THESIS

The Safety Procurement of TeV+ Collisions within the Particle Collider Industry

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Abstract

Mankind's greatest engineering feat to date is often credited as the construction of the Large Hadron Collider (LHC) at The European Organization for Nuclear Research (CERN), the world's largest and highest-energy particle accelerator. It is expected to address some of the most fundamental questions of physics, advancing the understanding of the deepest laws of nature [1]. Amid concerns from segments of the general public and many academics, I involved in the safety procurement debate on the issue of TeV+ collisions over the period 2007-2011 both in peer review of academic papers on the subject in challenge to Large Hadron Collider Safety Assessment Group (LSAG) conclusions at CERN, and in raising the matter of safety concerns with European Parliament (Petition Nr. 1329/2008). This thesis presents an overview of the concerns raised, the issues discussed, and conclusions drawn on the subject of TeV+ collision safety.

Dedicated to my two precious daughters Alissa Rose Kerwick & Rachel Marie Kerwick who are my greatest inspiration.

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1. Introduction

1.1. Particle Physics & The Standard Model

Particle physics is that branch of physics which studies the existence and interactions of particles that are the constituents of what is usually referred to as matter or radiation, and the currently accepted model is The Standard Model.

In current understanding, particles are excitations of quantum fields and interact following their dynamics. Most of the interest in this area is in fundamental fields, each of which cannot be described as a bound state of other fields.

The current set of fundamental fields and their dynamics are summarized in a theory called the Standard Model, therefore particle physics is largely the study of the Standard Model's particle content and its possible extensions.

Modern particle physics research is focused on subatomic particles, including atomic constituents such as electrons, protons, and neutrons (protons and neutrons are composite particles called baryons, made of quarks), particles produced by radioactive and scattering processes, such as photons, neutrinos, and muons, as well as a wide range of exotic particles. To be specific, the term ‘particle’ is a misnomer from classical physics because the dynamics of particle physics are governed by quantum mechanics.

As such, they exhibit wave-particle duality, displaying particle-like behavior under certain experimental conditions and wave-like behavior in others. In more technical terms, they are described by quantum state vectors in a Hilbert space, which is also treated in quantum field theory. Following the convention of particle physicists, ‘elementary particles’ refer to objects such as electrons and photons as it is well known that these types of particles display wave-like properties also.

All particles and their interactions observed to date can be described almost entirely by a quantum field theory called the Standard Model. The Standard Model has 17 species of elementary particles: 12 fermions or 24 if distinguishing antiparticles, 4 vector bosons (5 with antiparticles), and 1 scalar boson. These elementary particles can combine to form composite particles, accounting for the hundreds of other species of particles discovered since the 1960s.

The Standard Model has been found to agree with almost all the experimental tests conducted to date. However, most particle physicists believe that it is an incomplete description of nature, and that a more fundamental theory awaits discovery, often referred to as a Theory of Everything. In recent years, measurements of neutrono mass have provided the first experimental deviations from the Standard Model. Particle physics has impacted the philosophy of science greatly. Some particle physicists adhere to reductionism, a point of view that has been criticized and defended by philosophers and scientists [2][3].

Other physicists may defend the philosophy of holism, which has quite commonly been viewed to be reductionism's opposite [4].

The Standard Model describes the strong, weak, and electro-magnetic fundamental interactions, using mediating gauge bosons. The species of gauge bosons are the gluons, W-, W+ and Z bosons, and the photons. The model also contains 24 fundamental particles, which are the constituents of all matter. It predicts the existence of a type of boson known as the Higgs boson, referred to often as ‘The God Particle’ in more casual terms, but has yet to be discovered.

1.2. Engineering and Particle Physics Research

The major international laboratories in particle physics concerned with the collision of sub-atomic particles at high energy levels are Brookhaven National Laboratory (BNL) in the United States, The European Organization for Nuclear Research (CERN) in Europe, and Fermilab in the United States.

Particles are collided at high energies to dismantle their structure in order to view their sub-components in the attempt to identify new properties of matter.

The main engineering facilities involved in these experiments are the Relativistic Heavy Ion Collider (RHIC) at BNL, the Large Hadron Collider (LHC) at CERN, and the Tevatron at Fermilab. The RHIC at BNL collides heavy ions such as gold ions and polarized protons. It is the world’s first heavy ion collider, and the world’s only polarized proton collider. The LHC at CERN is the world’s most energetic collider of protons, and also aims to be the most energetic collider of heavy ions. The Tevatron at Fermilab collides protons and antiprotons and was the highest-energy particle collider in the world until the LHC had surpassed it.

The RHIC accelerator is an intersecting storage ring particle accelerator. Two independent rings circulate heavy ions and/or protons in opposite directions and allow a virtually free choice of colliding positively charged particles (while an anticpated eRHIC upgrade will allow collisions between positively and negatively charged particles). The RHIC double storage ring is itself hexagonally shaped and 3,834 m long in circumference, with curved edges in which stored particles are deflected and focused by 1,740 superconducting niobium-titanium magnets. The dipole magnets operate at 3.45 T.[5]. The six interaction points (between the particles circulating in the two rings) are at the middle of the six relatively straight sections, where the two rings cross, allowing the particles to collide. The interaction points are enumerated by clock positions, with an injection at one point and two large experiments, STAR and PHENIX are located along a stratis.

A particle passes through several stages of boosters before it reaches the RHIC storage ring. The first stage for ions is the Tandem Van de Graaff accelerator, while for protons, the 200 MeV linear accelerator (Linac) is used. As an example, gold nuclei leaving the Tandem Van de Graaff have an energy of about 1 MeV per nucleon and have an electric charge Q = +31 (31 of 79 electrons stripped from the gold atom). The particles are then accelerated by the Booster Synchrotron to 95 MeV per nucleon, which injects the projectile now with Q = +77 into the Alternating Gradient Synchrotron (AGS), before they finally reach 8.86 GeV per nucleon and are injected in a Q = +79 state (no electrons left) into the RHIC storage ring over the AGS-to-RHIC Transfer Line (ATR).

The main types of particle combinations explored at RHIC are p + p, d + Au, Cu + Cu and Au + Au. The projectiles typically travel at a speed of 99.995% of the speed of light. For Au + Au collisions, the center-of-mass energy is typically 200 GeV (or 100 GeV per nucleon); an average luminosity of 2×1026 cm−2s−1 was targeted during the planning. The current average luminosity of the collider is 20×1026 cm−2s−1, 10 times the design value.[10] For polarized p + p collision, Run-9 achieved center-of-mass energy of 500 GeV on 12 February 2009. [6].

One unique characteristic of RHIC is its capability to produce polarized protons. RHIC holds the record of highest energy polarized protons. Polarized protons are injected into RHIC and preserve this state throughout the energy ramp. This is a difficult task that can only be accomplished with the aid of a chain of solenoids and quadrupoles for aligning particles and AC dipoles, and are termed casually as ‘Siberian Snakes’. [7]. The AC dipoles have been also used in non-linear machine diagnostics for the first time in RHIC. [8].

The LHC at CER, as the world’s largest and highest-energy particle accelerator, is contained in a circular tunnel with a circumference of 27 kilometers, at a depth ranging from 50 to 175 meters underground. The 3.8-metre wide concrete-lined tunnel, constructed between 1983 and 1988, was formerly used to house the Large Electron–Positron Collider. It crosses the border between Switzerland and France at four points, with most of it in France. Surface buildings hold ancillary equipment such as compressors, ventilation and the control electronics.

The collider tunnel contains two adjacent parallel beam pipes that intersect at four points, each containing a proton beam which travel in opposite directions around the ring. Some 1,232 dipole magnets keep the beams on their circular path, while an additional 392 quadrupole magnets are used to keep the beams focused, in order to maximize the chances of interaction between the particles in the four intersection points, where the two beams will cross. In total, over 1,600 superconducting magnets are installed, with most weighing over 27 tonnes. Approximately 96 tonnes of liquid helium is needed to keep the magnets, made of copper-clad niobium-titanium, at their operating temperature of 1.9 K, making the LHC the largest cryogenic facility in the world at liquid helium temperature.

Once or twice a day, as the protons are accelerated from 450 GeV to 7 TeV, the field of the superconducting dipole magnets will be increased from 0.54 to 8.3 teslas (T). The protons will each have an energy of 7 TeV, giving a total collision energy of 14 TeV. At this energy the protons have a Lorentz factor of about 7,500 and move at about 0.999999991 c, or about 3 metres per second slower than the speed of light (c).[9]. It will take less than 90 microseconds (μs) for a proton to travel once around the main ring – a speed of about 11,000 revolutions per second. Rather than continuous beams, the protons will be bunched together, into 2,808 bunches, so that interactions between the two beams will take place at discrete intervals never shorter than 25 nanoseconds (ns) apart. However it was operated with fewer bunches when it was first commissioned, giving it a bunch crossing interval of 75 ns. The design luminosity of the LHC is 1034 cm−2s−1, providing a bunch collision rate of 40 MHz.

Prior to being injected into the main accelerator, the particles are prepared by a series of systems that successively increase their energy. The first system is the linear particle accelerator LINAC 2 generating 50-MeV protons, which feeds the Proton Synchrotron Booster (PSB). There the protons are accelerated to 1.4 GeV and injected into the Proton Synchrotron (PS), where they are accelerated to 26 GeV. Finally the Super Proton Synchrotron (SPS) is used to further increase their energy to 450 GeV before they are at last injected (over a period of 20 minutes) into the main ring. Here the proton bunches are accumulated, accelerated (over a period of 20 minutes) to their peak 7 TeV energy, and finally circulated for 10 to 24 hours while collisions occur at the four intersection points.

The LHC physics program is mainly based on proton–proton collisions. However, shorter running periods, typically one month per year, with heavy-ion collisions are included in the program. While lighter ions are considered as well, the baseline scheme deals with lead ions. The lead ions will be first accelerated by the linear accelerator LINAC 3, and the Low-Energy Ion Ring (LEIR) will be used as an ion storage and cooler unit. The ions will then be further accelerated by the PS and SPS before being injected into LHC ring, where they will reach an energy of 2.76 TeV per nucleon (or 575 TeV per ion), higher than the energies reached by the Relativistic Heavy Ion Collider. The aim of the heavy-ion program is to investigate quark–gluon plasma, which existed in the early universe.

The Tevatron is a circular particle accelerator in the United States, at the Fermi National Accelerator Laboratory, just east of Batavia, Illinois, and is the second highest energy particle collider in the world after the Large Hadron Collider (LHC). The Tevatron is a synchrotron that accelerates protons and antiprotons in a 6.28 km (3.90 miles) ring to energies of up to 1 TeV, hence the name.

The acceleration occurs in a number of stages. The first stage is the 750 keV Cockcroft-Walton pre-accelerator, which ionizes hydrogen gas and accelerates the negative ions created using a positive voltage. The ions then pass into the 150 meter long linear accelerator (linac) which uses oscillating electrical fields to accelerate the ions to 400 MeV. The ions then pass through a carbon foil, to remove the electrons, and the charged protons then move into the Booster.[10]

The Booster is a small circular synchrotron, around which the protons pass up to 20,000 times to attain an energy of around 8 GeV. From the Booster the particles pass into the Main Injector, which was completed in 1999 to perform a number of tasks. It can accelerate protons up to 150 GeV; it can produce 120 GeV protons for antiproton creation; it can increase antiproton energy to 120 GeV and it can inject protons or antiprotons into the Tevatron. The antiprotons are created by the Antiproton Source. 120 GeV protons are collided with a nickel target producing a range of particles including antiprotons which can be collected and stored in the accumulator ring. The ring can then pass the antiprotons to the Main Injector. The Tevatron can accelerate the particles from the Main Injector up to 980 GeV. The protons and antiprotons are accelerated in opposite directions, crossing paths in the CDF and DØ detectors to collide at 1.96 TeV. To hold the particles on track the Tevatron uses 774 niobium-titanium superconducting dipole magnets cooled in liquid helium producing 4.2 teslas. The field ramps over about 20 seconds as the particles are accelerated. Another 240 NbTi quadrupole magnets are used to focus the beam.

The initial design luminosity of the Tevatron was 1030 cm−2 s−1, however the accelerator has following upgrades been able to deliver luminosities up to 3x1032 cm−2 s−1.[11]. On September 27, 1993 the cryogenic cooling system of the Tevatron Accelerator was named an International Historic Landmark by the American Society of Mechanical Engineers. The system, which provides cryogenic liquid helium to the Tevatron's superconducting magnets, was the largest low-temperature system in existence upon its completion in 1978. It keeps the coils of the magnets, which bend and focus the particle beam, in a superconducting state so that they consume only 1/3 of the power they would require at normal (i.e. non liquid helium cooled) temperatures. [12].

1.3. Particle Collisions and the 1 TeV Threshold

Until the startup of the Large Hadron Collider in 2008, the threshold of 1 Terra electron Volt, denoted as 1 TeV, was the highest collision energy achievable in engineering efforts in particle colliders, a threshold that was reached many years earlier at the Tevatron particle collider at Fermilab. Throughout the construction of the LHC an ongoing debate and assessment was undertaken, primarily within the particle physics industry, as new physics was learned and understood.

As these collision energies were uncharted territory, a great deal of investigative theoretical physics was undertaken to ensure safety beyond reasonable doubt.

This culminated in a research paper published in 2008 by members of the LSAG at CERN ‘Astrophysical implications of hypothetical TeV-scale black holes’ [13].

This paper developed arguments to exclude any risk of dangerous black hole production at the LHC, and was published in the Physical Review D in 2008, [14] and a commentary article which appeared the same day in the journal Physics endorsed Giddings' and Mangano's conclusions.[15], as it was in popular news broadsheets of the day [16]. The LSAG report draws heavily on this research.

Despite general acceptance that safety review had been performed to sufficient levels, papers were written by academics in the field contradicting the findings of the paper by Giddings and Mangano, most notably by M.D. Maia & E.M Monte ‘On the stability of Black Holes at the LHC’ [17] and by Prof R. Paga ‘On the potential catastrophic risk from metastable quantum black holes produced at particle colliders’ [18], both published in 2008 in the response to the G&M paper.

On 9 February 2009, a paper titled "Exclusion of black hole disaster scenarios at the LHC" was published in the journal Physics Letters B. [19]. The article, which summarizes proofs aimed at ruling out any possible black hole disaster at the LHC, relied on a number of new safety arguments as well as certain arguments already present in Giddings' and Mangano's paper "Astrophysical implications of hypothetical stable TeV-scale black holes". [13]. Despite this publication, fear of analytical mis-judgement continued among certain high profile academics, most notably Prof. Otto Rossler - a renowned expert & pioneer on chaos theory, and Dr Walter L. Wagner, a physicist and campaigner on particle collider safety. It was also argued that the concerns raised by astro-physicist Prof R. Plaga remained unanswered, and the risks cited by Plaga, [18], remain unchallenged.

Despite the extreme risks cited by fringe theorists CERN commenced collisions regardless, and to date there have been no adverse consequences to these experiments. However, those who continue to argue safety concerns argue that the damage to the environment caused by these experiments in the early phase of MBH accretion would be undetectable, and the consequences of any flaws in the safety arguments of the experiments may not manifest for many decades, or even centauries, after the experiments due to the slow accretion nature of MBH.

Therefore one can argue that the safety of TeV+ collisions is not endorsed by an apparent safe operation of TeV+ energy level collisions. Herein, the aspects of these safety concerns are just as relevant today as they were prior to TeV+ level collisions within the particle collider industry, as MBH and other exotic states of matter may only be detectable by the effects they have at future accretion levels.

1.4. Theorized Safety Aspects

Experiments which began in late 2008 at CERN's Large Hadron Collider aim to recreate conditions similar to those which existed at the time of the creation of the universe. People both inside and outside the physics community have feared that the experiments are unsafe and may sooner or later cause a catastrophe of unprecedented proportions. This included alarmist statements from some risk evaluation entities, including Risk Evaluation Forum [20], who had stated that due to a high probability that micro black holes (MBHs) would be produced in the LHC, it had been estimated that for LHC the risk was in the range of 7% to 10%.

Although the CERN study indicated that MBHs present no danger because they would evaporate with Hawking evaporation [13], Hawking evaporation has never been tested or observed to this date, and this has been the cornerstone of many safety concerns. If the theory of Hawking Radiation proved to be false, or not as effective as theorized, then MBH accretion can be perceived with definitive risks.

Some experts fear that the risk of operating the LHC disproportionately outweighs anything science might gain from this experiment. It is not possible to know what the outcome of the experiment will be, but even CERN (the European Organization for Nuclear Research) scientists concede that there is a real possibility of creating destructive theoretical anomalies such as MBHs (miniature black holes), strangelets and deSitter space transitions. [21] Such events could arguably have the potential to fundamentally alter matter and destroy our planet.

At the present stage of knowledge there is a definite residual risk from MBHs production at colliders and a final conclusion by astrophysicist Ranier Plaga [18] differs completely from the one drawn by Giddings & Mangano. [13].

Black holes are usually conceived as being the remnant of a massive star that has used up its nuclear fuel, and crushed itself under its own weight. [21]. Its gravitational pull at its surface then becomes so great nothing can escape, not even light. It becomes literally a “hole” in the fabric of space-time, and anything that enters can never escape. In theory, however, a black hole can be of any size, not just very large ones. Any amount of matter, if crushed in upon itself, can theoretically form a black-hole, albeit a very small one if only a small amount of matter is crushed. Some theories suggested that miniature black holes might have been formed in the earliest history of the Universe. Other theories suggest that particle colliders, by crushing two atoms together at tremendous speed, might create a miniature black hole of very tiny dimension. Stephen Hawking in the early 1970s theorized that such miniature black holes were once in great abundance, but later “evaporated” by a quantum tunneling process, so that such miniature black holes no longer exist in our Universe. This process, first theorized by Stephen Hawking, would possibly cause a black hole to evaporate.

If virtual particles are produced in the vicinity of a black hole, it might be possible for one member of the matter-antimatter pair to be pulled into the black hole while the other escapes into space. The particle that would fall into the black hole would negate some of its mass and so the black hole would shrink a little. This would make it look as if the particle that escaped into space had come from the black hole. Hawking radiation would be particularly important in the case of miniature black holes, which might explode in this way. Black holes of very low mass, such as would be created in particle colliders, would have masses of about 10,000,000 atomic mass units, and lifetimes of about 1 E-23 seconds, If Hawking Radiation works as predicted. However, Hawking Radiation has never been experimentally detected, and exists only in theory. [21].

In theory, a miniature black hole created at rest relative to Earth is considerably different that one created by high-energy cosmic rays striking the Earth. If such high energy cosmic rays were to on occasion create a miniature black hole, as some theories have suggested, it would be traveling at very high speed [0.9999+ c] relative to Earth, and much like a neutrino, simply pass right through Earth in ¼ second without interacting, or if it did interact, it would glom on to a few quarks and barely slow. [21]. Conversely, any miniature black hole created at rest in a particle collider would essentially be trapped in Earth's gravitational field, and over seconds to hours, would slowly interact and acquire more mass if Hawking radiation does not work as predicted or as quickly as predicted, and cause the newly-minted miniature black hole to fail to evaporate and instead accrete mass.

The other main concern regarding TeV+ collisions are the creation of a theorized form of matter termed the 'strangelet'. Strangelet is the name given to a theoretical form of matter that might exist in nature. Under some theories, a more stable form of nuclear matter might exist, when compared to our normal form of nuclear matter that is formed of up and down quarks combined into protons and neutrons [either two up and one down, or two down and one up], which in turn combine to form the nuclei of atoms. Under these theories, an equal number of up, down and strange quarks would form a slightly more stable form [slightly less mass], more stable than the Iron nucleus, the most stable form of normal nuclear matter. This is called strange matter, or strange quark matter [sqm]. Unlike normal matter, in which increasing the number of protons and neutrons beyond the 56 present in Iron increases the coulombic repulsion and de-stabilizes the nucleus, no such coulombic repulsion would exist in strange quark matter, and the larger the nucleus, the more stable the sqm nucleus. A very small chunk of sqm is called a strangelet. This sqm could be either slightly positive, or slightly negative, or neutral, under various theories.

Strangelets are also theorized to be creatable in particle colliders if they collide two large atoms together, such as two lead atoms. In nature, such large atoms do not collide at LHC energies. Instead, high-energy incoming cosmic rays are believed to be single protons, which would likely plow right through a large nucleus sitting on the moon. Also, as is true for miniature black holes, if natural strangelets are neutral they would simply pass through Earth neutrino-like at high speed if created by cosmic rays. If created instead at rest relative to Earth in a collider, they would be trapped by Earth's gravitational field, and potentially be able to interact with normal matter, acquire quarks, and grow larger.

Cosmologists have theorized that so-called "neutron stars" can form from collapsed stars in which the electrons and protons of a massive collapsed star, not quite large enough to form a black hole, combine together to from neutrons, so the entire star becomes a massive single nucleus of nothing but neutrons. Most theories about such neutron stars now show that they would more likely form into sqm, and they are now called “strange stars” instead of “neutron stars”.

1.5. Preview of Topics

In section 2 I shall explore the above mentioned theorized risks and present an overview of each, illustrating why some academics still concern at high intensity TeV+ collision energies in particle collider experiments, and why others state the risks cited are either negligible or not valid arguments. In section 3 I will look specifically at the nature of Micro Black Holes and the widely accepted theory of Hawking Radiation which determines that these have no environmental impact. In section 4 I will assume Hawking Radiation is a valid theory in order to discuss the spin polarization effects in MBH evaporation and how concerns were raised in this area in 2009 by physicists at Kyoto University, Japan [22]. In sections 6 and 7 I shall discuss the more exotic concerns, most notably the theorized forms of matter & space-time such as strangelets, magnetic monopoles and deSitter space transitions. In section 8 I shall look at what happens when particles collide and why these are commonly referred to as a re-creation of ‘the big bang’ at a microscopic level, but also explains the significance of the argument that in some of the more standard models of the universe, nothing existed prior to ‘the big bang’ so as such ‘the big bang’ started at a microscopic level, whereby there must be an indeterminable threshold in re-creating these conditions where a similar runaway explosive effect could occur in what one could only describe as a catalytic cataclysm of universal proportions. However, it is also argued that the energy levels to reach such a threshold far exceed those at modern colliders. In section 8 conclusions are drawn based on the topics discussed herein as to whether any extreme or residual risks are being taken by TeV+ level collisions.

2. Overview of Theorized Risks

2.1. Fundamental Argument of Uncertainty

In the case of the LHC, there are several theoretical arguments that point to a risk of negative outcomes [23]. The existence of these theories, some critics claim, shows that a negative outcome is plausible where reassuring arguments based on astrophysical or lower energy collision data are insufficient. The existence of these theories, therefore demonstrate, the un-tenability of CERN's official policy of stating that the risk is zero [23]. A widely accepted opinion with campaigners is that CERN officials are instructed, with respect to the LHC and any adverse environmental impact, catastrophic or otherwise "not to say that the probability is very small, but that the probability is zero" [24].

In contradiction to this mantra, CERN scientists have shown that they in fact accept an official worst case scenario where the experiments at the LHC initiate the destruction of Earth [13] in several billion years (citing a slow accretion rate of any MBH created by CERN experiments in this era). CERN scientists therefore appear to accept the extreme implications of these experiments, with the only 'safety factor' being the long time until that potential is realized. However, there is a need to clarify, on behalf of academics at CERN, that this is a disposition largely taken out of context. It is stated in the context of a theoretical outcome of the experiments which academics at CERN do not adhere to. Regardless of this disposition, it is clear there is a fundamental theoretical argument of uncertainty, and the matters pertained to herein are therefore credible philosophical debate.

In 2010, an international group of critics and experts filed a complaint at the Human Rights Committee of the United Nations in Geneva concerning risks and dangers of the planned experiments at the Large Hadron Collider (LHC) operated by CERN in Swizterland. The group impeaches the CERN member states, making specific reference to Switzerland, France and Germany, stating that they had not carried out their legal responsibilities to keep citizens safe [23].

After a year of repairs and redesign of some LHC safety systems due to a massive equipment failure in 2010, the LHC was prepared to inject circulating beams without further safety debate. First beam collisions at injection energies were planned to follow shortly afterwards. The comprehensive and detailed communication to the UN was worked out by well-known critics and experts, relying upon the work of specialists on black hole theory, cosmic rays, particle physics and on risk researchers and several experts in international law. The communication demonstrated concrete dangers arising from the planned high-energy experiments at the LHC and weaknesses in CERN safety assessments.

To guarantee safety, the complaint demanded an external risk evaluation done by those without ties to CERN. Further, closer study of cosmic ray (AUGER observatory) and other recent empirical data highly relevant for the LHC-safety arguments was requested as a matter of urgency, as it was awaiting upcoming observing experiments in the atmosphere [25].

The legal aspects focused on the special responsibility of Switzerland, France and Germany (by territory as ownership principle and CERN-council membership) and addressed also the other CERN member states not having insured LHC-safety on life and environment according to the International Protocol of Civil and Political Rights of the United Nations. This complaint was supported by several organizations and a wide group of international critics of the planned what was critically described as a ‘big bang experiment’. It included a clear and detailed description of the scientific discourse on several risks and dangers arising from the artificial and extreme states of matter planned to be created, such as risks from micro black holes and strangelets as described in a number of studies - and even dangers of transitions in the energy level of space.

Enclosed were critical studies of the method used in the CERN risk studies, one from members of the “Future of Humanity Institute” of the University of Oxford and a review on the LHC safety assessment process by risk assessment expert and ethicist Dr. Mark Leggett concluding that CERN at this date has fulfilled not more than one fifth of necessary criteria expected for a modern safety study. [25].

As long as there is no clear evidence that the possible production of micro black holes (expected to be created by many CERN scientists) pose neither long- nor short-term danger to life and to planet Earth, CERN and the member states should not aim for their production in high energy experiments at all. Instead, it was argued that it had first to demonstrate by observation and empirical tests -

1. That the comparison of natural events in the atmosphere to the experiments at the LHC (as proclaimed by CERN) is legitimate in all necessary respects. With a quantifiable certainty.

2. That the possible mass production of micro black holes at particle colliders (as regarded possible by CERN) is clearly and 100% harmless. With a quantifiable certainty.

Several ongoing and planned experiments (Earth based and in the atmosphere) on high energetic cosmic rays are expected to throw light on these questions.

Thus, it was argued, that as long as the credentials of a safe operation of the ‘big bang machine’ are not provided, no high energy collisions should be conducted at the LHC [25]. If necessary, a claim for interim measures at the UN should follow such that operation and planning of high energy colliders should be controlled and regulated by an agency similar to the International Atomic Energy Agency at the UN or directly established at the IAEA as soon as possible [25].

The safety assessment entity Concerned International [26], which consists of different organizations and individuals having established a complaint to the UN consists of or is in direct contact with the most well known critics of the LHC project, most notably Prof. Otto Rossler, Dr. Walter Wagner. The complaint provided many critical views of independent experts from different fields, including physicists, astrophysicists, risk researchers, philosophers and legal experts. This underlines the Fundamental Argument of Uncertainty discussed.

2.2. Micro Black Holes and Accretion Rates

One of the theories that allow catastrophe is the theory that LHC collisions might create micro black holes. Stellar black holes are among the most extreme phenomena in the universe and have been found both in theory and by observation. These indirectly observable objects are commonly a result of a gravitational collapse after the supernova explosion of a giant star, where matter has been compressed to the extreme. The prevailing gravitational forces are so strong that not even light can escape, so the celestial body appears black. Modern, reputable theories of gravity at the micro scale, proposed five years after the LHC was approved, revise how gravity applies at this scale and propose that the LHC could create these objects in miniature form by proton collisions. *“If the scale of quantum gravity is near a TeV, the LHC will be producing one black hole (BH) about every second.”* Prof. Savas Dimopoulos (University of Stanford) and Prof. Greg Landsberg (Brown University). [29].

"If the fundamental Planck scale is of the order of a TeV, as is the case in some extra-dimensional scenarios, future hadron colliders such as the Large Hadron Collider will be black hole factories." Prof. Steve B. Giddings (Department of Physics and Institute for Theoretical Physics, University of California, Santa Barbara), Scott Thomas (Institute for Theoretical Physics, University of California, Santa Barbara, Department of Physics, Stanford University). [30].

A TeV (tera electron volt) is a unit of energy. It is 1,000,000,000,000 electron volts. Because of the equivalence of energy and mass, it is also a unit of mass. Assertions about micro black hole creation are worth following in detail. The work of astrophysicist Dr. Rainer Plaga [18] and scientist in multiple fields including physics Prof. Otto E. Rössler [29] outline how catastrophe from the LHC can be a realistic prospect, and both provide - among others - key theoretical bases for considering a definitive risk. As later illustrated, their risk arguments are either not correctly understood by CERN or are ignored by them.

Plaga's published papers include many on high energy particles known as cosmic rays – which are strongly relevant to LHC risk discussion. Plaga states: "*With the very small accretion timescale (1 second) that was found with the parameters.. ..a mBH [micro black hole] created with very small (thermal or subthermal) velocities in a collider would appear like a major nuclear explosion in the immediate vicinity of the collider*." [18]. Rössler helped pioneer 'Chaos theory' and its application to physical systems. Three of his many published physics papers involve discussion of black holes. Dr. Paul Werbos is the author of several peer-reviewed physics papers and has stated that *"..what will happen if we find really new experimental setups, different from what has happened by accident already in the atmosphere, which can produce small black holes?* [31] *Those calculations basically predicted that small black holes would burrow into the Earth, grow for a few thousand years, and result in a very sudden catastrophe gobbling up the whole Earth with little warning"*. [32]. As mentioned subsequently, Dr. Tony Rothman (Princeton University), a physicist who specializes on black hole physics [33], outlines his potential basis for concerns relating to physicist G.A. Vilkovisky under 'Black holes at the LHC could only evaporate about half their mass' below.

Collider advocates have asserted several safety considerations that purport to demonstrate that micro black holes are not a danger. Many of the safety considerations first touted as adequate to protect us from black holes have eroded, and are no longer considered adequate in current safety papers, even papers by collider advocates. This erosion of past safety considerations suggests the possibility that current safety considerations may also erode. RHIC collider operator Brookhaven conducted one safety study and LHC operator CERN conducted two safety studies that claim that there is no risk from black holes.The first safety paper claimed that black hole formation requires energy beyond the reach of any collider, [34] then peer-reviewed physics papers appeared, unrelated to the collider controversy, that predicted production of black holes at colliders.[27] [28].

The second safety paper claimed that black holes would evaporate instantly though Hawking radiation, then peer-reviewed physics papers appeared, unrelated to the collider controversy, that questioned even the fundamental theory behind Hawking radiation, a purely theoretical radiation that has never been observed. [35][36] Also the rapid decay interpretation itself was undermined by Casadio & Harms to allow a black hole lifetime of years [37] and an alternative analysis postulated that a black hole would not dissipate, but only lose half of its mass. [38]. An analogy between collider-created black holes and cosmic-ray created black holes was supposed to demonstrate safety, but the analogy as originally proposed was accepted by CERN as inexact, and had to be revised in CERN's paper [13] by Prof. Mangano (CERN) and Prof. Giddings (Department of Physics, University of California). Reliance upon their interpretation of astrophysical data implies that CERN's theoretical model for growth of black holes suggested growth to a dangerous size was supposed to take many billions of years [13], but some models enable faster growth [39].

Calculations regarding the time required for growing micro-black holes to swallow Earth have very different results. The most recent safety paper proposed new safety considerations, but these have been challenged. For example, CERN's Mangano & Giddings paper [13] argued this would take several billion years in the worst case. They further argue that neutron stars should capture micro black holes if they could be created, giving neutron stars lifetimes shorter than observed. However, Prof Otto Rössler theorises that superfluidity in neutron stars may well prevent micro black hole capture [40] and Rainer Plaga relies upon the Casadio & Harms paper [37] to predict black hole radiation levels that would not be detectable from white dwarfs or neutron stars but would be devastating within Earth [18]. It has been alleged that neither of these counter-arguments have been addressed by CERN [13].

Insofar as challenging and invalidating LHC safety arguments, the safety of the Large Hadron Collider has been the subject of investigation by a number of physicists. Herein I provide an overview of the arguments on LHC safety which some argue undermines the claim that safety for life and environment can be taken for granted. References in the following arguments include formulae from published papers (with formulae in italics), in order to demonstrate a theoretical backing. There are two common methods of calculating black hole decay and radiation, called the 'canonical' and the 'micro-canonical' interpretations of Hawking radiation. Stocker et al. [41] for example describe the rapid decay scenario as the 'canonical' application.

For micro black holes, the two different methods can yield significantly different results. While CERN considers that any black holes either immediately evaporate or do not decay at all [13], according to Casadio et al. 2002 [37] LHC black holes can last over 30 years in isolation based on an alternative Hawking radiation calculation. More recently, Casadio et al. 2009 [42] again considered LHC black holes with the slow decay 'micro-canonical' interpretation. Despite the fact that the 2002 parameter $MC=mp(L/lp)$ is still accepted by Casadio et al whereby selecting to calculate with a newer parameter giving a higher decay rate. In this way they conclude that the decay rate soon surpasses the accretion rate. Furthermore Stocker et al [41] already allow for the prospect that the black holes may continue to absorb matter at a faster rate than they decay thus implying continued black hole growth.

The micro black hole rapid decay 'canonical' approach has been the more conventional one for black holes, as it anyway gives the same results for ordinary (non micro) black holes. However, in principle, the alternative models for black hole decay have been startlingly described by S Hawking [31] in this way: "*one cannot use the normal statistical-mechanical canonical [immediate decay] ensemble when gravitation interactions are important.*" "*Although the* *canonical ensemble [immediate decay] does not work for black holes, one can still employ a microcanonical ensemble [enabling slow decay] of a large number of similar insulated systems each with a given fixed energy E*."

Presenting the possibility that Hawking radiation does not exist and that black holes cannot decay, the former main argument [13] for the safety of the LHC from black holes relied on rapid decay from Hawking radiation. However, Hawking radiation remains an unproven hypothesis, and as such it is not a satisfactory safety factor. Further, in several papers, it is argued by Professor Dr. Adam D. Helfer (University of Missouri). [35] and Prof. Vladimir A. Belinski (University of Rome, "La Sapienza"), [36] that the fundamental theory behind Hawking radiation is incorrect, so that Hawking radiation and decay would not occur. This possibility is principally accepted for exploration by Prof. Horst Stocker et al.[41] and by CERN [13], which published the most relevant CERN study for black hole safety arguments. For the above both general and specific reasons, then, Hawking radiation is not a satisfactory safety factor.

Uncartainties about accretion rates have been heavily debated in the field. Details of the accretion rate depend on parameters that are not known. This implies that there are no clear guides as to the accretion time of Earth. Calculations regarding the time it will require for growing micro-black holes to consume Earth have very different results. Author of published microgravity paper Prof. Otto E. Rössler (University of Tübingen) estimates "*not after millions of years of linear growth but after months of nonlinear growth*." Prof. Horst Stöcker (University of Frankfurt) et al, in a first version of his paper [41], projected a purely theoretical growth phase of 27 years until total destruction of Earth in one scenario, but they remove this in subsequent versions. A non reassuring astrophysical interpretation (such as Rössler's) would still allow growth within tens of thousands of years even according to some of CERN's purely theoretical considerations [13]. Stocker et al. point out that the approach to accretion of CERN [13] ".. *does not take into account any effects due to the [competing] strong interaction inside a nucleon.*" [41].

Doubts appear further justified concerning the lack of incorporation of the attributes of solid or liquid as the accretable medium and of the effect surrounding temperature could have upon accretion rate. The main and later accretion phase, known as the 'Bondi' phase, has been used previously for the gravitational accretion of gases by stars or astronomical black holes, but relies again on a formula specific to gases. Concerning temperature in this accretion phase again, white dwarfs have an estimated interior temperature around 1500 times that within the Earth's core. The heat related vibrational atomic motion could significantly reduce the extent of gravitational capture, especially within the 10 million Kelvin of white dwarf interiors. CERN's basis [13] for reassurance that the Earth would not be accreted in a time scale of a few decades relies on the survival of only a specific subcategory of ‘white dwarf’ stars and to a less confident extent on the survival of neutron stars. Reference is in the conclusion also to the greater influence of high energy neutrinos, though accepted, there is not yet evidence forthcoming and there are doubts as to such interaction. CERN calculated with higher value parameters (Rc) that nevertheless allow accretion of Earth in either tens or hundreds of thousands of years based on calculations for only two of the of candidate 'TeV gravity' theories. *Rc=.2mm*. The exclusion of these shorter duration calculations relies entirely on the survival of, and relative accretion rate estimates for, white dwarfs from cosmic-ray-caused black holes.

Another estimate [18] considers the implications of an analysis [43] of one TeV gravity theory that implies that an accreting micro black hole would continually subdivide. The accretion rate of the subdivided black holes is more rapid and the implication is of a whole Earth accretion (destruction) in an estimated time of around one hour. Again, it has been argued, that such an analysis has not been explored by CERN. What is critical here is that omissions and inconsistencies within safety reviews regarding relevance of astrophysical objects and cosmic rays, there are several factors that are not taken into account in safety studies to date at CERN [13] or Stocker et al [41] that survival of observed white white dwarfs or neutron stars can be an indication of LHC black hole safety. Rössler argues that internal superfluidity of neutron stars would prevent capture of micro black holes and accretion. His other astrophysical non reassurance arguments are also not considered. Furthermore, no consideration is made of how the expected, relatively small numbers of suspected high energy cosmic ray sources [44] could be blocked by high concentrations of interstellar dust that make up either the very extensive dust lanes [45] surrounding inner galaxies such as our own; or of dark nebulae of which over 300 [46] are known, or of how the identified relevant white dwarfs could in any way be fortunate survivors. Involved issues of relative astronomical motions are also a factor, but it is clearly relevant as a neglected risk consideration. Owing to the fact that these often completely obscure light from stars behind them, we can infer that cosmic rays would collide with them, particularly as they do so even within our invisible atmosphere. So it becomes plausible these particular white dwarfs do not experience the flux of high energy cosmic rays that is key to Giddings and Mangano’s demonstration. A proper appraisal of this would involve a detailed analysis of the relative positions of dust lanes, dark nebulae, suspected cosmic ray sources and particular white dwarfs type to which CERN's Giddings and Mangano [13] refer.

A contradiction with CERN's [13] specific type of astrophysical reassurance argument is given in Stocker et al.'s paper [41]. This states that the mechanism of accretion could be such that even white dwarfs (and by extension neutron stars) would not gravitationally capture cosmic ray-created black holes, where feasible low levels of accretion rate apply. This depends upon the argument that only a very tiny proportion of protons or neutrons (including their constituent 'quarks') that a micro black hole travels through, may be accreted. This is due to the fact that the strong nuclear force can be similarly effective to the 'TeV gravity' at short distances. So this approach, incorporating the competing influence of the strong nuclear force is then used to claim that the accretion of the Earth would take many times longer than the age of the universe. But it is admitted that this "*neglects a possible rapidity and area dependence of the black hole accretion.*" Yet the formula indicates that the radius for capture of black holes, decreases with speed. This is supported by Mangano [13]. Therefore, it is suggested that where white dwarfs do not accrete rapidly enough to gravitationally capture black holes (caused by cosmic rays), an accretion of the whole Earth within its lifetime could then apply, as opposed to the slow accretion time argument of [13].

Physicists have generally assumed that cosmic rays are protons, the nucleus of the hydrogen atom. Recent data of the Pierre Auger Observatory, the biggest and most renowned facility to study high energy cosmic rays, suggest that the highest energy cosmic ray data are most likely to be the nucleus of the iron atom. This up to date analysis contradicts the mostly proton high energy cosmic ray claim of CERN (Mangano and Giddings) [13] the only basis for their inclusion of neutron star survival within their ’Summary and Conclusions’. Though this iron nuclei suggestion is likely more reliable than the earlier proton claim, it is based not on direct measurements, but on the height of the collision in the atmosphere and the shower of secondary particles. This data may yet be consistent with even more exotic particles such as magnetic monopoles or strangelets, and if so they may not be analogous with energetic collider collisions. [18].

This is somewhat more suggested for the higher range collision energies. But as Plaga's paper implies, for conventional nuclei cosmic rays - just below such high collision energies - created black holes would not have sufficient mass to ensure they have the understood properties. Therefore, their stopping - and subsequent accretion - within white dwarfs may not apply. Cosmic rays at the energy level of the LHC have never been observed directly. They have only been observed by measuring the shower of secondary particles and computing the energy required for the expected type of particle to produce that shower. This leaves doubts that cosmic ray collisions are in fact comparable to LHC collisions due to the differing interaction process of the collision. Direct measurement with soon to be launched, or planned space probes (AMS, OWL, EUSO, AW) could remove that doubt. So this safety argument is built on hypotheses that have recently been weakened by empirical research, or are otherwise questionable to within reason.

Furthermore, Rössler's arguments [40] regarding how the internal superfluidity of neutron stars would prevent accretion and his other astrophysical non reassurance arguments have yet to be considered in line with safety assurances.

2.3. Strangelets

Former Berkeley University physics research assistant Walter Wagner proposed that lead-lead nuclei collisions at the LHC may enable the production of dangerous particles known as 'strangelets'. Such risk is acknowledged by high energy cosmic ray particle specialist and astrophysicist Rainer Plaga [18]. Normal matter consists of 'up' and 'down' quarks. Strange matter adds a third type of quark, called a 'strange' quark. A small lump of strange quark matter that includes strange quarks is called a 'strangelet'. Some hypothesize that neutron stars consist largely of strange matter. It is accepted as plausible, that a negatively charged strangelet could catalyze conversion of normal matter into more strange matter (as a result of having a lower energy state), thus converting Earth as a whole into strange matter. One safety consideration that was supposed to protect us from strange matter was the idea that a strangelet would be electrically positive on its surface and not attract normal matter. It appears clear from the various high energy physics papers that consider the prospects for the existence of negative strangelets [47] that the analysis as offered by the LSAG report (2008) - is a partial representation of existing views. In at least three papers [48][49], from 1986 (Golowich et al.), Schaffner-Bielich et al. and C Greiner 1997 a negative strangelet has been theoretically proposed as a potential prospect in the context of collision experiments.

More importantly, this is for a predicted lifetime of longer than that minimum indicated as potentially catastrophic - longer than one ten millionth of a second (10^-7s) according to both Wilczek et al. [50] and Kent [51].

These papers, which indicate longer lived negative strangelet duration, were written before the catastrophic danger prospect was highlighted by 2000. [50]. No mention of this vitally relevant duration is made in either LSAG report, which, by failing to specify what a sufficiently 'long lived' strangelet do not in effect specifically argue against such 'metastable' negative strangelets with such duration. This prediction enabling the existence of dangerous negative strangelets is not acknowledged by any safety reviews and no references are given for papers suggesting plausibility of such theorized negative strangelets.

A further 2006 paper [47] also unreferenced by LSAG 2008, supports the feasibility for existence of negative strangelets, despite LSAG claiming only positive strangelets are credible. The only argument offered then is that it is extremely unlikely that such could be produced. This is because of reliance upon interpretations known as 'thermal' or 'coalescence' models for data from the RHIC collider, which has only one tenth of the energy of LHC.

In the paper "*New solutions for the color-flavor locked strangelets*" Peng, Wen and Chen write "*Recent publications rule out the negatively charged beta equilibrium strangelets in ordinary phase, and the color-flavor locked (CFL) strangelets are reported to be also positively charged. This letter presents new solutions to the system equations where CFL strangelets are slightly negatively charged. If the ratio of the square-root bag constant to the gap parameter is smaller than 170 MeV, the CFL strangelets are more stable than iron and the normal unpaired strangelets. For the same parameters, however, the positively charged CFL strangelets are more stable.*" The only argument offered then is that it is extremely unlikely that such could be produced. This is because of reliance upon interpretations known as 'thermal' or 'coalescence' models for data from the RHIC collider - which has only one tenth of the energy of LHC.

There are three considerations that are neglected in this context:

1. The relevance of ‘TeV gravity’ theories to this question is not considered in safety reviews. Although we cannot be sure the parameter values for micro black holes would be dangerous, it is argued here that this may not then apply for strangelets. At levels approaching but not reaching that of TeV gravity, although gravity would not be as strong as the nuclei-binding 'strong nuclear' force, it could still be stronger than the electromagnetic force (which is many times weaker than TeV gravity would be anyway) responsible for interactions dependent upon charge. "*The strength of gravity depends so strongly on position along the fifth [extra] dimension*" [52] Collisions that are sufficiently off centre, where the full centre mass of the travelling nuclei does not contribute to the collision energy, would meet such criteria. One example of this electromagnetic force is the repulsive interaction of positively charged sub nuclear particles in collision. The inhibition of such elasticity effects of collision at higher energies can be made possible where sufficiently near TeV gravity energies are attained between colliding particles.

2. Among several other peers, an alternative model of collider particle production is given by [48][49], called the ‘strangelet distillation' model. This relates to details of how collision energy levels relates to the behaviour of the immediate post collision 'quark gluon plasma' (earlier mentioned). This model is still referred to as plausible in [53], which was published as recently as 2008. As stated by Schaffner-Bielich et al. [48] “*At higher energy, ..strangelet distillation still works but lower mass numbers of A<10 are expected, which might be detectable with the ALICE detector at the LHC*.” But even for such low mass numbers of a strangelet, dangerous duration is allowed for the relevant ‘long lived’ duration strangelet as shown by Schnaffner.

3. Computer projection [53], more recent than that relied on for LSAG, for production likelihoods of very similar lumps of strange matter described as 'multiple hypernuclei exotic objects', indicates increasing production for various negatively charged types of this from around the maximum yet achieved energies for ion collision (200million 'electron Volts' referenced here). This suggests that such increases could continue up to LHC lead-lead collision energies (2 TeV per nucleon collision) - such is certainly not excluded. By implication, similar predictions appear plausible for negative strangelets, but which are not considered in this paper. As with the latter case, here 'TeV gravity' relevance is not considered.

It has been stated that there are no satisfactory astrophysical argument for strangelet safety. Four papers of 1999/2000 [34][51][54][55] addressed the question of whether astrophysical evidence demonstrates no danger from collider produced strangelets. One paper by Dar, Rujula, Heinz [54] concluded that strangelets from cosmic rays would be disrupted after they are produced because of the rapid subsequent impacts. This meant that there was no reassurance from the survival of relevant bodies such as the moon. This was countered by Wilczek et al.[34], but they then pointed out that Dar, Rukula, Heinz [54] only alternative astrophysical argument was insufficient given that the strangelet could last only a short time, as in the metastable strangelet predictions of [48][49]. In this other argument of Dar et al., such strangelets could emerge from collisions between cosmic rays. They could then emerge at slower speeds, making them undisreputable. However, Adrian Kent of the Oxford University department of Theoretical Physics, outlines [51] that this astrophysical reassurance of Dar et al. wouldn't be sufficient for the stable negative strangelets of [47] either. In fact, four arguments are offered in particular, as to how this could be. In the most highlighted argument [51], charge attraction implies that the negative strangelets would attract the hydrogen nuclei that are distributed throughout space. As a result strangelets could thereby gain speed due to feasible decay processes of these interactions, so that they would attain a disruptible speed by the time of reaching the nuclei within stars. Therefore no noticeable cataclysms involving stars and negative strangelets would occur. Then Wilczek et al's astrophysical argument against disruption of strangelets was strongly criticised by theoretical physicist Adrian Kent [51] who explains how Wilczek et al's argument relies on unjustifiably narrow parameter values. The 2008 LSAG report fails even to acknowledge the doubts raised here by Kent, or by nuclear physicist Francesco Calogero [55] - who reached the same conclusion that Kent did. One could easily conclude that there is no basis from astrophysical arguments to dismiss the danger of catastrophe at the LHC despite the fact that one of them is the basis for the upper bound risk value of one in five hundred thousand. [54].

2.4. *Quantum Tunneling*

Herein I cite theories involving transitions in the energy level of space. An established theory [56] postulates some form of phase transition in the energy level of space itself could be possible due to the high energy density created by a collider. This would have catastrophic implications and would involve a process known as 'quantum tunnelling' that would establish a sudden local expansion of the new space itself [57] through a transition of the fabric of space to a lower-energy vacuum state. A similar, but increased energy level of space transition, it has been postulated could have occurred during the phase of Universe evolution knowm as 'inflationary', immediately after the theorised big bang, itself theorised as a zero point energy release. Nothing like this has been clearly seen, so this theory is speculative. However, it relates to well established theoretical work whose related dangers, one could argue, have not been excluded, despite such claims [34][13], that relate to astrophysical data.

The two safety papers [34][13] considered a transition to a lower-energy vacuum state, and suggested the safety consideration that if such a transition were possible it would spread at the speed of light, and, having already occurred somewhere within our visible universe due to high energy cosmic rays would already have reached us. This argument however does not address work by Professor Paul Dixon [57] concerning the 150 million high energy collisions that would occur per second within a volume of less than 1/100th of a cubic millimetre [58] at each (of the four) collision points at the LHC. This gives 22.4 billion (2.24 x 10^10) collisions per cubic millimetre every second. This is vastly more frequent than the actual correlated energy cosmic ray frequency [13] where only one such collision would be expected to occur per cubic meter of the Earth's atmosphere (for example) over many thousands of years, even if the atmosphere were assumed to have a height of only 1 metre. Similarly, for cosmic ray particle collision energies approaching the highest level ever recorded (3 x 10^20eV), the energy is only a thousand times higher than the LHC correlated one, whilst the frequency would then be significantly less than one every thousands of years. This then creates a significantly different circumstance than that of isolated cosmic ray collisions. Therefore the actual danger analysis itself relating to the effect upon space of a high frequency of high energy collisions occurring within a small volume was avoided in review.

2.5. Magnetic Monopoles

Former Berkeley University physics research assistant Dr. Walter Wagner, once credited for co-discovery of the first possible magnetic monopole, outlined catastrophic danger from ‘magnetic monopoles’ at the LHC which has not been excluded and is thereby also a danger Magnetic monopoles would be particles that have only one magnetic pole. There are theoretical arguments that magnetic monopoles can exist and could be produced by the LHC. The argument considered by LSAG 2008 [13] that such particles would catalyze the protons and neutrons of ordinary matter into electrons and ‘neutrinos’ thus destroying the matter around it at some unknown rate. LSAG 2008 [13] then argues that magnetic monopoles would be stopped by astronomical objects after emerging from cosmic ray collisions, so that if dangerous to Earth, they would also destroy other astronomical objects they enter, and since such astronomical bodies exist, Earth must be safe. However this argument appears to contradict the claim in the same paragraph that LHC-produced magnetic monopoles would not be trapped by the Earth - even though these magnetic monopoles would be much slower moving than in the other case. The basis for these two arguments is from two CERN papers LSSG 2003 and LSAG 2008 [13]. These papers make no reference to the argument of the other paper, despite each having contradictory implications for the Earth in particular. Neither are the implications of one argument upon the other considered within LSAG 2008 [13]. More specifically, no account is taken of the different speeds magnetic monopoles would travel when created by the LHC as opposed to much faster magnetic monopoles, that – like with black holes – would naturally emerge from cosmic ray collisions with Earth. With respect to speed, the potential existence of another accepted magnetic monopole type, the cosmic ray magnetic monopole, has been excluded in space at speeds below 12km/s [51] which is above the gravitationally capturable10.5km/s, a prospect accepted for analogous LHC black hole speeds. Hence, it has been claimed [23], that the astrophysical reassurance argument stated in safety reports has been neither a satisfactory nor rigorous assessment.

2.6. Summary

It has been claimed in an appeal to the United Nations by Concerned International [23] that dangers allowed by credible theory are not excluded by safety arguments. Theories that imply danger are from theoretical principles of established physics and feasible parameters: black holes decaying over 30 years in isolation with increasing radiation, black holes absorbing the Earth in millennia, centuries or decades as allowed by feasible parameters, emerging negative strangelets or magnetic monopoles, and the transition to alternative energies of space. The only empirical reassurance is from cosmic rays that strike astronomical bodies. If resulting particles are strangelets, they are susceptible to disruption at such high speeds. Yet no argument is offered to challenge Plaga’s and Rössler’s claims that astrophysical reassurances may not apply. For black-hole-capturing white dwarfs or neutron stars there are unestablished implications regarding how the black hole speed affects the proportion of protons or neutrons absorbed or of the applicability of accretion itself because cosmic rays may not reach some astronomical bodies (concentrated interstellar dust domains) or may pass through astronomical bodies (internal superfluidity of neutron stars). Disruption of negative strangelets from cosmic rays, whether metastable or stable, has been argued to be feasible in three safety reviews. With energy transition, isolated cosmic rays do not satisfy the criteria for such transition according to Dr. Dixon and arguments concerning magnetic monopoles are not consistent or complete.

Things might well be expected to ‘go wrong’ when entering uncharted physical territory creating unprecedented conditions involving the creation of new types o matter in capturable states on Earth that have not existed for the billions of years of Earth’s existence. Every particle collision at the Large Hadron Collider will create a tremendous energy density in a small space. Energy and matter are interchangeable under the right conditions, so this energy will create a shower of new particles. Because the LHC will be more powerful than previous colliders, new particles and new state of matter that scientists have not seen before are expected. Scientists are eager to study these new things. They have many theories about what might be created. Unfortunately, some respectable theories predict creation of dangerous particles and dangerous states of matter and of space that could destroy the entire Earth. These include micro black holes that could swallow Earth or produce catastrophic energy release, strangelets that could convert Earth into a small ball of strange matter, and changes in space itself that could be catastrophic, according to advocates of safety assessment.

Assessment that seemed adequate to collider advocates have been repeatedly negated by peer reviewed papers, often papers generated independently of the collider controversy, or have been questioned by serious scientists. Black hole production by collider was supposed to be impossible, then papers appeared, based on new physics, that predicted production of black holes by colliders. Black holes were supposed to dissipate via Hawking radiation, but several papers questioned the fundamental theory behind Hawking radiation, a radiation that has never been seen. Strangelets were supposed to be electrically positive on their surface and not attract normal matter, however several papers said they can be electrically negative. Cosmic rays were said to demonstrate safety because they would make natural black holes analogous to those made by colliders if colliders could make them. However, black holes created by cosmic rays would be moving rapidly and would zip right through Earth like a neutrino, whereas some collider-created black holes would get trapped in the Earth's gravitational field. The idea that cosmic-ray-created black holes would not stop in Earth has been provisionally accepted by collider advocates, requiring that they modify the collider/cosmic ray analogy to consider conditions in white dwarf stars. Collider advocates say that cosmic-ray-created black holes would stop there, giving white dwarf stars a lifetime that is lower than observed, if unknown rates of accretion by black holes are fast enough to accrete Earth in any short time. However, several scientists question this claim.

History shows that catastrophic failures are often attributable to experts in their fields failing to properly recognize catastrophic dangers and failures to properly manage risk. A notable example was the fatal launch of the space shuttle Challenger in freezing weather despite evidence of partial o-ring failures on previous flights and strenuous objections from responsible technicians. Other notable examples of preventable engineering management failures include the loss of the ‘practically unsinkable’ Titanic when all five of her sealed compartments flooded, the distribution of the drug thalidomide to pregnant mothers, loss of magnets at the Large Hadron Collider due to basic math errors, the deployment of the Hubble space telescope with flawed mirrors due to simple errors and a failure to test before launch, and most recently the meltdown of world financial markets largely attributable to regulator failure at many levels. It has been argued, that the safety of the planet may now be compromised by the management of a single laboratory which has not sufficiently included external multi-disciplinary experts in their risk research and assessment process.

It is on these grounds that the theorized risks detailed in this section should be considered, as the basis of the most championed counter-argument s to safety.

3. Micro Black Holes (MBHs) and Hawking Radiation

3.1. The Basis of Hawking Radiation

Hawking radiation is a thermal radiation with a black body spectrum predicted to be emitted by black holes due to quantum effects. It is named after the physicist Stephen Hawking, who provided a theoretical argument for its existence in 1974.

Hawking's work followed his visit to Moscow in 1973 where Soviet scientists Yakov Zeldovich and Alexander Starobinsky showed him that according to the quantum mechanical uncertainty principle, rotating black holes should create and emit particles. [59]. The Hawking radiation process reduces the mass and the energy of the black hole and is therefore also known as black hole evaporation.

Because Hawking radiation allows black holes to lose mass and energy, black holes that lose more matter than they gain through other means are expected to dissipate, shrink, and ultimately vanish. Smaller micro black holes (MBHs) are predicted to be larger net emitters of radiation than larger black holes; thus, they tend to shrink and dissipate faster. Hawking's analysis became the first convincing insight into a possible theory of quantum gravity. In September 2010, a signal which is closely related to black hole Hawking radiation (analogue gravity) was claimed to have been observed in a laboratory experiment involving optical light pulses, however the results remain unrepeated and debated.[60].

Other projects have been launched to seek this radiation within the framework of analogue gravity. In June 2008, NASA launched the GLAST satellite, which will search for the terminal gamma-ray flashes expected from evaporating primordial black holes. In the event that speculative large extra dimension theories are correct, it is commonly accepted that CERN's Large Hadron Collider may be able to create micro black holes and observe their evaporation.[27][28].

If the mass of a black hole is M solar masses, Hawking predicted it should glow like a blackbody of temperature 6 x 10^-8/M kelvins, so only for very small black holes would this radiation be significant. The most drastic consequence is that a black hole, if not accreting matter, should radiate away its mass, slowly at first but then progressively faster as it shrinks, finally disappearing in an explosive event somewhat like a hydrogen bomb explosion [61]. However, the total lifetime of a black hole of *M* solar masses works out to be 10^{71} M^3 seconds. [61].

Therefore the processes is ineffective at the solar mass scale, and such a black hole would take an incredibly long time to evaporate according to both theory and observation – to date no scenario of black hole evaporation has been observed.

It is theorized to works on the basic principle of virtual particle pairs which are constantly being created near the event horizon of black holes. In other environments where these are created these would be created as a particle-antiparticle pair and they quickly annihilate each other. However, due to the strong gravitational forces at play on the event horizon of black holes, it is possible for one to fall in before the annihilation can occur, in which case the other half of the pair can escapes It is theorized, that if the captured particle is an antiparticle, then this reduces the mass of the black hole, and the non captured particle escapes as Hawking radiation. In this manner black holes reduce mass.

However, the effectiveness of this, and rate at which this can occur is debatable. It is only effective if, as theorized, antiparticles fall at a rate greater than the accretion of particles of such pairs by the same process, and by other processes. It has also been argued that the accretion of antiparticles would not reduce the mass of black holes, but actually increase their mass, as the characteristics of a particle and antiparticle are condensed in a manner which they cannot re-unite in the same manner they would annihilate in non black hole environments. [62].

A slightly more precise, but still much simplified, view of the process is that vacuum fluctuations cause a particle-antiparticle pair to appear close to the event horizon of a black hole [63]. One of the pair falls into the black hole whilst the other escapes. In order to preserve total energy, the particle that fell into the black hole must have had a negative energy (with respect to an observer far away from the black hole). By this process, the black hole loses mass, and, to an outside observer, it would appear that the black hole has just emitted a particle.

In another model, the process is a quantum tunneling effect, whereby particle-antiparticle pairs will form from the vacuum, and one will tunnel outside the event horizon. An important difference between the black hole radiation as computed by Hawking, and thermal radiation emitted from a black body, is that the latter is statistical in nature, and only its average satisfies what is known as Planck's law of black body radiation, while the former fits the data better. Thus thermal radiation contains information about the body that emitted it, while Hawking radiation seems to contain no such information, and depends only on the mass, angular momentum, and charge of the black hole (the no-hair theorem).

However, according to the conjectured gauge-gravity duality (also known as the AdS/CFT correspondence), black holes in certain cases (and perhaps in general) are equivalent to solutions of quantum field theory at a non-zero temperature.

This means that no information loss is expected in black holes (since no such loss exists in the quantum field theory), and the radiation emitted by a black hole is probably the usual thermal radiation. If this is correct, then Hawking's original calculation should be corrected. As an example, a black hole of one solar mass has a temperature of only 60 nanokelvins. Such a black hole would absorb far more cosmic microwave background radiation than it emits. Yet smaller primordial black holes would emit more than they absorb, and thereby lose mass.

Of significant relevance here is the trans-Planckian problem. This is the observation that Hawking's original calculation requires talking about quantum particles in which the wavelength becomes shorter than the Planck length near the black hole's horizon. It is due to the peculiar behavior near a gravitational horizon where time stops as measured from far away. A particle emitted from a black hole with a finite frequency, if traced back to the horizon, must have had an infinite frequency there and a trans-Planckian wavelength.

An outgoing Hawking radiated photon, if the mode is traced back in time, has a frequency which diverges from that which it has at great distance, as it gets closer to the horizon, which requires the wavelength of the photon to "scrunch up" infinitely at the horizon of the black hole. In a maximally extended external Schwarzschild solution, that photon's frequency only stays regular if the mode is extended back into the past region where no observer can go. That region doesn't seem to be observable and is physically suspect, so Hawking used a black hole solution without a past region which forms at a finite time in the past. In that case, the source of all the outgoing photons can be identified – it is a microscopic point right at the moment that the black hole first formed.

The quantum fluctuations at that tiny point, in Hawking's original calculation, contain all the outgoing radiation. The modes that eventually contain the outgoing radiation at long times are redshifted by such a huge amount by their long sojourn next to the event horizon, that they start off as modes with a wavelength much shorter than the Planck length. Since the laws of physics at such short distances are unknown, some find Hawking's original calculation unconvincing.

The trans-Planckian problem is nowadays mostly considered a mathematical artifact of horizon calculations. The same effect occurs for regular matter falling onto a white hole solution. Matter which falls on the white hole accumulates on it, but has no future region into which it can go. Tracing the future of this matter, it is compressed onto the final singular endpoint of the white hole evolution, into a trans-Planckian region. The reason for these types of divergences is that modes which end at the horizon from the point of view of outside coordinates are singular in frequency there. The only way to determine what happens classically is to extend in some other coordinates that cross the horizon.

There exist alternative physical pictures which give the Hawking radiation in which the trans-Planckian problem is addressed. The key point is that similar trans-Planckian problems occur when the modes occupied with Unruh radiation are traced back in time.[64] In the Unruh effect, the magnitude of the temperature can be calculated from ordinary Minkowski field theory, and is not controversial.

Hawking radiation is required by the Unruh effect and the equivalence principle applied to black hole horizons. Close to the event horizon of a black hole, a local observer must accelerate to keep from falling in. An accelerating observer sees a thermal bath of particles that pop out of the local acceleration horizon, turn around, and free-fall back in. The condition of local thermal equilibrium implies that the consistent extension of this local thermal bath has a finite temperature at infinity, which implies that some of these particles emitted by the horizon are not reabsorbed and become outgoing Hawking radiation.

A Schwarzchild black hole has the following metric:

$$ds^2 = -\left(1 - \frac{2M}{r}\right) dt^2 + \frac{1}{1 - \frac{2M}{r}} dr^2 + r^2 d\Omega^2$$

The black hole is the background space-time for a quantum field theory. The field theory is defined by a local path integral, so if the boundary conditions at the horizon are determined, the state of the field outside will be specified. To find the appropriate boundary conditions, consider a stationary observer just outside the horizon at position r = 2M + u2 / 2M. The local metric to lowest order is:

$$ds^2 = -\frac{u^2}{4M^2} dt^2 + 4du^2 + dX_\perp^2 = -\rho^2 d\tau^2 + d\rho^2 + dX_\perp^2$$

The metric describes a frame that is accelerating to keep from falling into the black hole. The local acceleration diverges as u\rightarrow 0. The horizon is not a special boundary, and objects can fall in. So the local observer should feel accelerated in ordinary Minkowski space by the principle of equivalence. The near-horizon observer must see the field excited at a local inverse temperature.

$$\beta(u) = 2\pi\rho = (4\pi)u = 4\pi\sqrt{2M(r-2M)}.$$

The gravitational red-shift is by the square root of the time component of the metric. Therefore for the field theory state to consistently extend there must be a thermal background everywhere with the local temperature redshift-matched:

$$\beta(r') = 4\pi\sqrt{2M(r-2M)}\sqrt{\frac{1-\frac{2M}{r'}}{1-\frac{2M}{r}}}$$

This can be condensed [63] so a field theory defined on a black hole background is in a thermal state whose temperature at infinity can be expressed more cleanly in terms of the surface gravity of the black hole, the parameter that determines the acceleration of a near-horizon observer. The following equation then applies:

$$T_H = \frac{\kappa}{2\pi}$$

This equation relates k, the surface gravity at the horizon with the temperature T.

In engineering units, the radiation from a Schwarzschild black hole is black-body radiation with temperature as calculated by the following formula [63]:

$$T = \frac{\hbar\, c^3}{8\pi G M k_b} \quad \left(\approx \frac{1.227 \times 10^{23}\ kg}{M}\ K\right)$$

The radius of a black hole is twice its mass in natural units, so the entropy of a black hole is proportional to its surface area is equated as follows [63]:

$$S = \pi R^2 = \frac{A}{4}.$$

Assuming that a small black hole has zero entropy, the integration constant is zero. Forming a black hole is the most efficient way to compress mass into a region, and this entropy is also a bound on the information content of any sphere in space time. The form of the result strongly suggests that the physical description of a gravitating theory can be then encoded onto a bounding surface.

According to the theories of black hole radiation, when particles escape, the black hole loses a small amount of its energy and therefore of its mass. The power emitted by a black hole in the form of Hawking radiation can easily be estimated for the simplest case of a non-rotating, non-charged Schwarzschild black hole of mass M. Combining the formulas for the Schwarzschild radius of the black hole, the Stefan–Boltzmann law of black-body radiation, the above formula for the temperature of the radiation, and the formula for the surface area of a sphere (the black hole's event horizon) rates for the decay of micro black holes can derive. Under the assumption of an otherwise empty universe, so that no matter or cosmic microwave background radiation falls into the black hole, it is possible to calculate how long it would take for the black hole to dissipate:

$$\boxed{t_{\text{ev}} = \frac{5120\pi G^2 M_0^3}{\hbar c^4}}$$

In the above equation M is the mass of the black hole, and t is evaporation time, so one can see that the smaller the mass, the greater the evaporation rate. The lower classical quantum limit for mass for this equation is equivalent to the Planck mass, such that quantum black hole Hawking radiation evaporation time:

$$\boxed{t_{\text{ev}} = 5120\pi\sqrt{\frac{\hbar G}{c^5}}}$$

For a black hole of one solar mass, we derive an inordinate time to evaporate, in terms of it being much longer than the age of the known Universe. But for a black hole of 1011 kg, the evaporation time is shorter. This is why some astronomers are searching for signs of exploding primordial black holes. However, since the universe contains the cosmic microwave background radiation, in order for the black hole to dissipate, it must have a temperature greater than that of the present-day black-body radiation of the universe of 2.7 K = 2.3 × 10−4 eV. This implies that M must be less than 0.8% of the mass of the Earth. [65].

Black hole evaporation has several significant consequences: Black hole evaporation produces a more consistent view of black hole thermodynamics, by showing how black holes interact thermally with the rest of the universe . Unlike most objects, a black hole's temperature increases as it radiates away mass. The rate of temperature increase is exponential, with the most likely endpoint being the dissolution of the black hole in a violent burst of gamma rays.

A complete description of this dissolution requires a model of quantum gravity, however, as it occurs when the black hole approaches Planck mass and Planck radius. The simplest models of black hole evaporation lead to the black hole information paradox. The information content of a black hole appears to be lost when it dissipates; as under these models the Hawking radiation is random (it has no relation to the original information). A number of solutions to this problem have been proposed; including suggestions that Hawking radiation is perturbed to contain the missing information, that the Hawking evaporation leaves some form of remnant particle containing the missing information, and that information is allowed to be lost under these conditions.

Formulae from the previous section are only applicable if laws of gravity are approximately valid all the way down to the Planck scale. In particular, for black holes with masses below Planck mass (~10−5 g), they result in unphysical lifetimes below Planck time (~10−43 s). This is normally seen as an indication that Planck mass is the lower limit on the mass of a black hole.

In the model with large extra dimensions, values of Planck constants can be radically different, and formulas for Hawking radiation have to be modified as well. In particular, the lifetime of a micro black hole (with radius below the scale of extra dimensions) is given by the following formula: [65]

$$\tau \sim \frac{1}{M_*}\left(\frac{M_{BH}}{M_*}\right)^{(n+3)/(n+1)}$$

Here M is the low energy scale (which could be as low as a few TeV), and n is the number of large extra dimensions. This formula is now consistent with black holes as light as a few TeV, with lifetimes expected, according to the theories of Hawking radiation to be on the order of "new Planck time" ~10−26 s.

3.2. Hawking Radiation from Meta-stable MBH

Astrophysicist Dr Rainer Plaga raised the issue of the dangers of Hawking radiation from meta-stable MBH [18]. He takes the view of Stocker et al of accretion surpassing decay rate and argues for the application of a formula given by Casadio et al. [37] to consider the effects of the increasing radiation effect that Stocker et al. unjustifiably neglect. The recent choice of formula giving a different parameter value by Casadio et al. in a 2009 paper [42] for calculations, appears questionable as partly reliant upon circumstantial factors. However Plaga recalculates including for this, by considering a further parameter ('L'), at a larger, though still feasible, value, so that a catastrophic result can be obtained even for any of the three given parameter formulae of [42].

While Plaga had already argued [4], that by considering a parameter, mid range between two indicated by Casadio et al [37][42], the radiating behavior of the micro black hole becomes catastrophic. Plaga calculates that micro black holes could reach a steady state, where they release energy through Hawking radiation that corresponds to the energy in the matter they accrete. The energy release would be of the order of a major thermonuclear explosion each second, but would continue for many millions of years. This would be disastrous at the surface of Earth, and also deep within Earth because of geothermal effects [18].

"*While the exact phenomenology provoked by such a mBH accreting at the Eddington limit remains to be worked out, eventually catastrophic consequences due to global heating on an unprecedented scale and global-scale earth-quakes would seem certain*." [18] Plaga in the same study: “*From these quotes I conclude: theories with extra dimensions robustly predict the existence of microscopic collider-producible black holes and Hawking radiation. But the detailed decay properties presently remain very uncertain. It then seems important to study alternatives to the standard thermodynamical treatment of Hawking radiation on the safety issue. This is the aim of my paper.*” and finally concluding *“I stand to my general conclusion that there is a residual catastrophic risk from metastable microscopic black holes produced at particle colliders.*” [18]

It has been argued by academics at high profile that such an object (a meta-stable black hole produced at LHC) could not be destroyed or removed from the Earth by any technique until all life on the planet is destroyed. [23].

Plaga argues that there is no astrophysical reassurance regarding the scenario in his paper [18] and predicts black hole radiation levels that would not be detectable from white dwarfs or neutron stars but would be devastating within Earth. This argument that there is no astrophysical reassurance has not been challenged. Cosmic ray-caused micro black holes emerging from other sides of earth or other planets would have undetectably low radiation because of their negligible mass. Therefore, it has been argued, the effects are a silent process.

Stocker et al. [41] claim to exclude risk from black hole absorption rate surpassing decay such as Plaga outlines, however it has been shown [23] that they fail to do so. In the relevant 'weak radiation' section it is argued that there can be no danger from this because black holes emerging from high energy cosmic ray collisions would maintain their charge sufficiently to enable their stopping within the Earth (due to long range electromagnetic interaction with surrounding matter[41]). The argument posits the following: If collisions can make black holes, and if black holes stop in Earth, and if they can destroy Earth, this would have already happened due to cosmic ray collisions with Earth, thus demonstrating by analogy that collider collisions are safe. However, if black holes lose their charge, relativistic black holes created travelling at near light speed by cosmic rays should travel virtually unimpeded through Earth like neutrinos, whereas slow black holes made by colliders would occasionally be captured by Earth. Stocker et al. [41] claim that such black holes would stop because of their charge, but they fail to incorporate the established theory of 'Schwinger radiation' which acts to immediately neutralize any charge that the black hole has at a given time. Yet Stocker et al. do incorporate this same Schwinger radiation in another, negligible radiation scenario where CERN argues it is less likely to apply. This is stated in [13], where the ‘usual picture’ incorporates both Schwinger radiation (preventing dangers from black hole stopping) and Hawking radiation. Therefore black holes with slow decay Hawking radiation caused by cosmic rays striking the Earth would pass through with negligible interaction. The implication is that Stocker et al. offer no argument to exclude the prospect of a sufficient absorption of matter within Earth enabling Hawking radiation to cause catastrophic results from LHC black holes. This assertion is indisputable.

However, in retorts on claimed risk from meta-stable black holes [66] Giddings and Mangano base their entire criticisms upon two arguments which can be shown to be relying on misunderstandings of Plaga's analysis. Plaga himself demonstrated this in his response to their critique of his paper [18]. One argument confuses the canonical rapid decay luminosity formula with the micro-canonical slow decay luminosity formula that Plaga relied upon [23]. The other confuses Plaga's ‘Eddington Limit’ with their version. Plaga’s version of the Eddington limit is the effect of the Hawking radiation upon the matter around the black hole, while in Mangano and Giddings' version the Eddington Limit is understood in terms of the low level radiation caused by the process of accretion itself. Plaga states [18] that since the Giddings and Mangano retort [66] he has been awaiting a further analysis from them which was not forthcoming. This is doubly mystifying as Plaga is well and currently published, only last year writing on astrophysics in the world’s premier journal of science, *Nature.* Another theory of black holes at the LHC is provided by Grigory Vilkovisky [38].

When considered with the slow decay interpretation it appears likely to enable catastrophic results, through allowing accretion and by maintaining a still significant 10% of increasing radiation. But any analysis of this theory has been completely neglected in all LHC safety reviews. The prominent author and physicist Tony Rothman (Princeton University) refers to it [40] as follows: “*A few years ago, Grigory Vilkovisky, a Russian physicist, published a trilogy of papers claiming that if one properly took this effect [of the Hawking radiation itself] into account, black holes would evaporate only about half their mass; the rest would remain. If Vilkovisky’s conclusion is correct, it would not only radically alter our ideas of black-hole physics, but would have a tremendous impact on our ideas about dark matter and would pave the way for the possibility that any black holes created at CERN might actually survive long enough to be taken seriously."* [40].

Rainer Plaga proposes risk mitigation measures which he categorizes as feasible methods to reduce but not eliminate risk, particularly applicable to the start up phase of the LHC [18] which has since safely passed. Plaga's proposal sought to detect warning signs of danger *before* irreversible outcomes are reached. Plaga proposes altering LHC operations to increase energy levels by no more than a factor of two before studying and excluding potentially dangerous events [18] and to analyse all operational events rather than only a small fraction of events, and to immediately and reliably detect meta-stable black holes and immediately interrupt LHC operation and conduct off-line investigation if meta-stable black holes are detected. However, irreversible outcomes could be reached suddenly and without prior indication [23], and the consequences to Earth of miscalculation are potentially *infinite*. Therefore Plaga's proposal only aims at reducing risks and it is insufficient to definitely exclude any global risks according to some. [23].

4. The Spin Polarization Effect of MBH Evaporation

4.1. Review of studies at Kyoto University

This section deals with a review of studies at Kyoto University (2009) on the spin polarization effects in micro black hole evaporation. [22]. This considered the evaporation of rotating micro black holes produced in high energetic particle collisions, taking into account the polarization due to the coupling between the spin of the emitted particles and the angular momentum of the black hole. This paper highlighted that the effect of rotation shows up in the helicity dependent angular distribution significantly. By using this effect, there is a possibility to determine the axis of rotation for each black hole formed, suggesting a way to improve the statistics. Deviation from thermal spectrum is also a signature of rotation. This deviation is due to the fact that rapidly rotating holes have an effective temperature Teff significantly higher than the Hawking temperature TH. The deformation of the spectral shape becomes evident only for very rapidly rotating cases. It was shown that, since the spectrum follows a blackbody profile with an effective temperature, it is difficult to determine both the number of extra-dimensions and the rotation parameter from the energy spectrum alone. It was argued that the helicity dependent angular distribution may provide a way to resolve this degeneracy, and so illustrated such results for the case of fermions.

Within the context of TeV-scale gravity, the possibility that colliders or cosmic ray facilities may observe micro black holes has attracted enormous attention. A close look at the limits on the fundamental Planck scale shows that a window of about 5 TeV is still open for the LHC to observe such exotic events [22], while the window is much wider for cosmic rays. It is estimated that micro black holes with even higher energies could be produced from the collision of a cosmic ray with an atmospheric nucleon, a dark matter particle, or even another cosmic ray.

In these studies, micro black holes resulting from the collision of two particles at energies much higher than the higher dimensional Planck mass MP were considered. Here were considered models with MP of order of a few TeV and The Standard Model confined on a 3-brane, embedded in a (4 + n)-dimensional bulk. These black holes have horizon radius smaller than the size of the extra dimensions, and are expected to follow balding, spin-down, Schwarzschild, and Planck phases. Micro black hole formation has been studied both analytically and numerically, and their evaporation has also been the subject of considerable attention [18]. Previous work suggests that micro black holes will emit mostly brane modes [68][69], and the deviations from the blackbody spectrum have been investigated using numerical and semi-analytical methods. [70][71][72][73].

The fermion emissions from spinning evaporating black holes were analyzed, and assuming that the black hole horizon is significantly smaller than the extra dimensions, an approximation of it was made by a vacuum higher dimensional:

$$\begin{aligned} ds^2 \;=\; & \left(1-\frac{M}{\Sigma r^{n-1}}\right)dt^2+\frac{2aM\sin^2\theta}{\Sigma r^{n-1}}dt\,d\varphi-\frac{\Sigma}{\Delta}dr^2 \\ & -\Sigma d\theta^2-\left(r^2+a^2+\frac{a^2M\sin^2\theta}{\Sigma r^{n-1}}\right)\sin^2\theta\, d\varphi^2 \\ & -r^2\cos^2\theta\, d\Omega_n^2\ , \end{aligned}$$

where $\Delta \equiv r^2+a^2-Mr^{1-n}$ and $\Sigma \equiv r^2+a^2\cos^2\theta$.

MP is normalized to one for this, and since we are interested in the visible brane modes, the background space-time is given by the projection of the above metric on the brane. Massless fermions emitted by the black hole are described:

$$e_a^{\mu}\gamma^{a}\left(\partial_{\mu}+\Gamma_{\mu}\right)\psi=0$$

where ψ is the Dirac spinor wave function, eμa a set of tetrads, Rμ the spin-affine connections determined by Rμ = γa γb ωabμ / 4 , with ωabμ being the Ricci rotation coefficients. The matrices γμ = eμa γa are chosen to satisfy the relation γμ γv + γv γμ = gμv, with gμv being the metric on the brane.

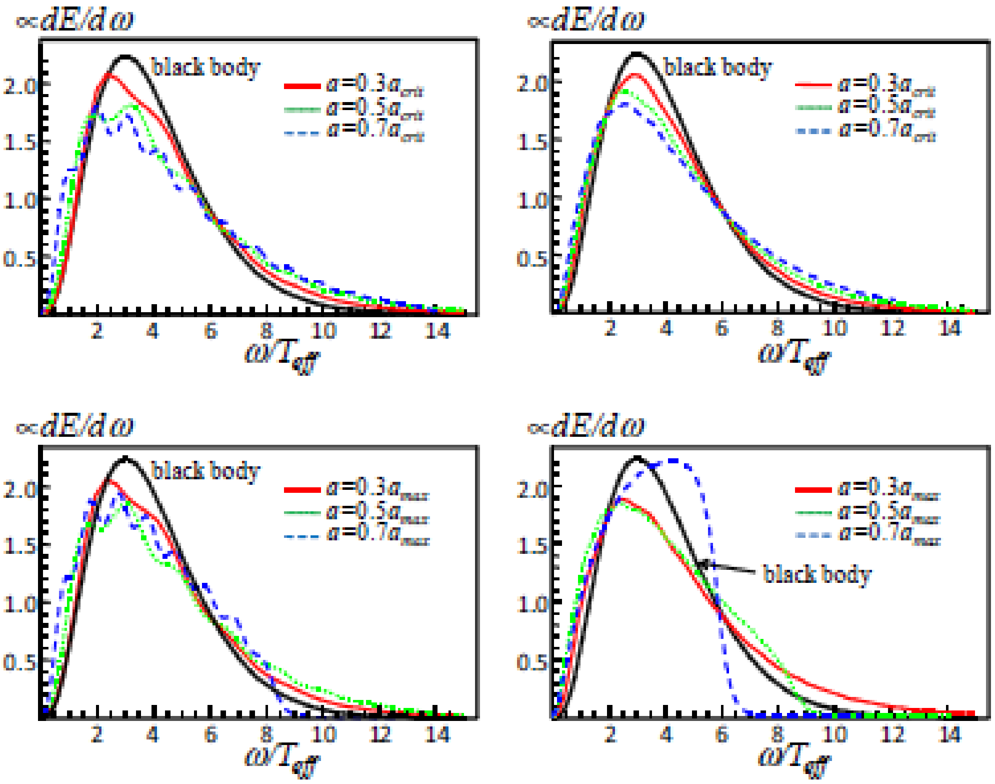
The Dirac equation for massless fermions on a Kerr background have been studied extensively in four and higher dimensions [71][74][75][76][77][78][79]. Here I re-quote the calculation, closely following the approach of W. Unruh [77]. Due to symmetries of the Kerr space-time, the spinor wave function factorizes:

$$\psi=\mathcal{N}e^{i(m\varphi-\omega t)}\begin{pmatrix}\vec{\phi}\\ \pm\vec{\phi}\end{pmatrix}$$

In this last equation, the + and − signs refer to negative and positive helicities, respectively. It was illustrated for results for the case of negative helicity, while it was argued that the positive helicity case could be obtained by a trivial chirality transformation. The field takes the below form:

$$\vec{\phi} = \begin{pmatrix} R_{-}(r)S_{-}(\theta) \\ R_{+}(r)S_{+}(\theta) \end{pmatrix}$$

The normalized energy spectrum of the emitted fermions were presented. The horizontal axis is rescaled by the effective temperature determined by fitting the data by a black body profile. The overall amplitude is also normalized since the absolute magnitude is not observable. The upper and the lower panels are the plots for n=2 and n=4, respectively. The rotation parameter a is set to 30%, 50% and 70% of a_crit (left) and a_max (right). These results are presented here:



Supplemented with regularity conditions at θ = 0 and π, the set of angular equations provides an eigenvalue problem, which determines κ [79]. In order to compute the particle flux, and it was explained a solution to the radial equation supplemented by ingoing boundary conditions at the horizon was required.

The number of particles emitted, for fixed frequency ω, is distributed according to the Hawking radiation formula, specific to a Hawking temperature for which it applies. For negative helicity modes, the angular distribution reads:

$$\frac{dN}{d\omega d\cos\theta} = \frac{1}{2\pi\sin\theta}\sum_{l,m}|S_-(\theta)|^2\frac{\sigma_{l,m}}{e^{\bar{\omega}/T_H}+1}$$

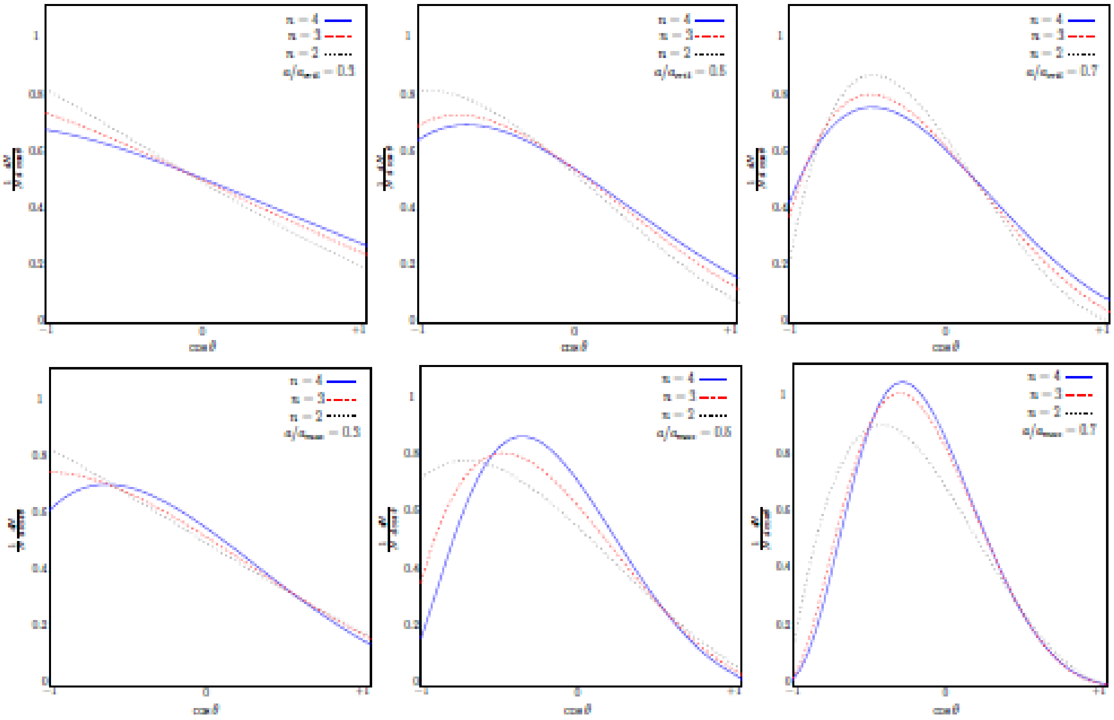
In the above TH is the Hawking temperature, and the grey-body factor, σ l,m, is the squared amplitude of the transmission coefficient of an incoming wave [80].

Herin now are discussed the results. The initial angular momentum of the produced black holes J = 2aM/(n + 2) is restricted by requiring the impact parameter b = J/M to be smaller than the horizon radius rh, determined by delta(rh) = 0. Then, the maximum value of the rotation parameter a turns out to be amax = n+2 2 rh [71]. The upper bound on J might be even lower for n ≥ 2. In fact, it was presented, there exists a critical value for a, acrit ≡ (n + 1)(n − 1)−1r2h, where |∂(T, h)/∂(M, J)| vanishes. If the same argument as in the case of black branes applies, black holes with a > acrit suffer from the Gregor Laflamme instability (and is backed up by other research [81]). Then, acrit represents the maximal value below which the higher dimensional Kerr solution is adequate. The value at which the dynamical instability is expected to set in may be slightly different from acrit, which only represents an indicative estimate of the critical value. Interestingly acrit < amax (for n = 2, 3, 4 extra dimensions, acrit = 1.09, 1.07, 1.06, whereas amax = 1.25, 1.89, 2.46). Although it is widely believed that a dynamical instability exists, the value of acrit obtained above is only heuristic. Thus, we consider two possible cases: the maximal value allowed for a is acrit or amax. A set of representative values for the parameter a is chosen as a/amax = 0.3, 0.5, 0.7, and a/acrit = 0.3, 0.5, 0.7. M is set to unity. Another natural choice to present the results would be to use the impact parameter b. In these studies, the ratios a/acrit and a/amax were used, which correspond respectively to b/bcrit and b/bmax, where bcrit and bmax are the values for the impact paramter corresponding to the critical and maximal cases respectively.

Having fixed a in the above way, the energy spectrum was computed, as shown on an earlier page. The horizontal axis was normalized by using an effective temperature Teff determined by fitting the data by a blackbody spectrum profile. The effective temperature Teff is much higher than the Hawking temperature as shown in Fig. 2. However, the spectral shape is not so different from the thermal one except for the cases with a ≈ amax. In previous work, it is cited, the enhancement of emission at large frequencies was reported. However, the deviation from a blackbody spectrum was not quantified. It was found that the renormalized spectra are enhanced for both lower and higher frequencies compared with the black body spectrum at T = Teff. Except for very large values of a, it was shown that the obtained spectra can be fit well by super-positions of black body profiles with width of about 2 H × Teff. The intuitive reason for the enhancement of the effective temperature is that the motion of the hypothetical emitting surface on the rotating black hole, relative to observers at infinity, causes an additional blueshift factor (which varies from place to place). This is because co-rotating emitted particles encounter less suppression from th statistical factor. This can be made precise by closely inspecting the combined behavior of the greybody and statistical factors. The dominant contribution to the spectrum comes from the l = m modes and for larger values of the rotation the contribution to the spectrum from such modes, with large l, is non-negligible.

However, because of the change in the temperature and the rotation parameter during the evaporation, the broadening of the spectrum due to the rotation would not be identified straightforwardly. Distortions could be also seen in the spectrum for a small number of extra-dimensions. However, these are likely to disappear as T and a change during the evaporation. When the rotation velocity is high, the deviation from the thermal spectrum is much clearer. As a novel signature, it was found that the spectrum is sharply cut off at high frequencies for rapid rotation. This new signature may survive even after one takes into account the superposition of spectra along the evolutionary track of an evaporating micro black hole. With this in effect, this highly spinning regime is realized for a > acrit.

In the following plots herein, angular distribution of negative helicity particles is displayed for various parameters, setting ω to a representative frequency ¯ω. The value ¯ω is chosen by requiring that the fraction of particles emitted with frequency below ¯ω, N(¯ω) = R ¯! 0 dN, to be 0.5. These are reproduced here:



This shows the angular distribution of emitted helicity fermions. In each plot the cases with n = 2, 3 and 4 are shown simultaneously. The reference values of the rotation parameter are a_crit and a_max in the upper and lower panels, respectively, and is set to 30%, 50% and 70% (left - right) of the reference value.

The emission turns out to be suppressed in the direction anti-parallel to the black hole angular momentum. For rapid rotation, the particles tend to be emitted towards the equatorial plane. This concentration in the rapidly rotating case can also be seen in the helicity independent angular distribution [73]. The emission around both poles looks suppressed, but the observed apparent suppression is simply caused by the large enhancement of emission in the directions close to the equatorial plane. The asymmetry in the helicity dependent angular distribution is visible even for relatively slow rotation and becomes evident as a increases. Note that, for very fast rotation, the concentration of the emitted particles toward the equatorial plane, observed in the angular distribution, may affect the features of cosmic ray air showers mediated by such black holes.

For slow (rapid) rotation, the asymmetry decreases (increases) as the number of extra-dimensions n grows. This tendency may be used as an indicator to discriminate scenarios with different number of extra-dimensions. For a/acrit fixed the peak position of the helicity dependent angular distribution is almost independent of n, and this fact was noted in the presentation of the results.

If the direction of the axis of rotation of the black hole is aligned for various events, the experimental data could be used to achieve high statistics for the angular distribution of emitted particles, and it was noted that the LHC may allow to perform such measurements, if such conditions can be measured to occur.

In the statistical analysis, an estimation of the error in the determination of the axis of rotation was provided, assuming that N particles are emitted per black hole. However, no scientific basis is made for the assumed quantity of particles.

4.2. Discussion

In the collision of two particles at trans-plankian energy, a rotating black hole is expected to form and decay. The possible signatures of rotation of such black holes were studied in departure of the energy spectra from the thermal profile, and in the features of the helicity dependent angular distributions. However, this is based on the assumption of the formation and decay of these, and a formation of such micro black holes in no way guarantee a rapid decay as a result [18].

Continuing with the thermodynamics deduced in these studies, it seems to suggest the presence of an instability for a ≥ acrit. This critical value acrit is smaller than the maximal value amax allowed by the kinematical requirement of formation of a black hole in the collision of two particles. As far as a ≤ acrit, the shape of the energy spectrum is almost independent of n. The largest dependence on n will appear in the effective temperature. However, it was noted that this n-dependence must be interpreted with caution. When the ratio a/acrit is fixed, the enhancement of the effective temperature is larger for a smaller number of extra-dimensions. While the tendency is completely opposite if the ratio a/amax is fixed. Hence, under the situation in which the true maximum value of these are unknown, it is rather difficult to extract the information about the number of extra-dimensions without changing the colliding particle energies.

In this context it should be noted that these studies are based on several unknowns and although the findings presented are quite detailed, it is based on speculative parameters, even if the theoretical behavior is widely accepted.

It is argued that the peak position of the helicity dependent angular distribution may give valuable information, because it seems to be a good indicator of a/acrit (or a itself since acrit is always close to 1). [22]. Moreover, the amplitude of the anisotropy depends on the number of extra-dimensions. Hence, measuring the helicity dependent angular distribution may provide a very important signature to extract the value of n. To develop analysis of this kind based on experiment, one needs to coherently accumulate data from many events, and for this purpose, it is necessary to identify the rotation axis of the formed black hole for the events.

In these studies [22] on the spin polarization effects of micro black hole evaporation, it was therefore demonstrated that this identification is marginally possible if one can detect sufficient number of particles. However, to date no such signatures have been detected in experiments at the LHC. These findings also do not in any way overturn the risks cited by Plaga [18] of meta-stable micro black holes, and evidence of such findings referenced by Plaga could be elusive. One could therefore argue that none of these studies reinforce the commonly held belief that on creation of MBH in such collisions, these would be detectable, which undermines the considerations of Plaga [18] of a cautious incremental approach to discovering whether any environmental damage is being produced by such experiments, and instead one must look at the overall energy injected into these collisions relative to the measured energy of the particles generated in so far as unaccountable energies could be assigned to undetectable MBHs.

Therefore from a safety procurement perspective, one must instead return to the derived implications of MBH creation [17], accretion rates and evaporation rates.

5. Theorized Forms of Matter: Strangelets

5.1. The Hypothesis of Strangelets

A strangelet is a hypothetical particle consisting of a bound state of roughly equal numbers of up, down, and strange quarks. Its size would be a minimum of a few femtometers across (with the mass of a light nucleus). Once the size becomes macroscopic (on the order of meters across), such an object is usually called a quark star or "strange star" rather than a strangelet. An equivalent description is that a strangelet is a small fragment of strange matter. Although hypothetical, strangelets have been suggested as a dark matter candidate [82], and this is a case in point I will return to later, as if this is the case, strangelets despite ‘hypothetical’, may be the most common form of matter in the Universe.

The known particles with strange quarks are unstable because the strange quark is heavier than the up and down quarks, so strange particles, such as the Lambda particle, which contains an up, down, and strange quark, always lose their strangeness, by decaying via the weak interaction to lighter particles containing only up and down quarks. But states with a larger number of quarks might not suffer from this instability. This is the "strange matter hypothesis" of Bodmer and Witten.[82][83]. According to this hypothesis, when a large enough number of quarks are collected together, the lowest energy state is one which has roughly equal numbers of up, down, and strange quarks, namely a strangelet. This stability would occur because of the Pauli exclusion principle, having three types of quarks rather than two as in normal nuclear matter, allows more quarks to be placed in lower energy levels.

According to this strange matter hypothesis, strangelets are more stable than nuclei of regular matter, so nuclei are expected to decay into strangelets. But this process may be extremely slow because there is a large energy barrier to overcome: as the weak interaction starts making a nucleus into a strangelet, the first few strange quarks form strange baryons, such as the Lambda, which are heavy. Only if many conversions occur almost simultaneously will the number of strange quarks reach the critical proportion required to achieve a lower energy state. This is very unlikely to happen, so even if the strange matter hypothesis were correct, nuclei would never be seen to decay to strangelets because their lifetime would allegedly be longer than the age of the universe. [84]. However, due to this principle of potentially existing in a lower state of energy it has been theorised that such strange matter, being more stable than other forms of matter could on creation trigger a chain-reaction of converting all matter reaching contact with it into strange matter also, and some acclaimed experts [85] have argued that this could occur rather instantanously - almost in the blink of an eye.

Although nuclei do not readily decay into strangelets, there are other scenarios in which strangelets can be created, so if the strange matter hypothesis is correct, then we should be able to find such exotic forms of matter in the Universe. There are several ways they might be created in nature - Cosmogonically, in the early universe, when the QCD confinement phase transition occurred, in high energy processes it is possible that when cosmic rays collide with neutron stars they may provide enough energy to overcome the energy barrier and create strangelets from nuclear matter, or more locally - via ultra high energy cosmic rays impacting on Earth's atmosphere.

At heavy ion accelerators like RHIC, nuclei are collided at relativistic speeds, creating strange and antistrange quarks which could conceivably lead to strangelet production. The experimental signature of a strangelet would be its very high ratio of mass to charge, which would cause its trajectory in a magnetic field to be very nearly, but not quite, straight. The STAR collaboration has searched for strangelets produced at the Relativistic Heavy Ion Collider, but none were found [86]. The higher energy experiments at the LHC are also likely to produce strangelets and searches are planned with the ALICE detector.[87].

It has been argued that stranglet production is more likely to occur at lower luminosity heavy-ion collisions [13], so failure to have detected them at the RHIC leads one to suspect they would not be detected by the ALICE detector. This notion has been hotly disputed by critics of Large Hadron Collider safety, most notably by activists Walter L. Wagner [85] and Luis Sancho [88].

It is now public knowledge that if the strange matter hypothesis is correct and its surface tension is larger than expected values, then a larger strangelet could be more stable than a smaller one. One speculation that has resulted from the idea is that a strangelet coming into contact with any ordinary matter could convert the ordinary matter to strange matter. [54]. This disaster scenario is theorized as follows. One strangelet hits a nucleus, catalyzing its immediate conversion to strange matter. This liberates energy, producing a larger, more stable strangelet, which in turn hits another nucleus, catalyzing its conversion to strange matter. In the end, all the nuclei of all the atoms of Earth are converted, and Earth is reduced to a hot, large lump of strange matter.

It is argued that this is not a concern for strangelets produced in cosmic ray collisions because they are produced far from Earth and have had time to decay to their ground state, which is predicted by most models to be positively charged, so they are electrostatically repelled by nuclei, and would rarely merge with them.[89][90]. It has also been argued, however, that high-energy collisions could produce negatively charged strangelet states which live long enough to interact with the nuclei of ordinary matter [48] which would be a definitive risk.

The danger of catalyzed conversion by strangelets produced in heavy-ion colliders has received some media attention, and concerns of this type were raised at the commencement of the Relativistic Heavy Ion Collider (RHIC) experiment at Brookhaven, which could potentially have created strangelets. A detailed analysis concluded that the RHIC collisions were comparable to ones which naturally occur as cosmic rays traverse the solar system, so we would already have seen such a disaster if it were possible. [84].

However, the RHIC has been operating since 2000 and no information has been released to date concerning strangelet detection. Similar concerns have been raised about the operation of the LHC at CERN, but such fears have been dismissed as far-fetched by scientists [13], and counter-intuitively claimed that such outcomes are less likely to occur at the higher intensity levels to be practiced in heavy-ion collisions at the LHC when compared to those already to have taken place at the RHIC over the past decade.

In the case of a neutron star, the conversion scenario seems much more plausible. A neutron star is in a sense a giant nucleus (20 km across), held together by gravity, but it is electrically neutral and so does not electro-statically repel strangelets. If a strangelet hit a neutron star, it could convert a small region of it, and that region would grow and eventually convert the neutron into a quark star. What has been dubbed 'the neutron star paradox' regarding the persistence of neutron stars in the universe today despite the potential effects of such cosmic ray collisions has been disputed strongly by respected academics [40] as this can be explained by a theorised process of superfluidity in neutron stars.

The strange matter hypothesis remains unproven. No direct search for strangelets in cosmic rays or particle accelerators has resulted in strangelet detection. If any of the objects we call neutron stars could be shown to have a surface made of strange matter, however, this would indicate that strange matter is stable at zero pressure, which would vindicate the strange matter hypothesis. As there is no strong evidence for strange matter surfaces on neutron stars, this seems less likely, superfluidity scenarios exempt.

As previously mentioned, another argument against the hypothesis of strangelets is that if it were true, all neutron stars should be made of strange matter. This is again disputed by the superfluidity argument. It is argued, that even if there were only a few strange stars initially, violent events such as collisions would soon create many strangelets flying around the universe. [13].

As one strangelet will convert a neutron star to strange matter, by now all neutron stars would have been converted, it is argued. [13]. This argument is still contested [40], but if it is correct then showing that one neutron star has a conventional nuclear matter crust would go a long way toward disproving the strange matter hypothesis to must. This is an over-simplified argument, however, and one could argue that large swathes of matter in the Universe commonly referred to as dark matter, could well be made up of strangelets, and the continued existence of neutron stars is attributable to superfluidity and a theoretical misunderstanding of the strangelet interaction on the neutron stars.

5.2. Dark Matter

In astronomy and cosmology, dark matter is matter that neither emits nor scatters light or other electromagnetic radiation, and so cannot be directly detected via optical or radio astronomy.[91] Its existence is inferred from gravitational effects on visible matter and gravitational lensing of background radiation, and was originally hypothesized to account for discrepancies between calculations of the mass of galaxies, clusters of galaxies and the entire universe made through dynamical and general relativistic means, and calculations based on the mass of the visible "luminous" matter these objects contain: stars and the gas and dust of the interstellar and intergalactic medium. Many experiments to detect dark matter through non-gravitational means are underway.

According to observations of structures larger than solar systems, as well as Big Bang cosmology interpreted under the Friedmann equations and the FLRW metric, dark matter accounts for 23% of the mass-energy density of the observable universe. In comparison, ordinary matter accounts for only 4.6% of the mass-energy density of the observable universe, with the remainder being attributable to dark energy.[91] From these figures, dark matter constitutes 83%, of the matter in the universe, whereas ordinary matter makes up only 17%.

Dark matter was postulated by Fritz Zwicky in 1934 to account for evidence of "missing mass" in the orbital velocities of galaxies in clusters. Subsequently, other observations have indicated the presence of dark matter in the universe; these observations include the rotational speeds of galaxies, gravitational lensing of background objects by galaxy clusters such as the Bullet Cluster, and the temperature distribution of hot gas in galaxies and clusters of galaxies.

Dark matter plays a central role in state-of-the-art modeling of structure formation and galaxy evolution, and has measurable effects on the anisotropies observed in the cosmic microwave background. All these lines of evidence suggest that galaxies, clusters of galaxies, and the universe as a whole contain far more matter than that which interacts with electromagnetic radiation. The largest part of dark matter, which by definition does not interact with electromagnetic radiation, is not only "dark" but also by definition, transparent.

Dark matter is crucial to the Big Bang model of cosmology as a component which corresponds directly to measurements of the parameters associated with Friedmann cosmology solutions to general relativity. In particular, measurements of the cosmic microwave background anisotropies correspond to a cosmology where much of the matter interacts with photons more weakly than the known forces that couple light interactions to baryonic matter. Likewise, a significant amount of non-baryonic, cold matter is necessary to explain the large-scale structure of the universe. In which case there is a candidacy for strangelets here.

An important property of all dark matter is that it behaves like and is modeled like a perfect fluid, meaning that it does not have any internal resistance or viscosity. Whether strangelets can fit such criteria is open to question. This means that dark matter particles should not interact with each other (except through gravity), i.e. they move past each other without ever bumping or colliding. Also, theories of ‘cold dark matter’, as opposed to the ‘warm dark matter’ or ‘hot dark matter’ perspectives on the composition of dark matter, gained favor at better explaining what are the observable phenomena. [91]. In this regard the question as to whether strangelets fit with dark matter theory is rational and reasonable, so as to say that strangelet material should be considered as a highly credible form of matter, despite its hypothetical status.

5.3. Critical Viewpoints

The information now presented is taken primarily from the ‘CERN Truth’ activist site [88], where highly critical opinions on LHC safety are raised.

The CASTOR project at CERN, a ‘Centauro and Strangelet Object Research’ is designed specifically to search for strangelets likely to be produced at the LHC.

Allegedly, leaked internal documents from CERN [88] indicate that CERN have been dishonest in public relations regarding the possibilities of creating this form of matter at the LHC, which is critically described as ‘the ultra-dangerous, ultra-dense liquid explosive made of up, down and strange quarks, responsible of the ice-9 reactions that cause supernovas’. In those documents, it is alleged that CERN affirms there is a 65-70% of chances of producing negative strangelets.

It is alleged, that according to the most advanced theoretical research on the subject [47], heavy ion collision can create strangelets that would sink the Earth into a rock of a few kilometers of diameter. Strange liquid, it is suggested, is the quark-gluon soup that causes the big-bangs of Novas, Super-Novas and maybe even long ago caused the big-bang of the cosmic Universe.

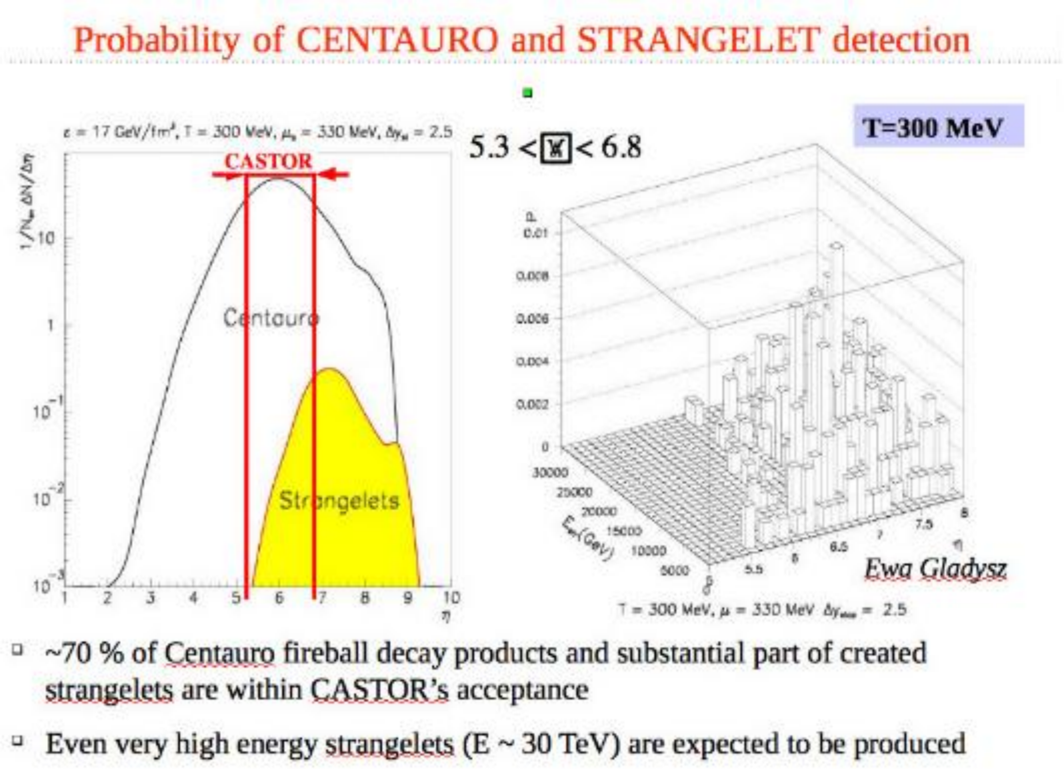
Why strangelets are so dangerous? Simple, he argues. A strangelet is a mass of quarks, which works with 3 attractive forces far superior to those of any atom:

a. The strong force of its massive number of quarks (100 times stronger than the weak electromagnetic force)

b. The gravitational forces of quarks (which is far stronger than any atom, since most of the mass of atomic particles are in the quarks)

c. The charge of the quarks in the strangelet (far stronger than any ion, due to the enormous numbers of quarks in the strangelet)

The 3 forces together, it is theorized, would attract atoms, positive ions if the strangelet is negative; electronic covers is the strangelet is positive; normal atoms with the gravitational force if the strangelet is neutral; atomic nuclei with the strong force in the quark-gluon soup made by the LHC. And so they will start either an explosive ice-9 reaction (fast process that triggers a super-nova) or in the case they are forming with a small mass of quarks, falling towards the center of the Earth where they may catalyze, a distillation of new strangelets, as new atoms peg to the original strangelet attracted by those 3 super-forces.



Probability of CENTAURO and STRANGELET detection

- ~70 % of Centauro fireball decay products and substantial part of created strangelets are within CASTOR's acceptance
- Even very high energy strangelets (E ~ 30 TeV) are expected to be produced

The above graphs are taken from the official CERN website, regarding the strangelet hunt at CMS, QCD at Cosmic Energies II Workshop. 2005.

Indeed, it is argued, that CERN states the probabilities of extinction are small, often casually cited by CERN physicists as the likelihood of winning a national lottery in two successive weeks. However, this is dismissed by Sancho as public relations propoganda. One must understand the meaning of probabilities in quantum theory, Sancho argues: quantum probabilities are not referred to the existence or not of an event, which either exists if the laws of science allow it – the totalitarian principle of physics: all what is not forbidden by the laws of science will happen - or do not exist if those laws are wrong. Quantum probabilities merely are a tool to know where a certain electron exists in a certain place, due to the uncertainty of its position – but there is not uncertainty in its existence in time, the electron does exist. Thus, probabilities apply to the task of finding the location of the electron in space, not to define if the electron exists or not. For the same reason, it is argued by Sancho, if the laws of strangelets preclude that strangelets will be formed, they will be formed. So there is a 100% likelihood that those strangelets will be formed and grow. If we lower those chances is because we give certain ‘hope’ or chance for those laws to be wrong at our present knowledge. Therefore, it is argued, that as CERN have used the expression ‘likely’ and a 65-70% chances, as theory today seems to confirm they will happen. However, Sancho argues, the reader must understand that the scientific method and the sound mathematics and theories behind the formation of strangelets have been proved ‘ad nauseam’ – i.e. there is no disputing this.

According to the Chinese Institute of Higher Energy Physics, Sancho states, the strangelet would grow untill it acquires the size of the Compton wave of the Electron, which is 2.42×10 up to −12 meters, a bit smaller than the Hydrogen atom (Bohr radius). This is more than 3 magnitudes bigger than the Proton radius which packs those quarks: The nucleus of a hydrogen atom is indeed a proton with 3 quarks, whose size is in the range of 1.75 fm (1.75×10−15 m). On the other hand the volume of a sphere is 4/3 π r3 where r is a radius. Thus, the volume is a bit less than 3 magnitudes bigger than the radius. To calculate the number of quarks in the strangelet, we have to consider that the strangelet will have to pack triads of quarks, with the same density they are packed in the nucleus, but in a space + 3 magnitudes bigger in radius and – 3 magnitudes bigger in volume. Thus, Sancho argues, if we add the minus 3 magnitudes of volume and the plus 3 magnitudes of radius and multiply them for the 3 quarks inside each nucleus that simple calculus shows that each stable strangelet will pack around 3 x 10 up to 6 quarks in a space equivalent to a Compton Electron wave… This implies that each strangelet has around 3 million quarks packed in a size smaller than a hydrogen atom. Since the strong force is 100 times stronger than our electroweak force, you have a particle with around 100 million times more strong forces than the Hydrogen atom. Also the strangelet’s gravitational force will be ‘awesome’, falling to the center of the Earth very quickly. It will be then a particle seating in the center of the Earth, which will become a mass-well of attractive gravitational and strong forces in which the Earth matter will fall.

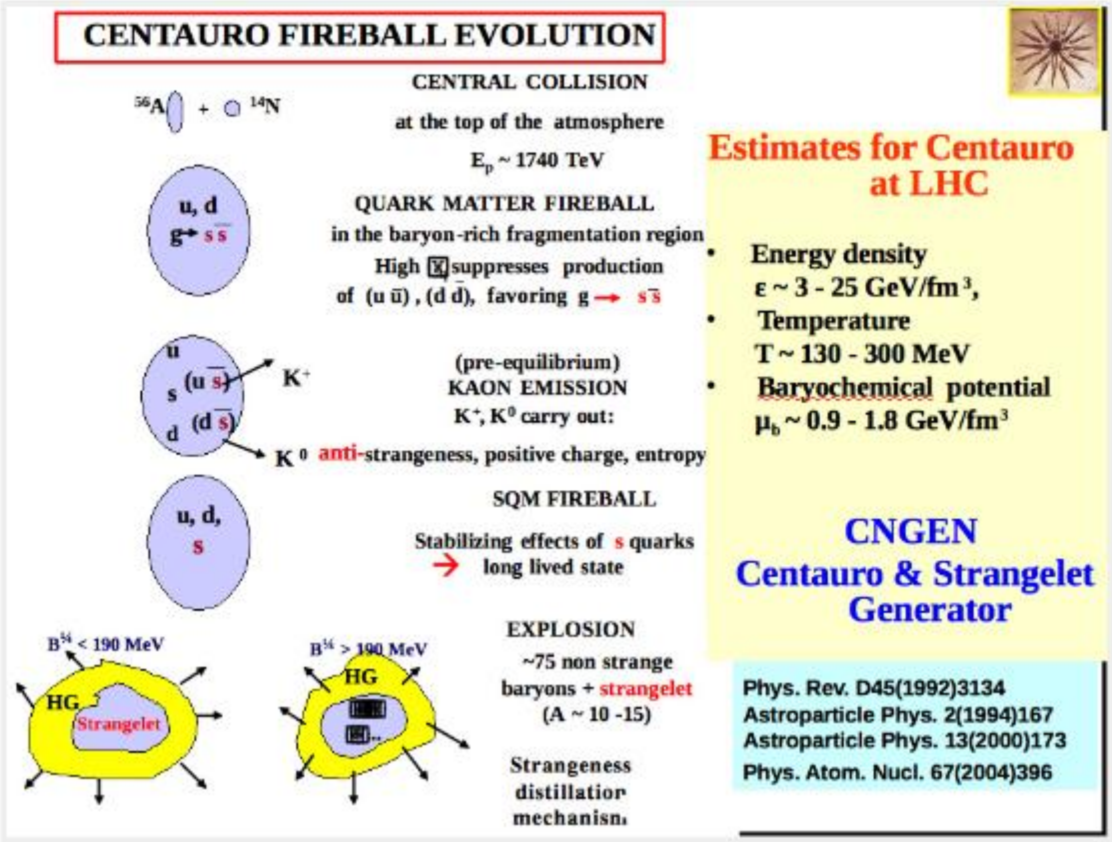
The final result is therefore presented in what would be an irreversible outcome. As the strangelet would shrink the radius of the Earth in the aforementioned 10 up to 3 order of magnitude, and since the diameter of the Earth is 12.756 kilometers, it means the Earth would become a rock of 13 kilometers of diameter, and for academic purposes is described as what would be with an oblong form due to the liquid nature of strangelets and its enormous rotational forces that would flatten the ‘strangelet, ice-9 star’ across the rotational plane. However, Sancho fails to present a timeline for such a process to result in such a disaster.

An allegedly leaked document from CERN is presented by Sancho which shows that CERN have built the CASTOR detector specifically to look for strangelets at the LHC, therefore one must assume, despite the public relations statements by CERN, that strangelets are indeed expected as a likely fallout from experiments.

In that regard CERN published a LSAG safety assessment report which denies both the creation and danger of strangelets [13], against all published literature and against the affirmations Sancho discloses from other CERN documentation.

According to the CASTOR reports the probability given of Pb-Pb collisions creating such strangelets is of 1/1000th creating a total of 500 strangelets every month at full luminosity, which contradicts the LSAG assertion that probability for a strangelet emerging from LHC would be ‘negligible’:

Furthermore, according to the CASTOR related information, strangelets would be stable for enough time to produce an explosive reaction.



CENTAURO FIREBALL EVOLUTION

CENTRAL COLLISION
at the top of the atmosphere
$E_p \sim 1740$ TeV

QUARK MATTER FIREBALL
in the baryon-rich fragmentation region
High ☒ suppresses production
of $(u\,\bar{u})$, $(d\,\bar{d})$, favoring $g \rightarrow s\,\bar{s}$

(pre-equilibrium)
KAON EMISSION
K^+, K^0 carry out:
anti-strangeness, positive charge, entropy

SQM FIREBALL
Stabilizing effects of s quarks
→ long lived state

EXPLOSION
~75 non strange
baryons + strangelet
(A ~ 10 -15)

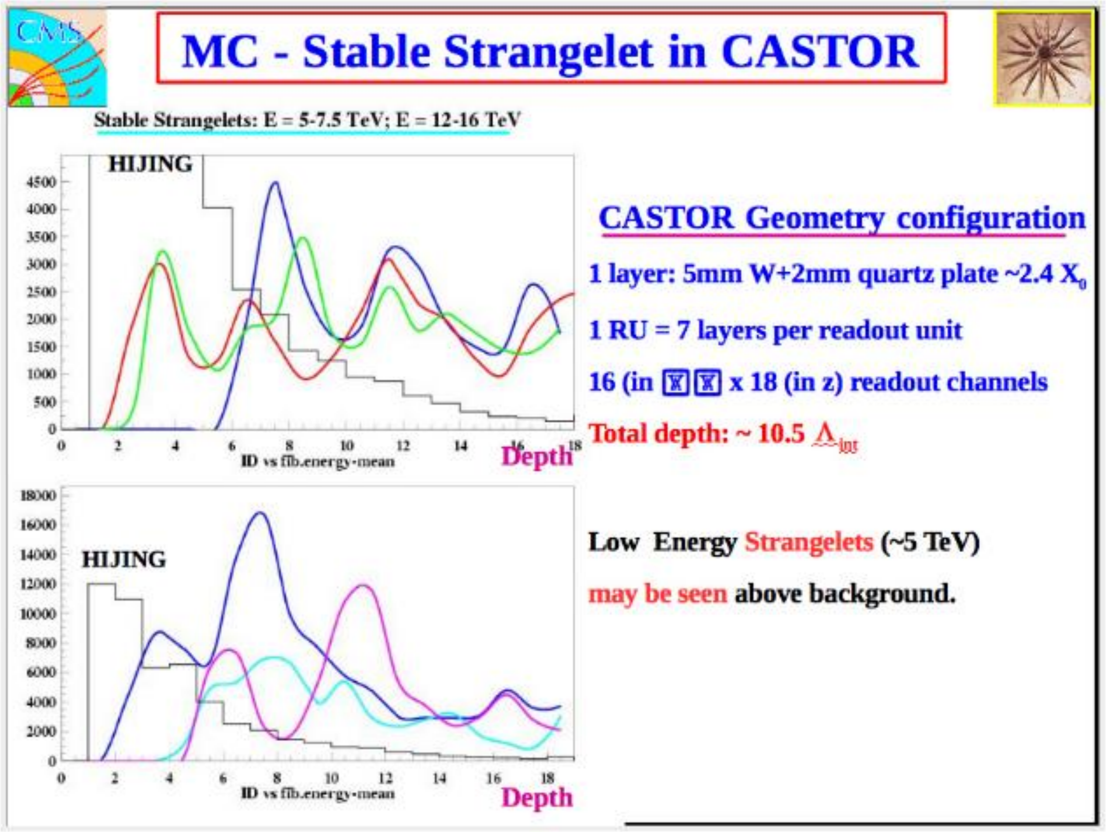
Strangeness
distillation
mechanism

Estimates for Centauro at LHC

- Energy density
  $\varepsilon \sim 3 - 25$ GeV/fm^3,
- Temperature
  $T \sim 130 - 300$ MeV
- Baryochemical potential
  $\mu_b \sim 0.9 - 1.8$ GeV/fm^3

CNGEN
Centauro & Strangelet Generator

Phys. Rev. D45(1992)3134
Astroparticle Phys. 2(1994)167
Astroparticle Phys. 13(2000)173
Phys. Atom. Nucl. 67(2004)396



MC - Stable Strangelet in CASTOR

Stable Strangelets: E = 5-7.5 TeV; E = 12-16 TeV

CASTOR Geometry configuration

1 layer: 5mm W+2mm quartz plate ~2.4 X_0

1 RU = 7 layers per readout unit

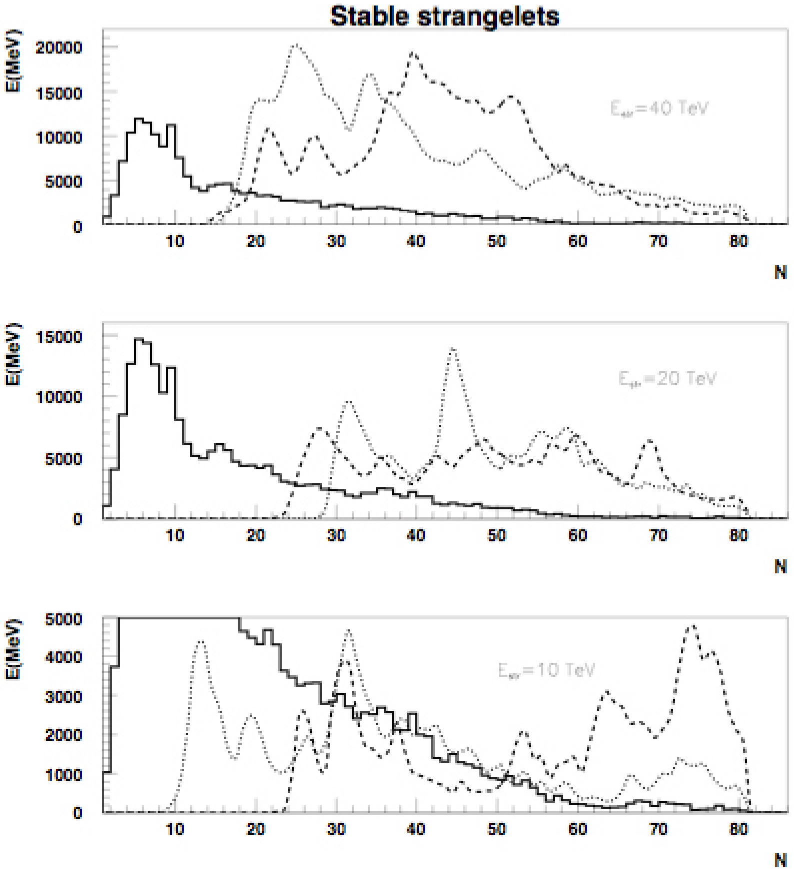
16 (in ☒☒) x 18 (in z) readout channels

Total depth: ~ 10.5 Λ_{int}

Low Energy Strangelets (~5 TeV) may be seen above background.

According to CASTOR reports, strangelets could realistically be produced with atomic mass number as low as 18 – and CERN will produce thousands of strange quarks per second, so it is argued, that it certainly will produce them. Again, it must be stated that this is in contradiction with assertions in the LSAG report [13] of negligible creation on that range. Therefore one has to conclude that information in the 2008 LSAG report on strangelets, is at best misleading.

In the charts on the following page, as presented by Sancho, the energy-loss curves for stable strangelets with energies Estr = 10-40 TeV and baryon number Astr = 15-40 are shown, with energy deposit (MeV) in each of the 80 calarimeter layers, in the octant containing a strangelet. Full line histograms show the HIJING estimated background for the full energy, less the strangelet energy.



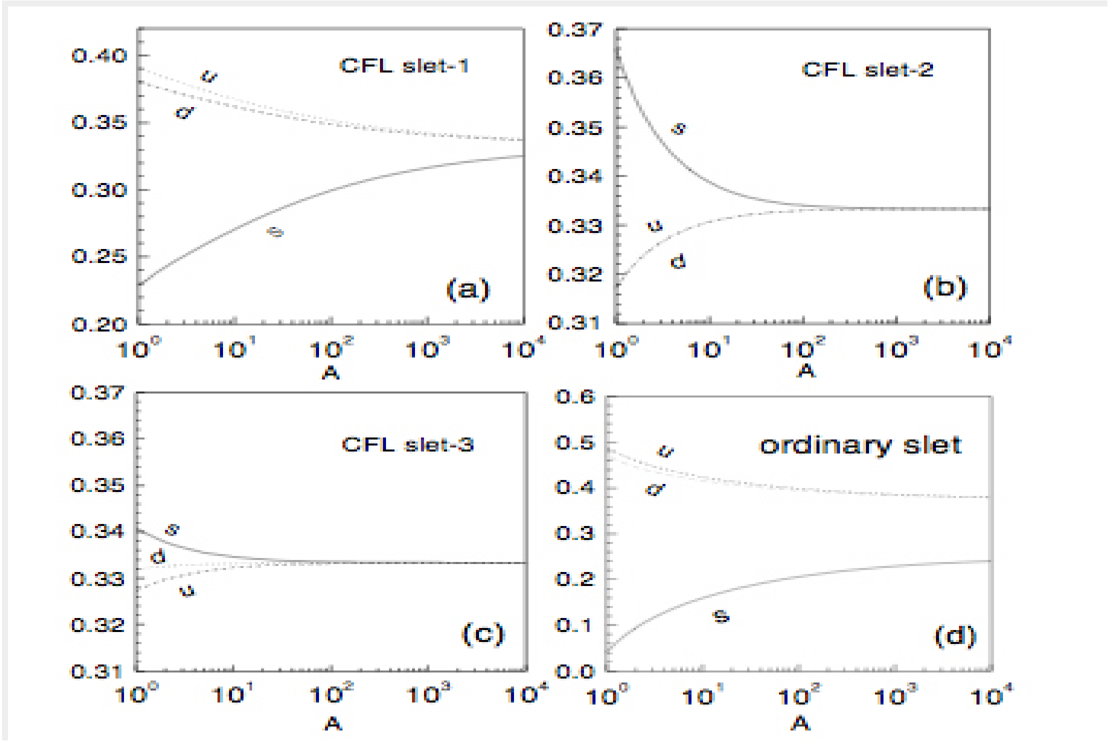
Sancho offers only a non-scientific estimate of between ‘a few minutes up to a century’ for his estimated doomsday scenario of planetary destruction through what would be an ever increasing cascade of earthquake occurrences.

The first knowledge we had about strangelets, Sancho explains, was advanced by MIT theorists, specifically Jaffe, in the 90s when the LHC was planned. Then it was speculated that strangelets would not form easily and the most dangerous, negative strangelets able to attract other nuclei, would not take place. However, as it turned out that ‘strange quarks’ are negative, having a 1/3rd charge, soon we learned that most strangelets would be negative. The next ‘impossibility’ – that strange liquid (the non abbreviated name of strangelets) – would not exist in nature, was destroyed by the increasing evidence that all pulsars, also called neutron stars, were actually strangelets, strange stars, with a strangelet nuclei and only a cover of neutrons, Sancho states. However, I find no evidence to back up these claims, though one should consider these claims unnecessary – as the dark matter theory is sufficient to explain the likely existence of strangelets. Since then, CERN have denied stubbornly the existence of strangelets, often quoting systematically the old papers of the 90s, which are largely outdated.

It seems that 20 years after that paper in which he affirmed that ‘strangelets’ were very ‘unlikely’ to exist in Nature, is now outdated, as it is reasonable to believe based on more recent theory that they are all over the cosmos. A series of breakthroughs of the Chinese Institute of High Energy Physics, proved mathematically (and have never been disputed), that all type of color-locked strangelets (negative, positive and neutral) will form and become stable, in the case of Neutral strangelets with just 6 quarks in the form of dibaryons, in the case of negative strangelets with a few thousand of them.

We shall therefore, Sancho concludes, once it is clear CERN will produce stable strangelets, provide the real scenarios of what will happen when those form.

Peng, from the Chinese Institute of High energy physics, rightly considers then that the strangelet will grow, absorbing quarks and transforming our matter into ultradense strange matter, till reaching a stable form with a size slightly smaller than a hydrogen atom. Then it will become an atom of strange liquid.



In the graph on the previous page, A is the number of quarks in the strangelet, figure a.b and c are for color locked strangelets, of positive (slet-1), negative (slet-2) and neutral (slet-3) strangelets. Figure d is for the 'old type' of strangelet, theorized before we knew that quarks 'lock themselves' into triads becoming far more stable. During the first phase of growth, positive and negative strangelets have an enormous imbalance of charge, becoming neutral at 1000 quarks (negative strangelet) or close to 100.000 quarks (positive strangelets). Neutral strangelets, start slightly negative and become neutral around 100 quarks. Thus in that first phase, strangelets grow attracting positive ions and electronic covers. This makes the reaction faster for positive strangelets, risking an ice-9 reaction.

The first phase, which can be followed in the previous graph of Peng's master article is obvious, according to Sancho: the strangelet would still be growing, and it has either a huge negative or positive charge, because it has different numbers of the 3 quarks, u, d, s, which have respectively +2/3rd, -1/3rd and -1/3rd. Only when the strangelet has the same numbers of u,s and d quarks it becomes neutral (since +2/3 – 1/3 – 1/3 =0 charge). Thus, in the previous phase as the strangelet falls to the center of the Earth, it would have a positive or negative charge in the order of thousands. This is an astounding attractive power, since the most attractive chemical reactions on Earth are triggered by atoms which have 2+ or 2- charges, he argues. This is the journey of growth of the strangelet towards the center of the Earth, catalyzing adjacent matter on reaching the core.

Because the strangelet has the size of an atom, despite having thousands of quarks inside, when the strangelet seats in the center of the Earth, where atoms are tightly packed, it will attract them now with its gravitational and strong forces. Sancho alleges that people at CERN are trying to find excuses for this not to happen, say that there will be a Coulomb barrier that prevents those atoms to fall into the strangelet, which he discounts as nonsense. The coulomb barrier is the product of the atomic number of the atom and the elementary charge, which even for the heaviest uranium gives us around 100, the value of the strong force of a single quark, so the theory that a single individual could stop the force of thousands of them – the strong force of the quarks inside the growing strangelet is implausible, he argues. Like in the case of Cosmic rays or the game of absurd probabilities, nuclear physicists are playing with the naivety and trust of people who don't know physics, he alleges, claiming that the strangelet would keep growing untill reaching the aforementioned size of an electron compton wave with 3 million quarks inside, in a size slightly smaller than a hydrogen atom, by which time its gravitational and strong force will catalyze the formation of new ‘strangelet atoms’ around it whereby the secondary process would take effect.

He makes some basic calculations, arguing that a single strangelet, smaller than a hydrogen atom, packs however the weight of 26 million normal quarks, a gravitational force equivalent to half a million atoms of water. That super-dense water, the Ice-9, as he refers to it, being so small and heavy will cut through the Earth as a knife cuts the water, falling at g-speed… It is easy to calculate because it will be a free fall and so it will follow the simple Galilean formula for the acceleration of a body: d=1/2 at^2 which gives a time of nineteen minutes in its descent. As they fall, seating on the center of the Earth, forming the first drops of ‘ice-9’, those strangelets would start crunching and feeding on ordinary matter as previously theorised in what would be a monotone series of big crunches and ‘big bangs’, taking the matter in and expelling electro-weak energy of electrons.

Indeed, he continues, because the strangelet will still attract further matter, the strangelet would not become static but would turn more atoms into strangelets. Nature is never static, he argues. Chemical reactions like this one, in which there is a release of energy, since the end product (the strangelet) is more stable than the original product (the atomic matter), would not stop ntill the initial products disappear, in this case utill the entire Earth eventually converts to strange matter.

These are referred to as exergonic reactions or spontaneous reactions for that reason, since just the initial kick of energy that triggers the creation of the first product makes the reaction self-sustained. He cites an unreferenced Physics World article which states ’a little energy is enough to transform a neutron star [with an iron cover] into a strange star’ so the same can be said of the Earth ‘a little energy is enough to transform the iron core of the Earth into a strange star’.

There are two common processes of nuclear reactions that could take place:

1. Catalysis of new strangelets, as the huge charge and mass of the strangelet attracts atoms that lump on the surface creating more strangelets: the stable Strangelet with its awesome charge and weight will keep attracting atoms and ions. Those atoms and ions, surrounding the stable strangelet will form new ‘atoms’ of strange liquids and so on.

2. Strangelet fissions into smaller pieces that will grow again, starting a nuclear reaction which Sancho continually refers to as ‘ice-9′ reactions, which would explode the Earth into a super-nova in a matter of seconds.

He argues that all the atomic nuclei that ‘grow’, split when they reach their limit and fission, starting a chain reaction that grows even faster, as strangelets do in Nature in Quark stars all over the cosmos. It happens in any atomic bomb, in any radioactive atomic nucleus. Therefore when the strangelet reaches the size of the Compton wave, he argues, since it is in fact a liquid, it will find very easy according to the drop-liquid model of atomic nuclei, to split/fission in several parts that will keep growing back to the 3 million quark stable package, exactly as in any chain reaction, resulting in the Earth exploding in a supernova-type manner.

The catastrophic scenario is simple and self-evident, he argues, and it can be seen all over the cosmos in the transformation of a normal star into a pulsar, which has a strangelet core. Basically the strangelet will follow the droplet model we use for fission processes. According to Peng, the growth of the strangelet will be fast in all possible types, neutral, positive and negative, because we have found a new quality of strange matter, called ‘color locked’, according to which those quarks are far more stable than have been previously thought.

The more likely scenario, neutral strangelets: creation of ‘usd’ particles, the minimal units of a strangelet that slowly grow and devour the Earth inside-out.

But even if the LHC produces far less quantities of strange quarks than predicted, neutral strangelets, the reaction can take place in a slower fashion.

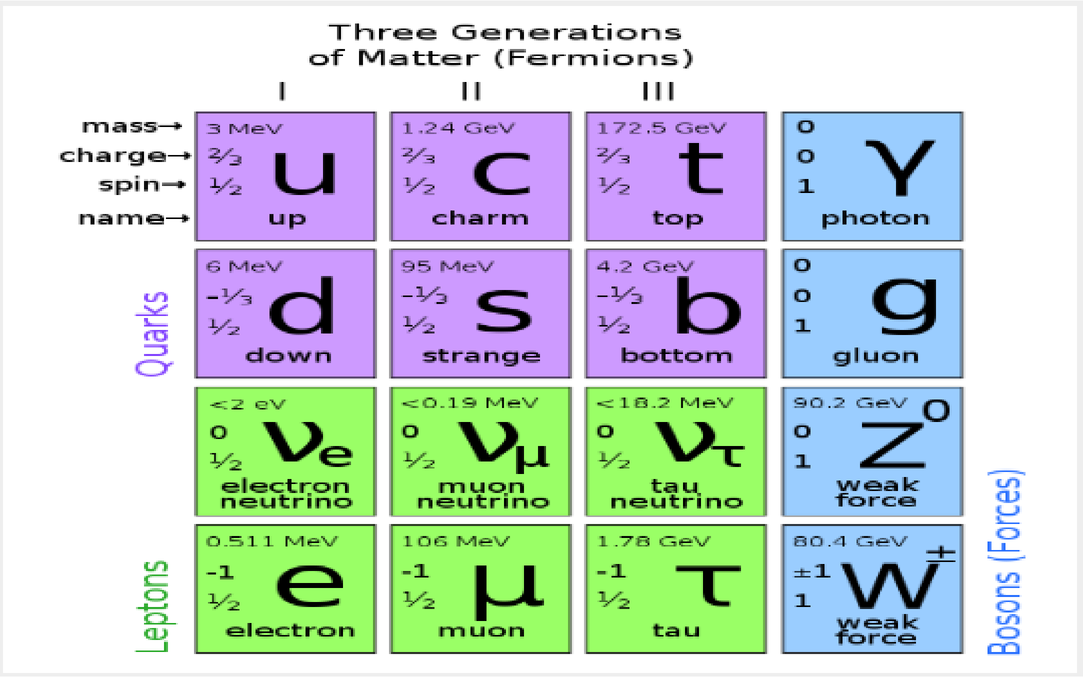
We already have experimental evidence of this, since the previous top Ion accelerator, RHIC, produced a few strange quarks that formed a cohesive liquid, a proto-strangelet, with far less energy/mass (E=Mc2), than the LHC will have. It made small, aborted phetus – Sancho claims, again not backed by references – didn’t stabilize, but grew a billion times faster than expected, and started to absorb other quarks. This allegedly surprised researchers that expected a gas and found a ‘perfect liquid’. Those were the first atoms of strangelets – mainly hyperons (usd atoms), just one stage below the double nuclei hyperon, the stable dibaryon, usd-usd. At RHIC we were lucky, Sanco claims. We only saw half dibaryons, usd atoms, which are not stable - unlike the double nuclei hyperon.

There are three kinds of ‘atoms’ of strange liquid, the said mixture of quarks:

1) Up-strange and down-strange Kaons. They are the first to appear and they are unstable, so they decay as antiparticles.

2) Hyperons, usd-atoms. They are only stable at high pressure, inside stars and maybe in the nuclei of Earth. At RHIC 70 hyperons were found, Sancho alleges, much more than expected. If 2 of them collide they form a dibaryon.

3) A dibaryon is a double Hyperon: usd-usd; and dibaryons are stable at normal atmospheric pressure. Those 2 atoms, hyperons and dibaryons are the only substances we know can provoke supernovas, Sancho claims, and we know they are the nuclei of pulsars, which are the remnant of those explosions.



Three Generations of Matter (Fermions)

	I	II	III		
mass→ charge→ spin→ name→	3 MeV ⅔ ½ u up	1.24 GeV ⅔ ½ c charm	172.5 GeV ⅔ ½ t top	0 0 1 γ photon	
Quarks	6 MeV -⅓ ½ d down	95 MeV -⅓ ½ s strange	4.2 GeV -⅓ ½ b bottom	0 0 1 g gluon	
	<2 eV 0 ½ ν_e electron neutrino	<0.19 MeV 0 ½ ν_μ muon neutrino	<18.2 MeV 0 ½ ν_τ tau neutrino	90.2 GeV 0 1 Z^0 weak force	
Leptons	0.511 MeV -1 ½ e electron	106 MeV -1 ½ μ muon	1.78 GeV -1 ½ τ tau	80.4 GeV ±1 1 $W^\pm$ weak force	Bosons (Forces)

Therefore, at 3.5 Tev in lead to lead collisions, the LHC could produce so many collisions between hyperons that it could create a constant stream of stable dibaryons, stable strangelet liquid. Dibaryons are the neutral, stable atom of strangelet liquids. You need only 2 hyperons, 2 usd-atoms joined in a collision to form a usd/usd di-baryon. Those stable and neutral dibaryons would then will fall to Earth’s center as previously discussed. A few hundred might form in each collision, he claims. In the earlier table strangelets, a dibaryon, usd-usd will have neutral charge (+2/3 -1/3 -1/3 +2/3 -1/3 -1/3) but it is already stable with 6 quarks.

In this interpretation of theory, according to Peng and Chen [47] a single dibaryon could initiate the process. However, this is the least slowest of the destructive processes, as the dibaryon will be neutral, and would seat on the center of the Earth and catalyze very slowly the creation of new dibaryons. This, according to Sancho, would be the best scenario, taking decades to blow up the Earth, though he offers no mathematical basis as to where he reached this figure. He also claims that this scenario might already be at play (as neutral dibaryons are invisible – only charged particles are detected in accelerators, so they could have been produced at RHIC without being noticed), is supersedeed by the thousands of strange quarks the LHC will produce in its collisions. The certainty of dibaryon creation in any case close to 100% he argues, if it didn't happen at RHIC already.

CERN have adamantly denied this in public. Yet again, Sancho claims to have found an internal document in which CERN affirms that 'dibaryons will be stable'.

Referring to Coffin et al. 'Search for strange dibaryons in STAR and ALICE' [92], a mass range, below 2055 MeV (the mass of a lambda and a neutron), where a Hdibaryon could only decay by a doubly weak decay into two neutrons. This is a deltaS =2 reaction and leads to a predicted lifetime of the order of days.

5.4. The Official Position

The official position held by CERN, and which is advocated by most respected academics and scientists in the field, is that concerns about the safety of whatever may be created in such high-energy particle collisions have been addressed for many years. In the light of new experimental data and theoretical understanding, the LHC Safety Assessment Group (LSAG) has updated a review of the analysis made in 2003 by the LHC Safety Study Group. [93].

LSAG reaffirms and extends the conclusions of the 2003 report that LHC collisions present no danger and that there are no reasons for concern. Whatever the LHC will do, Nature has already done many times over during the lifetime of the Earth and other astronomical bodies, it clarifies. The LSAG report has been reviewed and endorsed by CERN's Scientific Policy Committee, a group of external scientists that advises CERN's governing body, the CERN Council.

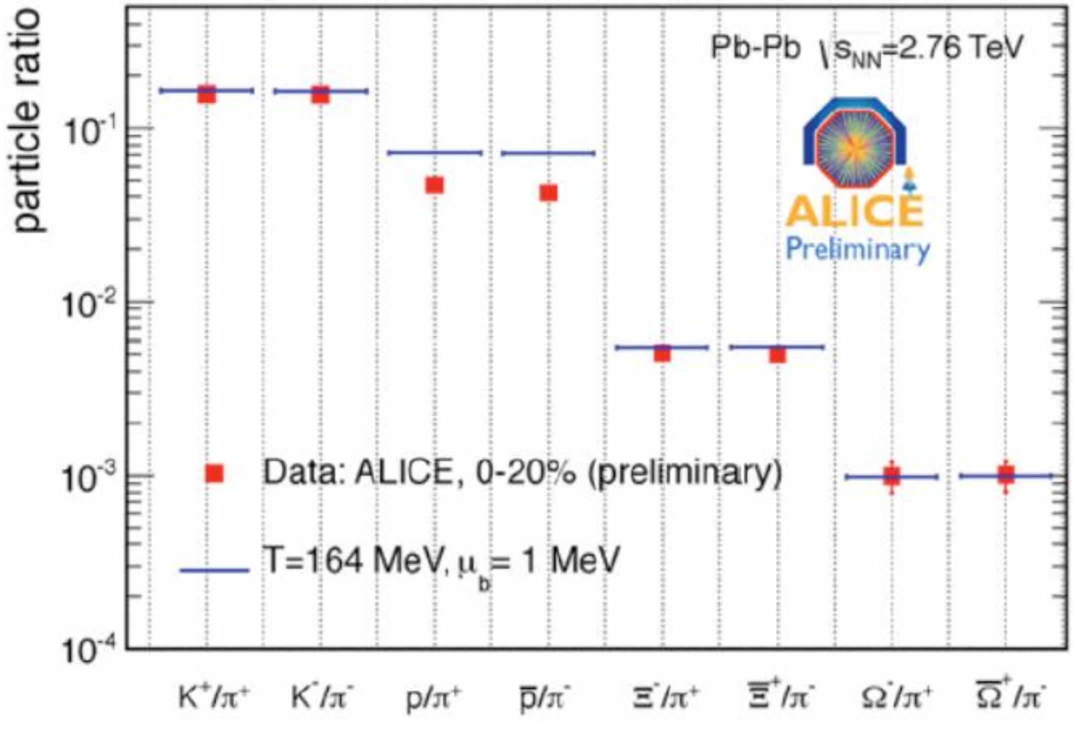
The official website for CERN specifically addresses the issue of strangelet production. It explains in lay-man's terms to the general public, that strangelet is the term given to a hypothetical microscopic lump of 'strange matter' containing almost equal numbers of particles called up, down and strange quarks.

According to most theoretical work, strangelets should change to ordinary matter within a thousand-millionth of a second. However, they pose the question - could strangelets coalesce with ordinary matter and change it to strange matter? This question was first raised before the start up of the Relativistic Heavy Ion Collider, RHIC, in 2000 in the United States. A study at the time showed that there was no cause for concern, and RHIC has now run for a decade, where it claims they have searched for strangelets without detecting any. At times, the LHC will run with beams of heavy nuclei, just as RHIC does. The LHC's beams will have more energy than RHIC, but the official CERN position is that this makes it even less likely that strangelets could form, explaining it is difficult for strange matter to stick together in the high temperatures produced by such colliders, rather as ice does not form in hot water. In addition, quarks will be more dilute at the LHC than at RHIC, making it more difficult to assemble strange matter. Strangelet production at the LHC is therefore less likely than at RHIC, and experience there has already validated the arguments that strangelets cannot be produced.

In a 2011 report by the LSAG [94], it clarifies that prior to the start of LHC operations, the good agreement of measurements of particle production at RHIC and other accelerators with simple thermodynamic models allowed one to constrain severely any production of hypothetical strangelets in heavy ion collisions at the LHC. In particular, LSAG estimated that the thermal production of a single *normal* $A = 10$ nucleus in heavy ion collisions would require running the equivalent of 1000 LHCs for the entire lifetime of the Universe. This estimate of the production of normal nuclear matter provided an extremely conservative upper bound on the production of hypothetical exotic forms of strange quark matter. This argument has now been sharpened by some more recent LHC data.

Aside from abundant production of strange quarks, the production of strange quark matter would require the availability of a significant net baryon number density in the collision, as well as a high probability that baryons coalesce. However, the baryon density was expected to decrease from RHIC to LHC energies, since the same number of baryons would be distributed over a larger volume. Also, just as ice cubes are not produced in furnaces, the high temperatures expected in heavy-ion collisions at the LHC would not allow the production of heavy nuclear matter, whether normal nuclei or hypothetical strangelets. First data from the LHC heavy-ion program give strong support for these arguments given in the LSAG report. In particular, the production of strange particles agrees with predictions of a thermal model according to which particles decouple from the heavy-ion ‘furnace’ at the expected temperature of 164 MeV, as explained by this most recent report on the subject [94]. Moreover, direct observations of protons, anti-protons, excited baryonic states and their corresponding anti-particles confirm that the produced matter has an extremely low net baryon density (μ ~ 1 MeV), in agreement with expectations in the LSAG report. In addition, the ALICE experiment has presented first LHC measurements of the lightest nuclei and anti-nuclei, namely (anti-)deuterons, (anti-)tritons, (anti-)3He and (anti)-4He in heavy-ion collisions [95], following similar observations in heavy-ion collisions at RHIC which were performed, safely, many years previous.

The observed yields correspond well to thermal expectations. Thus the three key ingredients in the LSAG analysis have already been validated by initial LHC data, and the conservative LSAG upper limit on the production of hypothetical strangelets is robustly confirmed. Having confirmed the essential validity of the thermal picture of particle production, scientific interest focuses now on a detailed quantitative analysis of the microscopic dynamics underlying particle production in heavy-ion collisions. Measurements by the ALICE Collaboration of the ratios of particle and antiparticle production in heavy-ion collisions at the LHC, which are generally in good agreement with a simple thermal model are illustrated below. The data confirms the expected rate of production of strange particles, as well as showing a low density of baryons, and one has to conclude Sancho [88] is basing his understanding of the science on misguided theories and wild speculation.



6. Magnetic Monopoles and deSitter Space Transitions

6.1. Magnetic Monopoles

A magnetic monopole is a hypothetical particle in particle physics that is a magnet with only one magnetic pole (a north pole without a south pole or vice-versa).[97] In more technical terms, a magnetic monopole would have a net "magnetic charge". Modern interest in the concept stems from particle theories, notably the grand unified and superstring theories, which predict their existence. Magnetism in bar magnets and electromagnets does not arise from magnetic monopoles, and in fact there is no conclusive experimental evidence that magnetic monopoles exist at all in the universe. Indeed one of Maxwell's equations, often referred to as Gauss's law for magnetism, is a mathematical statement that states that these simply cannot exist.

While a magnetic monopole particle has never been conclusively observed, there are a number of phenomena in condensed-matter physics where a material, due to the collective behavior of its electrons and ions, can show emergent phenomena that resemble magnetic monopoles in some respect. [98]. These should not be confused with actual monopole particles, it is fundamentally impossible to find a true magnetic monopole in ordinary matter. [96]. There have been speculative theories to suggest that, if magnetic monopoles do exist, they could cause protons to decay. However, these convey that monopoles would be too heavy to be produced at the LHC – which is CERN’s official position on this.

According to the official CERN safety statement on the matter of magnetic monopoles [93] it is suggested – in what must be pointed out is a flawed argument - that if the magnetic monopoles were light enough to appear at the LHC, cosmic rays striking the Earth’s atmosphere would already be making them, and the Earth would very effectively stop and trap them also. However, as any such particles created by collisions in particle colliders are the result of head-on collisions, the momentum of resultant particles can be much lower than those produced by cosmic ray collisions with the upper atmosphere, and so can get trapped in by the Earth's magnetic field or simply by gravitational forces.

However, it shall be assumed here that proton decay due to magnetic monopoles are a low risk to the environment, as most plausibly a non-catalytical theoretical event, and as not only is the magnetic monopole quite an implausible theoretical construct, and one fundamentally impossible to find in ordinary matter, but it has been reasonably argued that even if such a construct could exist, these could not be produced based on current TeV+ energy levels [13] as would be too heavy to form in these experiments. Therefore, one can reason that such hypotheses on magnetic monopoles and proton decay should not contribute to infringing on scheduling of planned experiments, unless contrary to all expectation, test results from these experiments show signatures of what could be considered a magnetic monopole, at which time the environmental impact should be re-assessed.

6.2. deSitter Space Transitions

There have been speculations that the Universe is not in its most stable configuration, and that perturbations caused by the LHC could tip it into a more stable state, called a vacuum bubble. [93]. In the language of general relativity, de Sitter space is the maximally symmetric, vacuum solution of Einstein's field equations with a positive (repulsive) cosmological constant Λ (corresponding to a positive vacuum energy density and negative pressure). When $n = 4$ (3 space dimensions plus time), it is a cosmological model for the physical universe. [99].

As for experiments at CERN causing a vacuum bubble, again, the official PR position taken at CERN is that if the LHC could do this, then so could cosmic-ray collisions. This could be considered a flawed argument. While two colliding beams at CERN of 5 TeV each would have a similar collision energy to a higher TeV cosmic ray colliding with the upper atmosphere, the characteristics are somewhat different – despite the well accepted theories of relativity, two beams at a particle collider could be interpreted to have superluminal speeds relative to each other, unlike cosmic rays hitting the upper atmosphere. Indeed evidence pertaining to the concept of particles travelling at a superluminal speeds has recently been suggested found in neutrino experiments as part of the OPERA collaboration, and though the interpretation of these results as such have been categorically excluded by a more recent paper [100], one could argue that even the most fundamental theories of physics are open to question when experimental evidence presents itself to suggest otherwise, and that the concept should not be dismissed out of hand. One has to assess whether superluminal collisions would present a greater strain on space-time than natural collisions as in the upper atmosphere, and the answer could be a resounding ‘yes’. However, it would be reasonable to assume that if one can interpret the collisions as such, not only do similar ‘superluminal’ collisions between cosmic rays occur all the time in other parts of the Universe, but collisions of much greater energy also.

One can therefore state, that as any deSitter Space Transition in one part of the Universe would quickly propagate across the Universe, such transitions have not occurred despite ‘superluminal’ collisions of much greater energy commonplace throughout the Universe, and as such man made collisions of much lower energy within particle colliders such as the LHC pose no such risks whatsoever.

Also, from both a science and engineering perspective, the utilization of such superluminal conditions could raise exiting possibilities in space-time windowing.

7. Sub-Atomic Explosions and Catalytic Cataclysm

Finally I would like to pass a brief commentary on some rather non-scientific concepts explored largely in the entertainment industry and sensationalist media over the course of the buildup to LHC experiments at CERN.

The LHC has been largely dubbed as ‘the big bang machine’ in an effort to convey the idea that these experiments attempt to re-create ‘the big bang’. This is quite a misnomer as it merely re-creates particles which were prevalent at the time of the ‘big bang’ in a manner which is done throughout the Universe such as in cosmic ray collision etc, except in a controlled, observable manner.

It would not be possible to create and contain a ‘mini big bang’ as one can easily surmise the big bang at the moment of singularity was a mini big bang, as it evolved from a vacuum, and therefore must have started rather small. All the matter in the Universe could not have appeared at one instant, one can argue, that it must have swelled from a vacuum outwards in the Planck epoch [101], and that the forces which lent itself to a ‘mini big bang’ were self-perpetuating.

As the energy levels associated with the LHC are minute compared with forces at play throughout the Universe, and the Universe remains intact, the concept that the LHC could re-create such an event should be discarded entirely.

8. Conclusions

It has been demonstrated herein that the TeV+ experiments being conducted today within the Particle Collider Industry, and most specifically at CERN, could be considered to have passed all reasonable debate on issues of safety procurement.

Two CERN commissioned safety reviews examined most concerns raised on the build-up to these TeV+ experiments and concluded that the experiments present no danger - a conclusion expressly endorsed by the American Physical Society.

However, one can reasonably argue that the debate on MBH should be left open. It has been shown [18] that an incremental approach is advisable, though methods of detection of such phenomena [22] could be flawed. Therefore I would argue that any unaccounted loss of mass in such collision experiments should be MBH attributable.

On the subject matter of MBH creation, the issue of accretion and evaporation rates requires further consideration. Evaporation of MBH due to Hawking Radiation may not be as effective in practice as in the mathematical model, and accretion rates are widely disputed, with certain academics [40] suggesting much faster accretion rates.

Indeed, at the recent Ars Electronica 2011 Symposium, famous Chilean philosopher Humberto Maturana, in reference to these experiments, described “certainty” in as a subjective emotional opinion and astonished the physicists’ prominence [102].

While the science and technology at CERN, and the safety assessment practices applied, are second to none, I would argue that there is a moral obligation for safety procurement of experiments to be discussed in a more inclusive context.

I would take the theories put forward in the public domain by Wagner [85] and Sancho [88] as a case in point here, as while their theories may be easily dismissed in the context of internal LSAG practices, a non-inclusive assessment results in the theories of these concerned individuals perpetuated through the public domain.

And so I close endorsing a statement reflecting as such made at Ars Electronica 2011, this time by French astronomer and "Leonardo" publisher Roger Malina, who expressed a hope that the LHC safety issue would be discussed in a broader social context, and not only in the closer scientific framework of CERN. [102].

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