerating expansion include some form of dark energy, dark fluid or phantom energy. The most important property of dark energy is that it has negative pressure which is distributed relatively homogeneously in space. The simplest explanation for dark energy is that it is a cosmological constant or vacuum energy; this leads to the Lambda-CDM model, which is generally known as the Standard Model of Cosmology as of 2003-2013, since it is the simplest model in good agreement with a variety of recent observations.

Lorentz transformation of the Special Relativity

In the referential frame of the accelerating electrons the charge density lowering linearly because of the linearly growing way they takes every next time period. From the referential frame of the wire there is a parabolic charge density lowering.

The difference between these two referential frames, namely the referential frame of the wire and the referential frame of the moving electrons gives the relativistic effect. Important to say that the moving electrons presenting the time coordinate, since the electrons are taking linearly increasing way every next time period, and the wire presenting the geometric coordinate. The Lorentz transformations are based on moving light sources of the Michelson - Morley experiment giving a practical method to transform time and geometric coordinates without explaining the source of this mystery.

The real mystery is that the accelerating charges are maintaining the accelerating force with their charge distribution locally. The resolution of this mystery that the charges are simply the results of the diffraction patterns, that is the charges and the electric field are two sides of the same thing. Otherwise the charges could exceed the velocity of the electromagnetic field.

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 Classical Relativistic effect

The moving charges are self maintain the electromagnetic field locally, causing their movement and this is the result of their acceleration under the force of this field.
In the classical physics the charges will distributed along the electric current so that the electric potential lowering along the current, by linearly increasing the way they take every next time period because this accelerated motion.

Electromagnetic inertia and Gravitational attraction

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.

It looks clear that the growing acceleration results the relativistic growing mass - limited also with the velocity of the electromagnetic wave.

Since $E = hv$ and $E = mc^2$, $m = hv / c^2$ that is the m depends only on the v 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.

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.

Electromagnetic inertia and mass

Electromagnetic Induction

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Relativistic change of mass

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The frequency dependence of mass

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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. [1]

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Gravity from the point of view of quantum physics

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.

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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. [2]

Conclusions

Professor Smartt said: "These are really special supernovae. Because they are so bright, we can use them as torches in the very distant Universe. Light travels through space at a fixed speed, as we look further away, we see snapshots of the increasingly distant past. By understanding the processes that result in these dazzling explosions, we can probe the Universe as it was shortly after its birth. Our goal is to find these supernovae in the early Universe, detecting some of the first stars ever to form and watch them produce the first chemical elements created in the Universe." [6]

The accelerating Universe fits into the accelerating charges of the electric currents, because the Bing Bang caused radial moving of the matter.

Needless to say that the accelerating electrons of the steady stationary current are a simple demystification of the magnetic field, by creating a decreasing charge distribution along the wire, maintaining the decreasing U potential and creating the **A** vector potential experienced by the electrons moving by **v** velocity relative to the wire. This way it is easier to understand also the time dependent changes of the electric current and the electromagnetic waves as the resulting fields moving by c velocity.
It could be possible something very important law of the nature behind the self maintaining **E** accelerating force by the accelerated electrons. The accelerated electrons created electromagnetic fields are so natural that they occur as electromagnetic waves traveling with velocity c. It shows that the electric charges are the result of the electromagnetic waves diffraction.
One of the most important conclusions is that the electric charges are moving in an accelerated way and even if their velocity is constant, they have an intrinsic acceleration anyway, the so called spin, since they need at least an intrinsic acceleration to make possible they movement .
The bridge between the classical and quantum theory is based on this intrinsic acceleration of the spin, explaining also the Heisenberg Uncertainty Principle. The particle – wave duality of the electric charges and the photon makes certain that they are both sides of the same thing. Basing the gravitational force on the accelerating Universe caused magnetic force and the Planck Distribution Law of the electromagnetic waves caused diffraction gives us the basis to build a Unified Theory of the physical interactions.
The electric currents causing self maintaining electric potential is the source of the special and general relativistic effects. The Higgs Field is the result of the electromagnetic induction. The Graviton is two photons together. [3]

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