



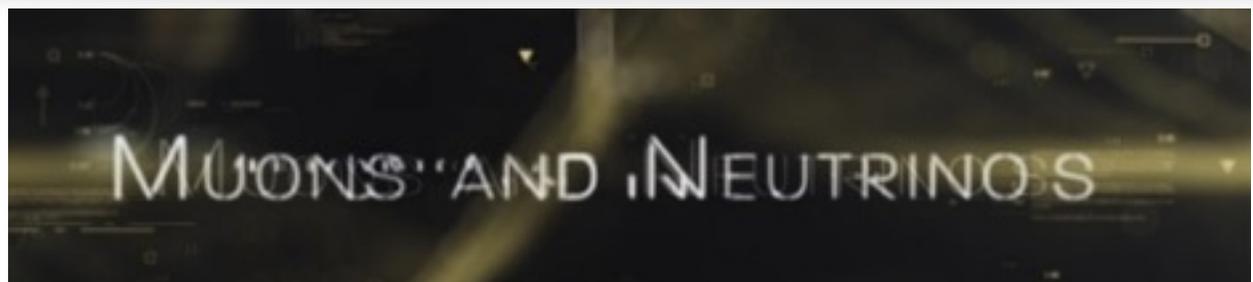
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# The Solari Report

February 15, 2018

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**Future Science –  
Muons and Neutrinos  
Excitement and Excitation  
by  
Ulrike Granögger**





# Future Science – Muons and Neutrinos Excitement and Excitation by Ulrike Granögger February 15, 2018

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**Ulrike Granögger:** Welcome to our first Solari Science Report, which I have dedicated to a discussion of muons and neutrinos. I've given it the title, 'Excitement and Excitation' as the science is really exciting, the developments are mind-blowing, and the excitation is a required physical property of matter to come to a detection of muons and neutrinos.

To give you a very quick overview of what we will cover, we will first look at muon applications, and we will next go into the properties of these subatomic particles, and move on to neutrino physics. Then we will begin to look at the exciting world of neutrino telescopes and detectors, which will lead us to neutrino ultra-high energy events and neutrino communication. This will be rounded off by some remarks on implications.

Since this presentation is over an hour, I would like to recommend that you watch it in installments, and think about the implications discussed during your break times. You may even want to do your own research, and for this, I've given the links to each of the articles and websites in a pdf.



First, let us look at some of the applications of these new technologies and the muon and neutrino particles. It is my hope that through looking at applications you will also feel some of the excitement that scientists, as well as big corporations, feel about the use of these new particles.

For many of us, muons and cosmic-ray particles may have received the very first practical side in November of last year when scientists published their findings on the Scan Pyramids project. This is a project that involves an international team of scientists from Egypt, Japan, France, and Canada involving different universities and institutions that looked at the Great Pyramid of Giza as well as other pyramids in Egypt, including tombs in the Valley of the Kings.

What they found is that by using muon tomography, new cavities and new chambers can be detected inside these vast structures. This is done by placing metal plates that have a special emulsion film on top of them, which will detect the in-fallen muon particles from space and register their passage through the structure.

I know most of us don't know yet where the muons come from, but we will discuss that later in the presentation. For now, it's sufficient to say that every minute on every square meter on the surface of the earth, there are about 10,000 of those muons generated by cosmic-ray bombardment in the upper atmosphere, reaching the surface of the planet. As these muons fall from space, they fall through the materials, hardly interacting with matter in their passageway.



They will be deflected by more dense materials and less so, naturally, by cavities or the absence of materials. That means that as you place these metal plates in specific strategic locations of the pyramidal structure and leave them there for weeks or months, over time an accumulated image will be generated. The areas where there is a greater accumulation of muons tracing on the metal plates will be areas that show voids in the structure that the muons have passed through.

In this way, the researchers could determine that there must be a very large chamber – maybe even several cavities – or different vacuous structures that can be seen as existing above the grand gallery in the Great Pyramid of Giza.

Here we see the placing of metal plates inside a structure. This is a picture taken from a press release of the Heritage Innovation Preservation Institute and the Cairo University showing the situation underground of the muon detectors.

Again, here is an artistic rendering of the Scan Pyramids project that shows the area of the void, namely an assumed cavity or maybe even a passageway that is 30 meters long and an additional cavity behind the entrance that has so far had not been detected.

It can also be seen that the scientists in this project used state of the art technology to visualize the findings, not only in terms of the measurements, but also in the rendering as well as processing of the images. Earlier – a year before – the same procedure was applied to the Bent Pyramid of Dahshur , which has a known internal structure -



structure and shows inside of the lower chamber where they placed the metal plates, the muon detectors. Here you can nicely see the angle of incidence that is possible to detect with the placing of the plates at the bottom of the room in the underground area of the Bent Pyramid.

Due to the sensitivity of the emulsion film on the metal plates, the incident angle of the downfalling muons can be taken into account and so a much wider angle of measurement can be taken. These are the internal chambers of the Bent Pyramid of Dahshur, which are known and, which have been confirmed by muon tomography in Egypt.

I personally find the case of the Bent Pyramid of Dahshur very interesting since I've been on an Egypt expedition at Dahshur with a group of Russian scientists involving Professor Oleg Khavroshkin, Ph.D., who is a known seismologist working at the Schmidt Institute of Physics of the earth and a member of the Russian Academy of Sciences. He has been publishing about the seismic properties of the pyramids of Egypt for a while. Not only can it be determined that pyramids themselves are seismic accumulators – meaning they are acoustic resonators with the internal vibrations of the earth, which is something that has also been confirmed by the organization I work for, the Academy for Future Science, which was looking for acoustic properties and sound properties of the Great Pyramid of Giza. Also, Khavroshkin indicates that the pyramids seem to pick up the seismic emissions or waves or shockwaves from space. These are shockwaves that can be precisely determined to come from nearby pulsars such as pulsar 1913 and 1916, which are the very sources for the acceleration of cosmic particles, which will produce neutrinos and muons.



So there is a direct relationship between the seismic properties of pyramids and the neutrino and muon component.

As shockwaves pass through space, they will not only reach our planet, but they will reach all the stars and all the planets and solar systems along their passageway, so they will also hit other planets in our solar system or the moons. This will come into play later as we look at large-scale muon and neutrino detectors that are being built, such as the one in Antarctica, but also the endeavors of our physicists to create muon/neutrino detectors in space.

Actually, there is a thought and a project that tries to involve the moon itself as a muon neutrino detector for human purposes. Khavroshkin has published on the seismicity of the moon for a long time, and he has always presented a much larger framework of cosmic interaction in terms of seismicity of our solar system. Also, our own sun has eight-minute pulsations of the sun. These are standing waves that propagate through the whole heliophere of the automagnetic field of the solar system, affecting every planet in the solar system.

Here I am with Professor Khavroshkin in Egypt in our little expedition.

There are more applications of muon tomography, and it will begin to dawn on us why it is important – even as people who are non-scientists but who may be investors or maybe simply interested in the money flows upon this planet – to know about these technologies as they are at the forefront of science and application.



For example, closer to my home in Switzerland, these muon tomographic processes are utilized to scan whole mountains. This is also being done for volcanoes to observe the magma core inside of the volcano. Here it is done to observe the flow and the extent of the glacier of Jungfrau Mountain. We see the metal plate of the muon detector being placed inside the tunnel that was built for the Jungfrau Mountain train that takes the tourists up to the mountaintop – mainly Japanese tourists. Then the muon traces are being read, and a map of the actual components and density distribution of the materials that make up the mountain, and its glacier is drawn.

Here is an artistic rendering of how this is happening. We have the detector inside the tunnel. This is the mountain train going up the mountain and through the tunnel. We have the muons impacting from space, and as they will be deflected by the different densities of materials, they are passing through the detector registers a very detailed image of the area directly above at a 90-degree angle. This allows the scientists to precisely trace the position of the glacier, the movement of the glacier, its layers, and also its composition of the ice and the snow cover.

Another similar application of muon tomography would be to help in the reduction of carbon emissions, namely in observing and surveilling the cavities and caves that are used to store captured carbon emissions in forms of liquids.



We will talk in more detail, as mentioned, about the generation of the muon and neutrino particles, but we can see here in this artistic rendering that these particles rain down upon the surface of the earth as in a shower of particles, penetrating the mountains. As we are able to capture them, it is possible to x-ray or see-through mountain areas and thus observe the behavior of the liquid carbon that may have been stored inside of the cavities.

This ability of muons to see through everything also lends them to be applied to areas that are off-limits for human subjects such as the radioactive area of the Fukushima disaster in Japan where several reactors broke.

It is impossible to go there with human subjects. Even the robots that are sent in suffer from the extreme radioactivity. So what was proposed was to use muon tomography again to look at the positioning of the denser materials or the density distributions of materials inside of what is left of the reactor.

Here is a simulation of what this would look like, and it is possible to determine the position and location of uranium with pictures of very dense material. Unfortunately, the muon tomography of the Fukushima reactor #1 has confirmed that there was a complete meltdown of the reactor in the 2011 disaster.

Border Patrol is already applying muon tomography to look into vehicles that pass across the borders, ostensibly to discover smuggled materials such as dangerous nuclear cargo that is illegally transported across the borders.



Here we have the report, a short description from Los Alamos National Laboratory that developed this method of looking inside a truck or a car as it passes through the muon detector.

Here the detector is above and below the target, and the muon track data is scattered before and after interaction with the target or that suspicious cargo transported in the truck. The incoming muons from space will go through the detector, above and below, and will render a readout of their deflections due to the different material densities of the cargo.

So the detector is this installation. The top and the bottom are necessary for the detection unit.

Muons – as well as with neutrinos – are the ultimate surveillance radiographic tool. You can see through every material utilizing these high-energy cosmic particles. It would not surprise me if certain agencies or companies with access to satellite technology, for example, would already be using muon tomography and muon radiography for surveillance purposes.

You might ask, “But would that be a very difficult undertaking?” You think that you need such a large detector, but no, unfortunately, this is not the case. A portable detector has already been built by young scientists at MIT who have produced the cosmic watch, namely a muon detector that you can put into your pocket, and it is available for as little as \$100 and can be assembled by people themselves.



I'm sure that you are already excited to know more about muons and where they come from. Know a little about the physics around it and not just the applications. For this, let us go to CERN in Switzerland and learn about the physics of muons and neutrinos. Before we do this, I would like to invite you to look at an art project that friends of mine from Australia have produced with the help of these cosmic friends.

The music that you are hearing and the sounds that you heard in the video is music triggered or produced by the infalling muons from space. This installation was part of last year's Adelaide Fringe art festival in Australia where Robert Hart, Darren Curtis, Bradley Pitt, and Jessica Curtis were working together to allow the triggering of light and sound signals as each muon impacts the muon detector – in this case, a Geiger counter. This way, an indoor and an outdoor installation was produced with beautiful sound, color, and light effects. Here is the outdoor installation that you saw in the video.

Let us look at some of the physics of the muon. The muon is a charged elementary particle of the lepton family - part of the standard model of elementary physics. Being an electron or related to the electron means that it does not consist of other sub components such as the quarks of which, for example, the proton or the neutron would consist of.

It is the heavy brother of the electron. It is very similar to the electron in all of its behavior except that it is 207 times more massive than the electron. There is also another cousin to the electron which is very similar to its behavior as well but even more massive. That is the so-called tau particle.



Both muon and tau are unstable particles, meaning that they will decay in a certain amount of time. The half-life of the muon is 2.2 microseconds. So it exists only for a very short time in its normal state.

As it decays, it will decay into an electron, the ground state of that particle, or into a positron – depending on its original charge – and into two neutrinos. So in alternative views of particle physics, which we hope to discuss in the future in this series, the muon can simply be seen as a resonant state of the electron – the electron being the stable state of that particle family.

The muon is the third lightest particle, the lighter ones being the electron, and even lighter is the electron-neutrino. We will talk more about those neutrinos. As you can see, the relationship between the muon and the neutrinos is already becoming obvious. All of these particles, including the neutrinos, belong to the lepton family.

We have the electron having an electron-neutrino association with it, the muon having a muon-neutrino, and the tau, a tau-neutrino associated with it.

Muons are produced in extremely high-energy interactions of matter, usually in our atmosphere by cosmic-ray impacts. This is what we have seen raining down upon us from space or the sky.

As muons arrive on the earth's surface, they have gone through the entire atmosphere and triggered in their passage a complete cascade or array of interactions. Cosmic-rays is really not the right word; it is high-energy primary particles such as hydrogen or helium or carbon atoms -



that arrive from the sun or arrive from other very violent explosions in the cosmos and impact at extreme speeds in the upper atmosphere of the earth colliding with molecules in the atmosphere such as nitrogen or oxygen molecules. That happens at the height of about 15,000 meters above sea level. This will create secondary cosmic rays or will produce the decay of the proton into a pion, as is indicated here with the pi, and this will immediately or very quickly – in a matter of meters – decay into radiation, into muons, and decay further into electrons and neutrinos.

Here we see a simulation of such a cosmic-ray impact and the cascade of secondary cosmic-ray particles. That is a result of the particle decay processes triggered by the original impact, much like in a particle collider.

Muons being generated at the height of about 15,000 meters and having a half-life of only 2.2 microseconds really should not – even though they travel at very high speeds – from our perspective, be able to reach the earth. They should decay after only about 600 meters in the air. However, due to what is called ‘time dilation’, which is a relativistic effect, we know that anything that is traveling at very high velocities, close to the speed of light, experiences time passing more slowly. So the muon, which has a speed at almost the speed of light due to its very tiny mass and its high acceleration, will be able to traverse the entire distance from the upper atmosphere down to the surface of the earth and even into the earth.

It happens that about one particle per square centimeter per minute reaches the surface of the earth and can sometimes be registered even underwater or inside mountains.



The same nuclear reaction outside of the cosmic-ray particle cascade produced by the impacting proton decaying into pions, which then decay in a cascade into muons, electrons, gamma rays, and especially neutrinos – together with the muons – is the same nuclear reaction that is created in the Large Hadron Collider and all other accelerators of human physics.

Here we are at CERN at the Large Hadron Collider, in particular, at the so-called ‘Compact Muon Solenoid’, which is one of seven particle detectors at the Large Hadron Collider installation. We see here the Large Hadron Collider spanning across Switzerland and also parts of France, and we see the different Collider installations like the ATLAS or the ALICE, and here the CMS (Compact Muon Solenoid). This is one of the places where super high-energy collisions, up to 13 tera electron volts (TeV), are being achieved. It is that place where the Higgs boson was confirmed. Here we see Peter Higgs in front of the CMS at CERN.

So we can see that the muon detection seems to be of great importance. Maybe you have already guessed from the title of this presentation why the muon is important. The reason is that the byproduct of the muon decay is the neutrino. It is really the neutrino that is at the forefront of the interest of most of the physicists today. It is the era of the neutrino after the era of Einstein, as some would say. Namely, it will change our complete perspective of the universe.

In combination with gravitational-wave research, the neutrino physics are the physics of the future according to most scientists today.



Before we go to the more important neutrino aspect of physics, let us quickly take a look at the Compact Muon Solenoid in this little video presented by a physicist of Fermilab:

If you're a science enthusiast, you should be really jealous because I am in one of the scientifically most fascinating places on the entire planet. Behind me is the CMS detector. CMS stands for Compact Muon Solenoid. It is one of two large particle detectors based at the Large Hadron Collider in the CERN laboratory.

The detector behind me is absolutely amazing. It is 50 feet high, 50 feet wide, 70 feet long, and it weighs 14,000 tons. The way to think of it is: It is a large digital camera that records the debris of collisions between protons traveling at nearly the speed of light.

This camera has 100 million pixels. That sounds like a lot, but then you realize that this cell phone has about 13 million pixels. So it's about seven times fewer. Maybe that's not such a big deal.

On the other hand, this camera can take 40 million pictures every single second. At the center of this detector when the particles collide, we recreate the conditions of the early universe a trillionth of a second after the big bang. This is a way for us small humans to recreate the very beginning of the universe and study it in detail.



By using this equipment, we will be able to write a new page in the book of knowledge – a book whose first pages were penned over 2,000 years ago.

The most fascinating part of our discussion today is namely the reality of the neutrino and the reality of the search and attempts to detect the neutrinos. Neutrinos are ubiquitous. Every second, trillions of them pass through our bodies without us noticing it, or maybe we do.

Neutrinos are the lightest known particles in the universe. They were originally thought to be massless, but they do have mass. The three neutrino flavors seem to be in superposition and change into each other, oscillating their mass values. This is what won the 2015 Nobel Prize in physics.

The fact that they do have mass was not predicted by the standard model of particle physics, which was one of the important indicators that the model is not complete. This discovery also makes them interesting candidates to explain dark matter and dark energy.

Neutrinos are neutral particles; they are not charged, and therefore only interact via the weak nuclear force and via gravity. They are not affected by electromagnetic forces or magnetic fields, which mean that they are not detectable directly or seen by our optical instruments. Because they have no charge, they travel in straight lines from their source – unaffected or un-diverted – which means that they bring a signature of their birthplace.



Their birthplaces are any radioactive decay processes going on in the universe, which is where they are created: For example, natural beta-decay of certain atoms or nuclear fusion processes in suns and all stars, as well as nuclear fission processes that occur in our nuclear reactors. They are used, therefore, to detect secret nuclear installations. They are also produced by nuclear bombs as well as by particle accelerators and, as we have seen in the extremely high energy cosmic events such as supernovae and gamma-ray bursts, but also when cosmic rays hit the earth's atmosphere as they are produced as a byproduct of the muon interactions.

Neutrinos propagate at very close to the speed of light due to their tiny mass. Although they are very small, they carry huge amounts of energy. Their energies are so large that they are extremely interesting and explain the vast endeavors that are undertaken to detect them.

The problem with neutrinos is that there is almost no interaction of them with normal matter; they pass through all materials, even through the earth itself. Therefore, you need to build extremely large detectors to happen upon a chance of an occasional interaction of a neutrino with an atom or a particle.

Now let us enter into this incredible world of the neutrino detection. As you will see, there is a massive amount of effort and money that is spent to detect them. In order to filter neutrino interactions from other interactions, you have to go underground or underwater because only neutrinos will penetrate so far (with muons doing that to an extent).



Neutrino detectors and neutrino observatories are usually built in large bodies of water or large bodies of ice or underground. One of the first neutrino telescopes was built in Russia at Lake Baikal, the NT200, which used these optical modules and lowered them down into the lake at approximately 1,000 meters in order to detect the infalling muons producing the neutrino reactions.

Another detector is situated in the Mediterranean Sea. It's the ANTARES neutrino detector. It is south of Toulon in the Mediterranean Sea, and has deployed a number of optical sensors that are anchored to the bottom of the sea and are detecting, again, the infalling muons and the high-energy neutrinos.

Another vast observatory for neutrino detection is the Pierre Auger Observatory and cosmic-ray observatory in Argentina. The entire area that is covered by the above-surface and sub-surface detectors is 3,000 square kilometers in Western Argentina.

One of the biggest neutrino detectors is the Super-Kamiokande in Japan. Because their website doesn't show the fantastic pictures, let's look at them here. This is a detector that contains 50,000 tons of the purest water that is surrounded by the photomultipliers, which will detect the incoming particle reaction.

Look at the sheer size and perfection of this enormous installation watching for high-energy cosmic particles.



One of the biggest and most important of these neutrino observatories is the IceCube Observatory at the South Pole. It is 1,000 times larger than the Super-Kamiokande and it is the successor or expansion of the previous AMANDA Observatory at Amundsen-Scott South Pole Station, which is at the very center of the South Pole or an Antarctic continent.

It consists of over 5,000 optical modules, namely photomultipliers, that would detect the radiation. These are deployed on 86 strings that are drilled down 2,400 meters into the ice of the Antarctic.

This is a surface view. Here is the airstrip, and here is the Amundsen-Scott South Pole Station. This is the IceCube Observatory. You can see each of the dots representing one of the strings that have been lowered down for hundreds and thousands of meters into the ice.

This is one of the optical sensors of photomultipliers as it is lowered down in one of the drilled holes.

This installation can only be appreciated if you see its full scale in their own documentary and in their own words. This video is shown with permission:

*Light can give us a picture of the universe at night. We see photons coming from the stars, galaxies, far away object. Photons are the most abundant particles in the universe. But can we see what is going on inside stars? How can we get a glimpse of the unknown?*

*Good news: An uncommon eye is opening up new frontiers.*



Why doing astronomy with neutrinos when they are so hard to detect? The reason is simple. First of all, the neutrino has no electric charge, so it is basically the same as a photon – the particle of light. So you are doing the same astronomy. The critical difference between neutrinos and light is neutrinos go through walls and light doesn't.

The inference is that they may reach us from places in the universe that we have never seen before. So we built IceCube to do astronomy with neutrinos.

The simplest way of thinking about astronomy is that you go out at night, you look at the sky, and you see beams of light coming from stars. This is the perfect analogy. IceCube is basically a big eye that looks at the sky. Instead of seeing beams of light, it sees beams of neutrinos.

Why were we interested in neutrinos? Why not use light? It's cheaper and easier? Well, we are very likely to see very different things. In fact, at the moment, we have detected our first beams, and we are trying to figure out what we are actually seeing. Educated guesses are that we are seeing very powerful cosmic accelerators – maybe supernovas remnants, gamma ray bursts, active galactic nuclei – all of the things that are part of the high-energy universe.



*What is so special about the South Pole? The South Pole ice itself is the detector. Between 1.5 and 2.5 kilometers below the surface groups of light sensors are in position to see the light produced by particles passing through the ice. Over 5,160 of these light sensors have been deployed, instrumenting a volume of one square kilometer under the ice.*

*High energy neutrinos produce a zoo of charged particles when they interact with the ice. These particles produce an explosion of light, and IceCube captures it in its sensors.*

*What is critical in the design is how far light travels through the ice. The light sensors have to be spaced according to the absorption length, the average distance light travels in the ice. In tap water, light will travel two meters. In distilled water, light will travel eight meters. In ice beneath the South Pole, light travels more than 100 meters. In some places, it travels even more than 200 meters. The ice in the South Pole is one of the clearest solids that exists. It may not be possible to build a solid in a laboratory as transparent as this ultra-pure ice which, in the end, is just snow that condensed and fell on Antarctica about 100,000 years ago at the depth of IceCube.*

About two years ago, we were doing an analysis where we were looking for extremely high energy neutrinos. We actually knew exactly what we were looking for: We were looking for something that is called cosmogenic neutrinos. It doesn't matter what it is; we didn't find any.



But when we looked at the data, we found something that we had never seen before. I remember when I was shown these events the first time, and over the years we have looked at thousands and thousands of events on the online display. I knew I had never seen events like those. In fact, they were so special that we called them Bert and Ernie.

After seeing them, it was clear what was special about these events, and we designed a new analysis that could go and look for more of these. So by now, Bert and Ernie have 26 more friends which we recently published, claiming that we have evidence for neutrinos that come from space.

Where do they come from? That is our next frontier. Of course, everybody already has ideas. We know that some of them are not emitted in the direction of the center or the plane of our own galaxy. So they come from outside the galaxy.

There are hints in the data that some of them actually may come from our own galaxy. The problem is that there are not enough statistics or events to come to a conclusion. So then we start a busy approach in a different direction. We started to look for more events.

I am afraid that you will have to stay tuned. Eventually we will figure it out.



What is next? Clearly finding out more about this very special event. By the way, what is so special about these events is that they have enormous energies. That is why they look different from anything I have ever seen before. We detect a neutrino every six minutes, but they are uninteresting and produced in the earth's atmosphere. These events have ten times bigger energy.

Clearly we want to get more of these. So what you do is build a bigger detector. We are now figuring out how to do that. It turns out that it's not that difficult because we found out while building IceCube that the South Pole ice is much clearer than we had guessed. This allows us to build a much bigger detector by basically doubling the number of sensors that we have to deploy in the ice. So we are busily designing our next step.

Let us put this into some sort of perspective. What they are looking for is the extremely high-energy events coming from space – neutrinos of galactic sources – while the average solar neutrino or atmospheric neutrino, which comes with Giga to Tera electron volts of energy. These events have Petaelectron Volts and even higher Exaelectron Volts that are extremely high-energy cosmic rays.

Could this be one of the reasons there is so much interest in Antarctica? Could Antarctica quite literally be a window or door to a completely new energy spectrum?



We also realized that the neutrino detectors are actually muon detectors because the neutrino cannot be seen. What is seen is the muon as it is excited into higher speeds by the impacting neutrino.

One can only see the indirect Cherenkov glow, which is an optical signal that will then be picked up by the optical sensors of photomultipliers. The higher the energy of the original neutrino impact, the brighter the glow.

On their website, the IceCube team is showing images of the 28 very high-energy events that were detected between May of 2010 and May of 2012. That was published in magazines of *Science* in November of 2013.

Here we see the second highest energy neutrino ever observed by IceCube. It has an estimated energy of 1.04 Petaelectron volts. This is impossible to be achieved by atmospheric neutrinos. If you placed this energy event over the city of Maddison, it would look like this.

While the fundamental research of particle physics is a legitimate endeavor, clearly these people are looking for higher sources of energy. It explains why ever larger neutrino detectors are being built.

Here we have the KM3NeT, (Qubic Kilometer Neutrino Telescope) which is the next generation neutrino telescope that will be built in the Mediterranean, combining three different locations of France, Italy, and Greece.



Here is an artistic rendition of one of its locations and how in the clear water on the bottom of the Mediterranean Sea, there will be these photomultipliers to search and detect these high-energy neutrino events.

The next generation neutrino detectors and observatories will go beyond anything that has come before. I would like to show you two additional special detectors that are being built. The first is The LAGUNA Long Baseline Neutrino Oscillation experiment.

All that you find on the web is a small PDF brochure. If you look for LAGUNA science, you will find a private British company incorporated in 2016 offering environmental consulting activities.

This neutrino detector is to be built in the deepest mine of Europe, located in Finland in the town of Pyhäsalmi. This installation will look at ultra-high energy events, which means events in the exa and even zetta electron volt range, 10 to the power of 20 and above.

This is an installation or an observatory that will be cooperating with CERN in Geneva and their accelerators. It says here that it will allow precise understanding of the neutrino properties in the propagation through matter over a distance of 2,300 kilometers – namely the distance between Geneva and Pyhäsalmi in Finland.

The neutrino observatory that will be employed here is called MIND (Magnetized Ion Neutrino Detector). It says that this will be an opportunity to develop new unexplored technologies in tight collaboration with industry.



So we can see that the whole thrust of the research is, not just to find out about fundamental physics, but to find out more about applied physics.

Finally, we will mention the Extreme Universe Space Observatory and Super Pressure Balloon combination (the EUSO-SPB project), which is a neutrino detector and also a high-energy cosmic-ray detector that is situated in space. It utilizes a Super Pressure Balloon that can go to very high altitudes and takes its flight path over the Antarctic continent.

This may be coupled with the Extreme Universe Space Observatory onboard the Japanese Experiment Module (the JEM-EUSO), which is a space-borne observatory for ultra-high cosmic energy events – ultra-high neutrino impacts. What we will see is that from the International Space Station, these particles and particle showers are being observed.

The space component in the neutrino research can also be seen by its cooperation now with the gravitational wave antennas, for example, LIGO here in the United States, LIGO. There is one antenna in Livingston and the other in Hanford, which were the observatories that registered the first gravitational-wave event that won a Nobel Prize. They are going to cooperate with ANTARES in the Mediterranean to see how gravitational-wave events and high-energy neutrino events coincide.

The gravitational-wave research itself is going to space as the proposed LISA mission and is a gravitational-wave antenna in space that is going to be built by 2028 in space and will circle or orbit the planet and the moon in search for gravitational waves.



Both neutrinos and gravitational waves must be understood as candidates for new forms of communication and information transfer. Any new source or form of energy has always resulted in a new form of transportation and a new form of communication. So if a higher source of energy was discovered in the neutrino physics, then it is not surprising that also forms of communication are being tested.

Researchers at the University of Rochester have been successful in sending a message using neutrinos. The implications are immense because with the ability of neutrinos to pass through all kinds of matter – even pass through mountains or through the entire planet – this message being sent does not require any cable networks or satellites. The communication would reach the bottom of the ocean or go through entire mountain ranges, even through the complete planet, at almost the speed of light.

More than that, the communication would also go into space. This would be the beginning of interplanetary or interstellar intergalactic communication. With the enormous effort and finance that is being put into neutrino astronomy and neutrino physics, it may well be that such neutrino communication technology is already in place in some of the aforementioned installations. That is at a much larger scale than what was achieved in this first published experiment.

Even Dr. Christian Spiering of the German DESY (the Deutsches Elektronen-Synchrotron) research center, in an expert in neutrino astronomy, predicted in a lecture back in April 2010 that certain research will be undertaken in analyzing the neutrino events for mathematical patterns or signals of intelligence and communication.



It turns out that given the ability of neutrinos to pass through all types of matter that the entire planet is a communications device. This brings us back to the work of my associate, Oleg Khavroshkin, and his seismic studies of the surface of the moon that – as we heard – coincide with the activity of pulsars that are clear sources of high- energy neutrinos.

Astronomers are beginning to use whole planets and moons as giant reflectors or mirrors looking into the recesses of the dark energy and dark matter regions of space. Since neutrino detection requires as large of a detector as possible, scientists are working with the surface of the moon as a perfect detector. Energies exceeding terrestrial observatories, cosmic rays, and ultra-high energy neutrinos, can be detected using the surface of the moon.

The most promising detection technique is to search for short radio pulses that are produced when the ultra-high energy neutrinos interact with a dielectric media like that in the ice for IceCube or like the lunar rock, which is creating particle showers when high-energy neutrinos impact the regolith or the loose, dusty surface deposit on the moon.

These particle showers will emit Cherenkov radiation, which can then be detected on the earth using radio telescopes. This is done in the Netherlands at the LOFAR radio telescope, which combines thousands of antennas that can, “Be electronically phased to form multiple simultaneous beams on the moon, thereby effectively turning the complete visible surface of the moon into a neutrino detector.”



Another project where the moon is utilized as a neutrino detector is the LUNASKA search project, which works with the Parkes radio telescope and the Australian Telescope Compact Array, both in Australia. Here, again, multiple antennas are put into place to scan the whole surface of the moon.

Now please connect this idea with the mother of all telescopes, which most people haven't heard about, namely the Square Kilometer Array (SKA) that is being built in South Africa and Australia. It is not specifically a neutrino detector, but a radio telescope. It will, nevertheless, search for the origins of dark matter and dark energy thought to be connected to neutrinos as well as for gravitational waves.

It is the biggest telescope ever built. The area covered by the Square Kilometer Array will comprise three regions and will cover 3,000 kilometers: The central region containing about five kilometer diameter cores, a mid-region extending out to 180 kilometers, and an outer region from 180 kilometers to 3,000 kilometers. This will comprise five spiral arms, along where dishes of the grouped stations of dishes will be located.

It will be built starting in 2018 and will be fully operational by the late 2020s. It will eventually use thousands of dishes and up to one million antennas that will enable astronomers to monitor the sky in unprecedented detail. Thus the connecting area will be one million square meters, while the entire layout will span the complete African continent, reaching over into Australia.



The SKA central computer will have the processing power of about 100 million PCs, and the dishes of the SKA will produce ten times the global internet traffic. The data collected on a single day would take two million years to playback on an iPod. The SKA will be so sensitive that it will detect an airport radar on a planet tens of light years away, and it will require computing technologies to handle the massive amounts of data currently being developed at Oxford University and IBM.

Those who have had the interest and the patience to follow this presentation, until now, will realize that this is a game changer. CERN is no longer our greatest concern; there are much bigger projects and much higher-energy detectors underway involving neutrinos, gravitational waves, and dark matter astrophysics.

The planet itself has turned into a giant telescope with the complete southern continents – Australia, Antarctica, and Southern Africa – involved. Nobody can tell me that this is only for fundamental physics in search of elusive particles or hypothetical black holes. They are first and foremost, energy sources, and we are seeing not only abstract physicists, but industry, engineering, big finance, big data, as well as global governance involved. It has begun to turn the earth itself into a spaceship of exploration.

How ingenious! I find this very inspiring despite the potential and likelihood of misuse of the privilege of access to the discoveries. Even on the Pierre Auger telescope homepage, it is said that just about 1% of the data is made public.



Nevertheless, humanity is becoming a new type of cosmic civilization, stepping from level zero on the Kardashev scale to level one.

While Kardashev and Freeman Dyson have defined the scale concerning energy output and usage, level zero being our type of civilization that is still based on fossil fuels, type one civilization would be a civilization capable of utilizing and storing the parent sun's energy. Type two and type three civilizations move onwards to utilizing the entire solar system or galactic energy output.

I like to define it in terms of communication abilities of civilizations, and the idea of using neutrinos and perhaps eventually, gravitational waves for communication showing that we are on the brink of entering a much larger interaction with the cosmos.

My personal speculation is that this is what is driving the interest in installation on Antarctica, namely that we may have established already a communications link with another more advanced civilization.

The successful deployment of neutrino communication means that we will be able to communicate with and explore areas that are invisible to the human eye and electromagnetic technology. Once each of us realizes that all physical matter as we observe it, is barely 5% of what the universe is composed of, we understand that neutrino research is not only a matter for scientists.

Do we really want to be oblivious to 95% of reality? Can we afford to ignore the larger part of energy and information in our own decision-making? I believe not.



Neutrinos are black. They are literally dark in that they do not interact electromagnetically – only via the weak interaction or nuclear force. Neutrinos may, therefore, guide us to a different form of perception – one that is creative and in the moment, not remembering or reconstructing the past as all electromagnetic perceptions do.

Electromagnetic telescopes see billions of years into the past, but they will never see the present moment. To see the present moment, you have to collapse the event horizon. The smallest known particle and the largest scale at the beginning of the universe are interconnected and ultimately collapse in human awareness.

Neutrinos interacting via the weak nuclear force, the one that is involved in betadecay, will thus enable us to see or perceive realities that are not registered with the electromagnetic body. We need different sensors, not just extensions of the human eye. The eye is in electromagnetic enslavement – quite literally – to the past, and it is hypnotized by the flurry of radiation of the electric screens of this world from TV screens to the screen of the atmosphere with its particle collisions.

Neutrino physics and the weak interaction may help us to break the trance and to cross the electromagnetic barrier, literally to cross the light barrier, into the greater 95% of reality that we have ignored.



There is one mysterious object on Earth, by the way, that is an indicator of this passage from electromagnetic to weak force. It is the passage from the visible to the invisible, and that is the Shroud of Turin – a holographic image of a body anti-gravitationally suspended in midair indicating instantaneous nuclear decay... But this deserves its own report.

## **MODIFICATION**

Transcripts are not always verbatim. Modifications are sometimes made to improve clarity, usefulness and readability, while staying true to the original intent.

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