TEMPERATURE INVERSION

The little known killer

QUAMRUL HAIDER, *Ph.D*

NORMALLY, air temperature decreases with altitude, from roughly 20 degrees Centigrade at sea level to - 60 degrees Centigrade up to an altitude of 10 kilometers. During this normal cycle, a parcel of warm air will float upward in an ambient atmosphere of colder air. If temperature drops steeply, the atmosphere becomes unstable, causing air from near the surface to rise quickly and be replaced by cooler air sinking from above. In the process, the air will carry pollutants with it and disperse them at higher altitudes. The unstable condition is desirable because it leads to a relatively pollution-free lower atmosphere. Occasionally, air temperature will increase with altitude, resulting in colder air near the ground and warmer air above it. This is called temperature inversion - collision between pollution and weather that creates warm-air lid over cooler air. It can occur anywhere from ground level up to few thousands of feet into the atmosphere

Temperature inversions are of great concern. In an area experiencing inversion, the warm-air lid prevents ground-level air from rising. Hence, the cool, dense ground air cannot mix vertically. The air is so stable that it is quiescent and pollutants become trapped below the warm layer of air, creating dirty air with dangerous concentrations of noxious pollutants. A hazy sky or a crimson colored sunset is an indication of inversion somewhere in the lower atmosphere. In areas with heavy pollution, problems with smog will be exacerbated by the presence of an inversion layer. If humidity in the cooler layer is high, thick ground-level fog will form. Temperature inversions are generally witnessed during winter months, when nights are long and cold. Inversion begins to form a few hours before the Sun sets. During

the day, the ground heats up more quickly than air. As the day ends, the air near the ground cools faster than the air above it. Making matters worse, inversions also coincide with the evening commute when pollution emissions from automobiles peak. The situation is reversed in the morning when sunlight strikes the Earth and vertical mixing begins. However, if there is a cloud cover, the ground does not warm up and the pollutants remain trapped. The duration of inversion can vary from few hours to several days. Temperature inversions can create extreme weather conditions. One example is freezing rain. Since inversion blocks an area's normal convection patterns of the air, it can give rise to intense thunderstorms and tornadoes. Temperature inversions in summer can be more troubling because sizzling temperatures will aggravate the already elevated level of pollution. Inversions are also common in mountainous regions where the Sun is obstructed by the mountains and therefore unable to warm the ground to stimulate vertical mixing. They can occur in coastal areas too where upwelling of cold water can decrease surface air temperature and the cold air mass stays under warmer ones. If inversion condition in an area persists for long periods, it will have severe impact on human health. It can cause respiratory problems, burning eyes, and even death. Studies by scientists at the Paris Cardiovascular Research Center found that for a rise in the concentration of pollutants by 10 micrograms per cubic meter, the risks of heart attack in a healthy person during episodes of temperature inversion increases by 5 percent. The most devastating incident of temperature inversion occurred in London on December 4, 1952. Sulfur dioxide and other particulates from burning coal, and the usual pollutants of a big city accumulated and remained trapped for four days. The noxious, lethal smog was so thick that people were unable to see their feet as they walked. "Now yellow, now amber, now black, the great killer held London in its grip, and by early evening, only twelve hours after its onset, the first of the city's inhabitants began to die." The deadly impact of inversion was realized when funeral homes ran out of coffins and florists out of flowers. At the end of the four-day period, an estimated 4000 thousand people died. In addition, thousands became seriously ill and died months later.

Finally, recent dense fogs in Bangladesh have an eerie resemblance to the Donora Death Fog of 1938 in Pennsylvania. It is attributed to temperature inversion and claimed 20 lives. We have a propensity to forget that "if the pollutants we put into the air are harmful to us during a temperature inversion then they are harmful to everyone all of the time."

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GETTING DIRTY

Kilogram gaining weight?

The international prototype kilogram.

THE kilogram may need to go on a diet. The international standard, a cylinder-shaped hunk of metal that defines the fundamental unit of mass, has gained tens of micrograms in weight from surface contamination, according to a new study.

As a result, each country that has one of these standard masses has a slightly different definition of the kilogram, which could throw off science experiments that require very precise weight measurements or international trade in highly restricted items that are restricted by weight, such as radioactive materials.

But ozone and ultraviolet light could be used to clean the kilograms without damaging them, the research suggests.

The cleaning technique, described in the January issue of the journal Metrologia, may eventually be widely adopted as a way to keep the fundamental unit of mass more consistent. [What's That? Your Physics Questions Answered]

In addition, since it uses "equipment that one could come by without too much investment of time and money," it is a practical technique that could be widely adopted, said Richard Davis, a metrologist who consults for the International Bureau of Weights and Measures in Paris, who was not involved in the study.

Source: **Live Science**

THE BLACK CAT

Chasing the Higgs boson: How it all began

DR. LASHKAR KASHIF

THE Higgs boson, dubbed the 'God Particle', has been much in the news during 2012. The discovery, announced on July 4, became Science magazine's Discovery of the Year, and the boson was briefly considered for the honor of Time's Person Of The Year. Being a member of the ATLAS experiment at CERN and directly involved in a Higgs discovery analysis, I was fortunate in getting a first-hand experience of the tremendous excitement and elation that have pervaded the atmosphere here over the past months.

This article is a not-too-technical exposition to the Higgs boson. This installment gives a summary of the Higgs mechanism and an introduction to CERN, the LHC and the experiments.

The Higgs mechanism

The Higgs mechanism is an integral part of the Standard Model of Particle Physics, which attempts to describe all elementary particles and their interactions. Elementary particles are entities that cannot be broken down further; to the best of our current knowledge, these are six quarks, six leptons, four force carriers or 'gauge bosons', and the newly-discovered Higgs boson. The Standard Model was devised in the 1960s, principally owing to the work of Sheldon Glashow, Steve Weinberg and the late Abdus Salam from Pakistan. As an aside, the word 'boson' was coined after our own Satyen Bose, a Bengali and a former professor and Chair in the Physics Department at Dhaka University. Prof. Abdus Salam was a Foreign Fellow of the Bangladesh Academy of Sciences, and remains the only Muslim to have received a physics Nobel Prize.

A central question that the Standard Model must answer is: how do particles acquire mass? In particular, the Model contains the massless photon, and two other gauge bosons named the W and the Z, which are massive. Since all three are carriers of the electroweak interaction, how would the W and the Z acquire mass if the photon is to remain massless? The Higgs mechanism, first proposed in 1964 by Peter Higgs and others, was adapted by Weinberg and Salam to answer this question. (The story is a bit more complicated, but this captures the essence.) The mechanism invokes a Higgs field, whose presence breaks the electroweak symmetry in such a way

An aerial view of the Swiss-French border region, with the LHC schematically superimposed. Lake Geneva is visible in the top-right corner.

as to yield one massless boson and two massive bosons, one of which has so-called longitudinal and transverse polarization modes. The process is known as spontaneous symmetry breaking, occurs in many contexts of physics, and is one of the most elegant theoretical mechanisms ever developed.

We physicists adore economy. We want to economize on the content of any theory: the fewer parameters, particles and interactions needed in a theory, the better. Therefore, once the Higgs mechanism was invoked to explain the masses of the gauge bosons, the natural question was whether it can explain the masses of all elementary particles. It turns out that, within the Standard Model, it can do so. Strictly speaking, the Higgs mechanism is not necessary to generate masses for the quarks and leptons, but it is economic if a single mechanism can explain their masses in addition to those of the massive bosons, and so it came about that this mechanism was hypothesized to give masses to all elementary particles.

So much for the Higgs mechanism; what is the Higgs boson? In particle physics, every field is associated with a field particle, and the Higgs boson is the particle associated with the Higgs field. More formally, the spontaneous breaking of electroweak symmetry leaves an elementary scalar particle in addition to the gauge bosons, this scalar being the Higgs boson. By the mid-1990s, all particles of the Standard Model had been discovered, except for the Higgs. But this was a crucial missing part, since unless the existence of the Higgs boson was confirmed, we would not know the mechanism of electroweak symmetry breaking, upon which the Standard Model is largely based. The Large Electron Positron (LEP) collider in Europe and the Tevatron collider in the US were unable to find the Higgs after two decades of search. Then the Large Hadron Collider turned on in 2010.

CERN and the Large Hadron Collider

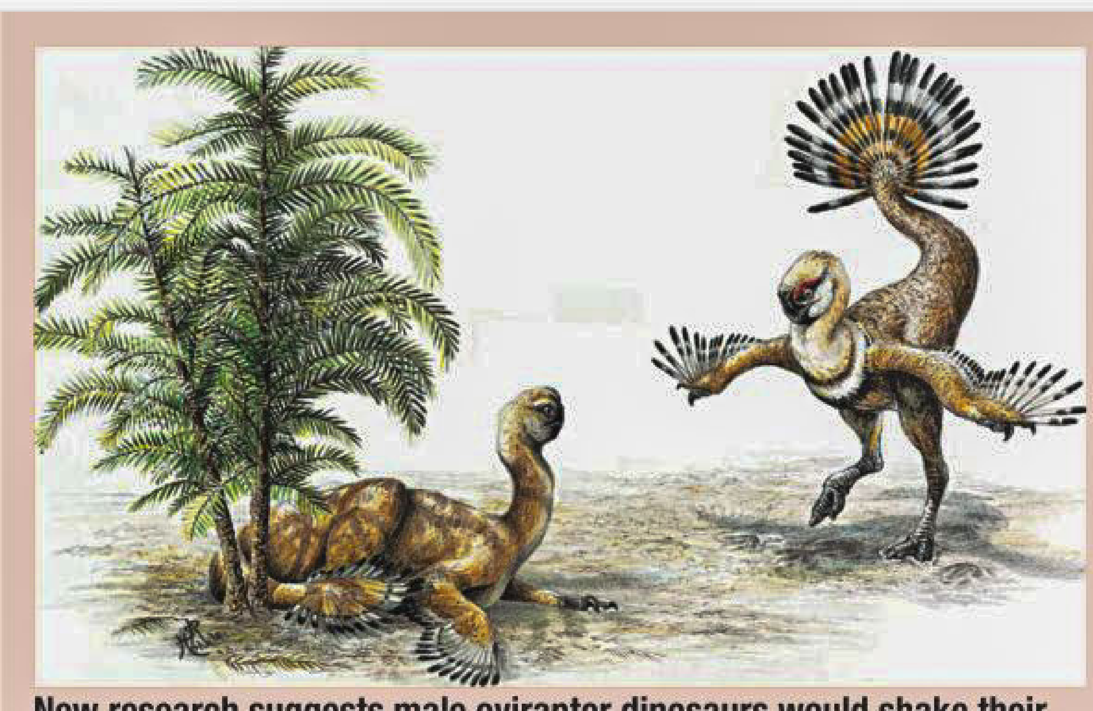
The European Council for Nuclear Research (CERN) is located partly in Geneva, Switzerland and partly in nearby France. It has twenty member states, all European countries, plus a number of so-called observer states. Together, the member and observer states provided the funding and technical expertise required to build the Large Hadron Collider (LHC), easily the most complicated single machine ever built. The LHC is a circular collider, 27 kilometers in circumference, situated 80-175 meters underground, and is by far the highest-energy particle accelerator on earth. It collides protons with protons at a center-of-mass energy of 8 TeV, which is the energy particles had less than a 100 trillionths of a second after the Big Bang. To rephrase, the LHC is able to recreate the conditions in the universe immediately after the Big Bang.

The LHC, however, is simply a tool to collide protons; we need more than the LHC to do physics. The collisions create heavy particles that have not existed since right after the Big Bang, and these particles decay to lighter particles that we can detect. This detection requires massive particle detectors, also called experiments. There are four particle detectors at the LHC, with cryptic names like ATLAS, CMS, ALICE and LHCb. ATLAS and CMS are so-termed general-purpose detectors, built to enable us to perform a wide range of physics analyses. Being a member of the ATLAS collaboration, I will give a short introduction to the ATLAS detector. ATLAS stands for A Toroidal Lhc ApparatuS, the largest particle detector ever constructed. A cylindrical apparatus built in a number of layers, it stands 7 stories tall, weighs about 7000 tons, and took 22 years to design, prototype, build, assemble and commission. The detector has close to a 100 million data-taking channels, which record particle collisions occurring 400 million times every second, 24 hours a day. At this time, about 3200 physicists from 176 institutes in 38 countries are members of the ATLAS collaboration. The CMS detector and collaboration are of similar size and complexity.

The first physics run of the LHC started in March 2010 and ended in December 2012, with some very impressive results. A major goal of the run was the discovery of the Higgs boson, which was achieved independently by the ATLAS and CMS collaborations. I want to emphasize here that the driving force behind this accomplishment was not senior scientists but young physicists: PhD students and post-doctoral researchers.

The writer did his undergraduate studies at Yale University, received a PhD in Physics from Harvard University, and is now a postdoctoral researcher with CERN/University of Wisconsin-Madison. He is based at CERN in Geneva, Switzerland.

PLUMED LIZARD



New research suggests male oviraptor dinosaurs would shake their tail feathers to woo potential female mates

Dancing Dinos

Feathered dinosaurs might have used muscular tails to shake tail feathers and lure the opposite sex, researchers say.

Scientists analyzed 75-million-year-old fossils of feathered, two-legged dinosaurs known as oviraptors retrieved during expeditions to the Gobi Desert in Mongolia. Although oviraptors were members of the meat-eating theropods, making them relatives of such fearsome predators as T. rex and Velociraptor, most oviraptors had beaks that lacked teeth.

Source: **Live Science**

DID YOU KNOW?

What is graviphoton?

In theoretical physics, a graviphoton (aka gravivector) is a hypothetical particle which emerges as an excitation of the metric tensor (i.e. gravitational field) in spacetime dimensions higher than four, as described in Kaluza-Klein theory. However, its crucial physical properties are analogous to a (massive)photon: it induces a "vector force", sometimes dubbed a "fifth force". Theelectromagnetic potential emerges from an extra component of the metric tensor , where the figure 5 labels an additional, fifth

dimension.

In gravity theories with extended supersymmetry (extended supergravities), a graviphoton is normally a superpartner of the graviton that behaves like a photon, and is prone to couple with gravitational strength, as was appreciated in the late 1970s.[2] Unlike the graviton, however, it may provide a repulsive(as well as an attractive) force, and thus, in some technical sense, a type ofanti-gravity. Under special circumstances, then, in several natural models, often descending from five-dimensional theories mentioned, it may actually cancel the gravitational attraction in the static limit.