

Impending solar storm

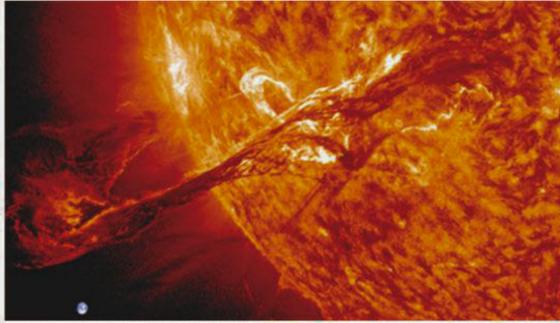
QUAMRUL HAIDER, Ph.D

THE end of the 5,126-year long Mayan calendar on December 21, 2012 was interpreted by many as the day Earth would cease to exist. The doomsday of Mayan calendar has come and gone. But the apocalyptic fears for a calamitous end of the world did not materialize. The Earth is still spinning and orbiting the Sun.

However, fears of an Armageddon have been heightened once again after NASA issued a bulletin warning that the Earth could be subjected to a solar storm of biblical proportions this year. If there is a direct hit, the impact could be catastrophic, costing trillions of dollars in damage to our economic and high-tech infrastructures and affecting some hundreds of millions of people. The doomsday believers are once again speculating that fall-out from the ominous solar storm could be the end of our planet.

A solar storm consisting of many solar flares is the most violent form of solar activity. A flare occurs when magnetic energy that has built up in sunspots is suddenly released. First discovered by Galileo in 1610, sunspots are relatively cool, dark floating islands of electromagnetic storms on the surface of the Sun called the photosphere. Near large sunspots, about a hundred flares occur each day. Typical length and width of a flare are 30 and 15 Earths stacked end to end, respectively.

A flare, accompanied by a burst of ultra-high speed protons and electrons, together with X-rays, ultraviolet, and visible radiation, is followed by a colossal amount of coronal mass ejection (CME). The energy packed in a large flare is equivalent to a nuclear explosion magnified a billion-fold! Relax, the entire energy does not reach the Earth; substantial amount is used up in heating the space surrounding the Sun, its corona (a tenuous uppermost layer of the solar atmosphere) and beyond to 100 million degrees Centigrade.



Solar flare on August 7, 2012

As the flare races toward Earth, its radiation and CME rip through the upper atmosphere and ionize neutral atoms by removing electrons from them. Most CME's take 18 to 30 hours to reach the Earth. Luckily Earth's magnetosphere guards us from the hazards of such outbursts by absorbing the worst of the radiation. Occasionally, charged particles flowing outwards from a CME escape into the solar wind. If the charged solar wind reaches the Earth, electrons in the wind collide with atmospheric atoms and excite them. The atoms quickly de-excite, emitting visible radiation which gives rise to a spectacular display of colors - auroras (borealis or australis) in the sky.

Flares are most common when numerous sunspots are visible on the solar surface. The time interval between waxing and waning of flares, called solar or sunspot cycle is approximately 11 years. The largest solar storm on record occurred in 1859. It was called the Carrington Event, named after the British Astronomer Richard Carrington, the discoverer of solar flares. It bathed "two-thirds of the Earth's skies in a blood-red aurora a night later, and crippled all of global navigation and global communication, such as it was at that time."

Two recent massive storms that pummeled the Earth are the Great Aurora of March 1989 and the Halloween Sun Storm of October 2003. The "geomagnetic storm" of 1989 blacked out lights for millions of people in Québec, Canada. Its violence marked the prelude to the solar activity cycle that peaked in July 1989. The Halloween storm disabled many satellites and damaged instruments on a Mars orbiter.

Between 2007 and 2009 the number of sunspots was at a minimum and solar activity went into hibernation. There were practically no flares of consequence during this time. The Sun came out of dormancy last year, spewing off numerous powerful flares, but the gigantic one is waiting in the wings for this year.

NASA believes that the size of the impending solar storm will eclipse the Carrington Event. If the storm hits the bull's-eye, it will disrupt everyday life and leave global economy in a bedlam. The energy released by the storm will cripple Earth's technological infrastructure, mess up satellites, radio communications, internet, and navigation signals from GPS satellites, halt aviation and severely damage electric power grids.

So are we going to witness the end of the world this year? The doomsday prophets will once again be disappointed. The thought of a solar Armageddon in 2013 is far-fetched because the thousands of miles thick magnetosphere 40,000 miles above won't fail us. Besides, lot of the CME is faced away from Earth and consequently the danger is lessened. In fact, other than the usual inconveniences caused by solar storms, we will be entertained to a dazzling show of the auroras. Nonetheless, in the future we can expect a monstrous solar storm that would make the Carrington Event look like a rain shower.

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TOOTHY TALE

Wings and teeth

A newly discovered bird of the dinosaur age, identified from a fossil, had some of the most elaborate teeth ever seen in a bird, scientists say.



Artist's reconstruction of Sulcavis georum in flight.

What makes it all the more interesting, they add, is that this bird flourished at a time when other bird species had already begun an evolutionary journey toward toothlessness.

"Maybe differences in diet played a part" in explaining the unusual features of the species, said Jingmai O'Connor of the University of Southern California, lead author of a new study on the findings.

Published in the latest issue of the Journal of Vertebrate Paleontology, the analysis suggests the animal, called Sulcavis georum, lived on a tough diet that may have included crabs. The researchers believe the teeth of the new specimen greatly increase the known diversity of tooth shape in early birds, and hints at previously unrecognized ecological diversity.

The fossil hails from the early Cretaceous era, an estimated 121-125 million years ago, from what is now Liaoning Province, China. The bird is believed to a member of a lineage known as Enantiornithines, the most numerous birds from the time of the dinosaur.

Source: World Science



THE ENO GAME

Homing in on the Higgs boson

DR. LASHKAR KASHIF

THE Higgs boson cannot be seen or detected directly. Being a heavy particle (about 125 times as heavy as a proton), it decays to lighter particles immediately after being created in a collision. Some of these decay products may decay to yet lighter particles. Depending on the final decay products, a number of techniques have been developed to search for the Higgs. There are five important search channels, with the Higgs decaying into:

- two photons (diphoton channel),
- two Z bosons, each of which decays into two electrons or two muons (4-lepton channel),
- two W bosons, each of which decays into an electron or a muon and a corresponding neutrino (lνlν channel),
- two tau leptons, which can decay in various ways (tautau channel),
- two bottom quarks, with the Higgs being produced in association with a W or a Z boson (bb channel).

Of these, the first two channels are the most sensitive, in that they provide the cleanest signatures of Higgs-like events. In each of these two channels, a number of events were found that looked very Higgs-like.

But when and how was it decided that a particle had been discovered?

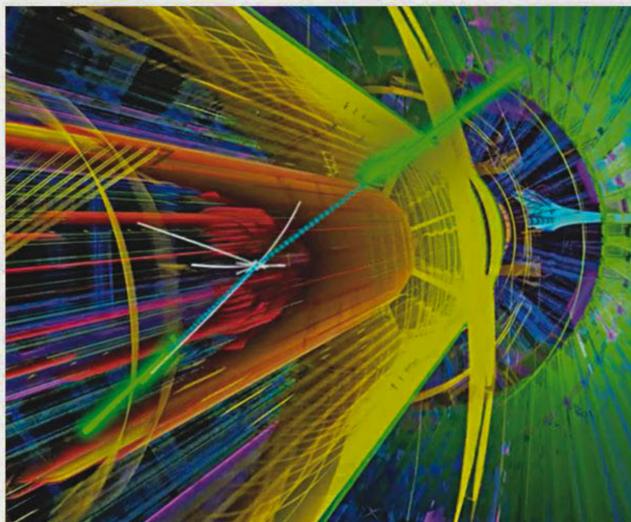
In high-energy physics, a specific quantitative measure is used to determine whether or not a discovery has occurred. This is necessary because, for example, events that are not from Higgs boson decays can look like Higgs decays, thus generating a fake Higgs signal. A particular set of events constitutes a discovery when the probability of these events being fakes is less than about 3 parts in 10 million. This is a very small number, and means that the analyzers are highly confident that what they see is a real signal. This probability is interpreted in terms of a significance: the significance necessary to claim a discovery is 5 sigma.

With the data collected by June 2012, ATLAS found

that while the diphoton and 4-lepton channels individually had significances of less than 5 sigma, a combination of the two yielded a significance of 5 sigma. At that point, ATLAS was ready to declare a discovery. Meanwhile, the CMS experiment had been analyzing their own data, and they also found that a combination of the diphoton and 4-lepton channels gave 5 sigma significance. So the ATLAS results were independently confirmed.

Moreover, the mass of the Higgs boson measured in each of the two channels by each experiment was around 125 GeV, which strengthened our conviction that we are all seeing the same particle. For comparison, the mass of a proton is a little less than a GeV.

The two experiments announced their discoveries in a heavily attended seminar at CERN on the morning of July 4, 2012. I have written about my emotions and experiences on that day previously in a short article, so I will not repeat them, except to say that this was the event of a lifetime in a very true sense.



An event display of a Higgs boson decaying to two energetic photons in the ATLAS detector. The cylindrical surfaces denote layers of the detector. The proton-proton collisions occur in the center of the detector, from where a numbers of lines are seen to emerge, each line representing a particle. The photons from the Higgs decay are indicated by the blue dotted lines ending in bright green lines.

Progress since the discovery

The Higgs discovery was not the end of the story by any means, since much remained to be done. For a starter, it is not known for certain that the discovered particle is in fact the Higgs boson predicted by the Standard Model: there are many models of particle physics that go beyond the Standard Model and predict one or more Higgs or Higgs-like particles. To ascertain whether this is

the Standard Model Higgs, it has to be observed in all five of the decay modes listed in the previous section.

Since July 2012, a large amount of additional data has been collected, and the search for the Higgs in the lνlν, tautau and bb channels has continued in addition to the two sensitive channels. None of the less sensitive channels is able to discover the Higgs on its own as yet, but some of them show hints of a Higgs signal. With all channels combined, the significance currently stands at 7 sigma, meaning that the probability of the discovery being spurious is 1 part in a trillion!

Another important step is the measurement of the spin and parity quantum numbers of the discovered particle. Any Higgs-like particle must have spin 0, while the Standard Model Higgs must have even parity. These measurements have already started. At this point, it is definitely starting to look like the Standard Model Higgs, or at least a very Standard Model-like Higgs.

What lies ahead...

2012 has been a phenomenal year for us; Higgs search and measurement results using the full 2012 dataset will be presented at major conferences in the spring and summer of 2013. It is expected that these measurements will go a long way toward answering the vital question: is this the Standard Model Higgs?

Notwithstanding, a full closure of the issue will require much more data than we have now. After a two-year break for upgrades, the LHC will start taking data again in 2015, at the substantially higher collision energy of 13 TeV. The event rate will also be higher, leading to a faster accumulation of Higgs-like events. We will be prepared to analyze these events, increase the accuracy of our measurements and explore the Higgs sector in detail.

Throughout all the Higgs excitement, we firmly keep in mind that this is only one of the principal goals of the LHC. High-energy physics at this crossroads faces a number of intriguing questions: What constitutes the so-called Dark Matter? Is SuperSymmetry a fuller explanation of nature than the Standard Model? Are quarks and leptons really elementary particles, or are they composed of something even more fundamental? We will be looking to answer these questions and more as the LHC program continues through the 2010s, the 2020s and possibly the 2030s.

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.



SPACE BEHEMOTH



KHOWA KHOWA KHOWA?

Largest spiral galaxy

Astronomers have crowned the universe's largest known spiral galaxy, a spectacular behemoth five times bigger than our own Milky Way.

The title-holder is now NGC 6872, a barred spiral found 212 million light-years away in the southern constellation Pavo, researchers announced on Jan. 10, 2013. The distance between NGC 6872's two huge spiral arms is 522,000 light-years, compared to about 100,000 light-years for the Milky Way.

NGC 6872 has ranked among the largest known spiral galaxies for decades. But it has only now been crowned champion, after detailed study of data gathered by a number of instruments, including NASA's Galaxy Evolution Explorer spacecraft, or GALEX.

What are marsupials?

Marsupials are an infraclass of mammals living primarily in the Southern Hemisphere; a distinctive characteristic, common to most species, is that the young are carried in a pouch. Well-known marsupials include kangaroos, koalas, possums, opossums, wombats and the Tasmanian devil. Marsupials represent the clade originating with the last common ancestor of extant metatherians. Like other mammals in the

Metatheria, they are characterized by giving birth to relatively undeveloped young, often residing in a pouch with the parent for a certain time after birth. Close to 70% of the 334 extant species occur in Australia, New Guinea, and nearby islands, with the remaining 100 found in the Americas, primarily in South America, but with 13 in Central America, and one in North America, north of Mexico.



Female Eastern Grey Kangaroo with a joey in her pouch.

The spiral is 522,000 light-years across from armtip to armtip, which makes NGC 6872 about 5 times the size of the Milky Way.

SOURCE: LIVE SCIENCE