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Universe in age crisis!

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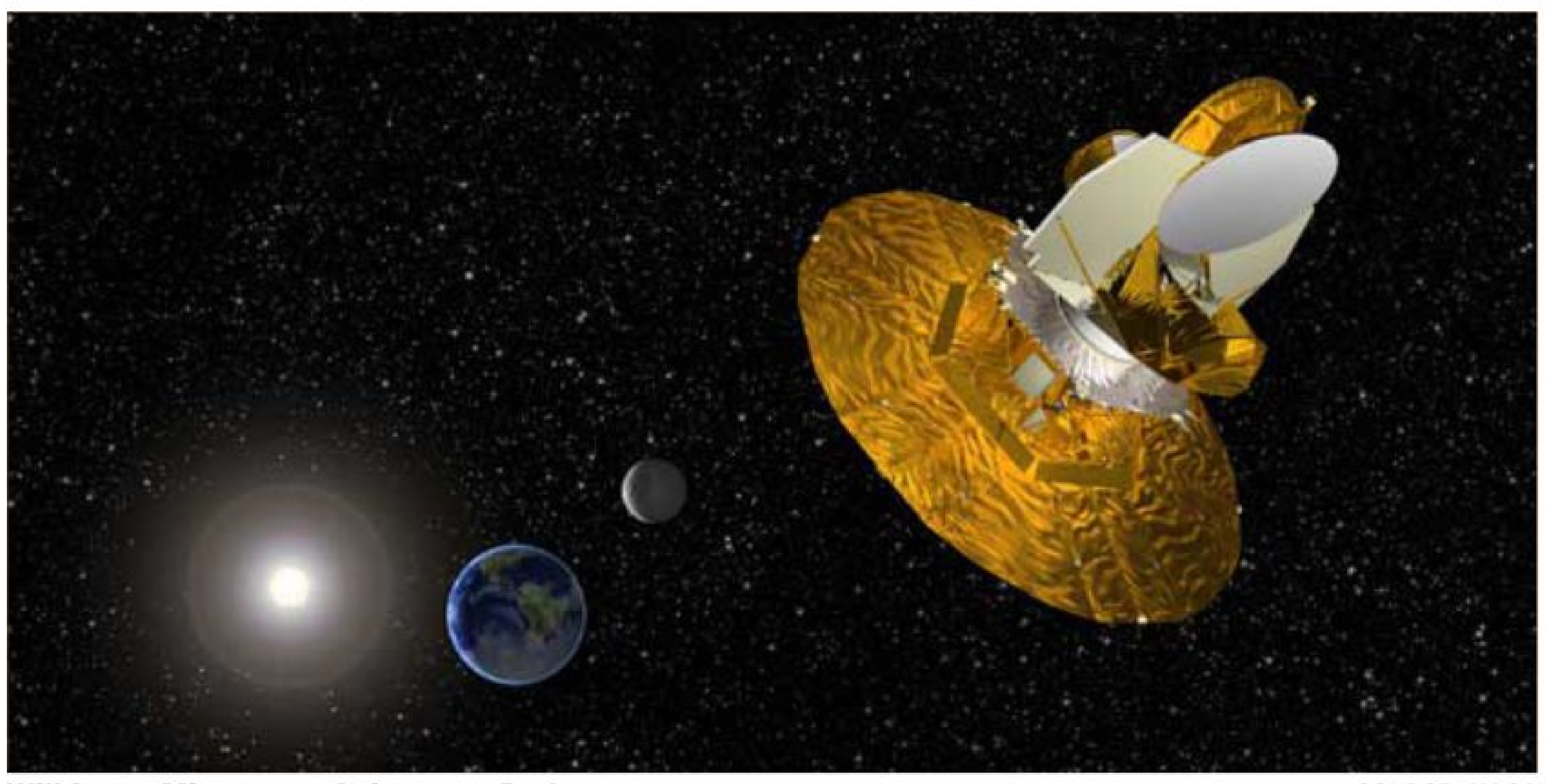
How old is the Universe? How long ago did the Big Bang take place? It may seem like a daunting task to date the birth of something as vast and all-encompassing as the Universe. But according to Edwin Hubble, the indisputable father of modern astronomy, it is not.

In 1929, Hubble observed that light and radiation from distant galaxies are red-shifted. A red shift is drift of the wavelength toward longer values if sources of radiation are receding from the observer. The red shift together with cosmic microwave background radiation (CMBR) cold remnants of the hot and highly energetic radiation that emanated after the Big Bang and red-shifted to low-energy, long wavelength microwaves are proof that the Universe is expanding and its contents are moving away from us. In fact, red shift and CMBR are the living storytellers of the Universe. They tell us that before birth, the Universe was a mathematical singularity with all the mass concentrated into an effectively zero volume. The Universe, therefore, has a finite age.

Hubble also found that there is a direct correlation between the distance of a galaxy and its speed of recession. Galaxies nearer to us are moving away slowly, whereas more distant galaxies are rushing away from us rapidly. If their distance from us and speed of recession can be measured, we can use them as clocks to determine the age of the Universe.



Wilkinson Microwave Anisotropy Probe SOURCE: NASA

Hubble discovered that the ratio of the speed of recession to the distance of a galaxy is constant, known as the Hubble constant. If the constant is 100 km/second/Megaparsec, it implies that for every Megaparsec (19 million trillion miles) of distance, the velocity increases by 100 km per second. Thus the constant gives the current expansion rate of the Universe. The constancy of the ratio ensures that Hubble constant will be same for any pair of galaxies. The reciprocal of the constant has the dimension of time and is called "Hubble time." It is a measure of the age of the Universe.

The Hubble constant is determined from the best fits to the large body of data on galactic speeds and distances gathered by NASA's Wilkinson Microwave Anisotropy Probe (WMAP) spacecraft. The data is obtained by analyzing the warmer and cooler spots of the Big Bang's CMBR across the sky. From the fits, the expansion rate is found to be 71 km/second/Megaparsec with accuracy within ± 1%. To convert Hubble's unconventional unit to years, multiply Hubble time by 976 billion.

According to the Standard Cosmological Model (Big Bang), the age of the Universe depends on its shape. (See Is the Universe closed or open? TDS June 26, 2012.) The age of an "open," low-matter density Universe, expanding forever at a constant rate, is simply the Hubble time 13.7 billion years. The age of a "flat" Universe, barely managing to continue expanding forever is two-third of the Hubble time 9.2 billion years. Because of its higher density, a "closed" Universe decelerates rapidly. Consequently, it has been expanding for a shorter time, making it younger than a flat Universe. Its age is half of Hubble time 6.85 billion years.

Astronomers are uncomfortable with these estimates of the age, particularly for the flat and closed Universe, because they are less than the age of some of the oldest stars. Clearly, the Universe cannot be younger than the oldest objects it contains. This is equivalent to saying that the child is older than the biological mother.

Apparently the Universe is suffering from an age crisis. The crisis can be resolved once the actual shape of the Universe is pinned down. That will require an accurate computation of the matter density with the inclusion of all the matter in the Universe visible, invisible, "dark," etc. Meanwhile, there is no reason to doubt the value of Hubble constant as it is deduced from the most reliable source, CMBR.

Finally, Hubble constant should decrease with time. Otherwise, the Universe will not age; it will forever remain stuck at one of the ages mentioned above. In that sense, it is really not a constant but a parameter.

"Age is an issue of mind over matter. If you don't mind, it doesn't matter." Mark Twain.

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LEADING LIGHTS

Usher of modern Physics

SIR Isaac Newton was an English physicist, mathematician, astronomer, natural philosopher, alchemist, and theologian. He is considered to be one of the most influential scientists, who ever lived. He was born on December 25, 1642 in Wools Thorpe. He described universal gravitation and the three laws of motion. These theories dominated the scientific view of the physical universe for the next three centuries. His monograph Philosophiæ Naturalis Principia Mathematical was published in 1687 for most of classical mechanics.

Sir Isaac Newton PHOTO: AFP

Newton built the first practical reflecting telescope and developed a theory that a prism decomposes white light into the many colours that form the visible spectrum. He also formulated an empirical law of cooling and studied the speed of sound.

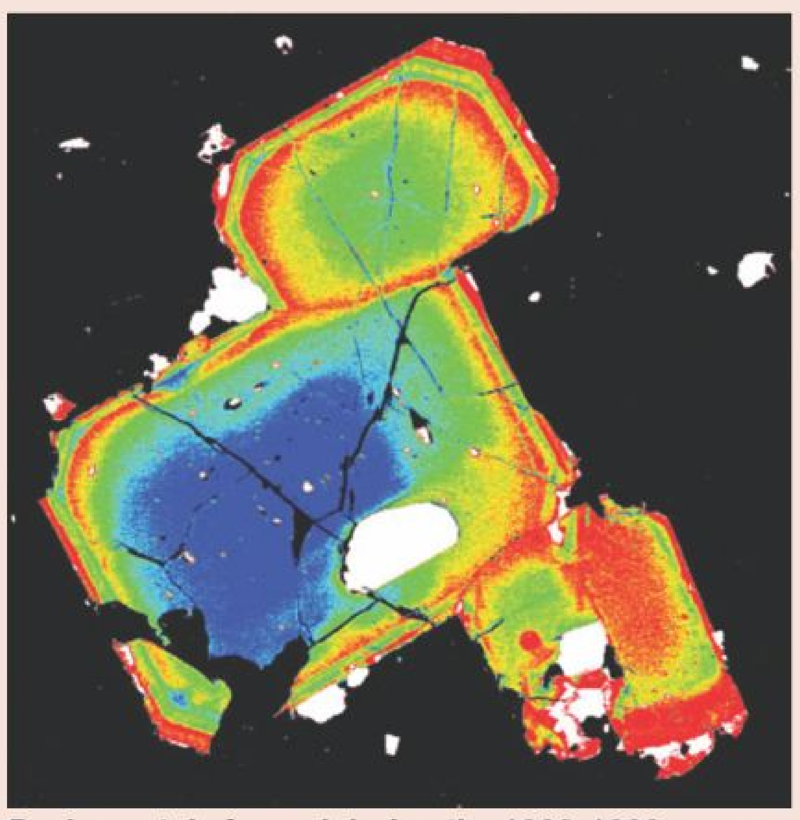
He showed that the motions of objects on Earth and of celestial bodies are governed by the same set of natural laws, by demonstrating the consistency between Kepler's laws of planetary motion and his own theory of Gravitation, thus removing the last doubts about heliocentrism and advancing the Scientific Revolution.

Sir Newton was educated at Trinity College, Cambridge, where he lived from 1661 to 1696. In 1696 he was appointed Master of the Royal Mint, and moved to London, where he resided until his death. Beginning in 1714 he served on the government's Board of Longitude. Later, on March 20, 1727, he died in London and was buried in Westminster Abbey.

Sources: Wikipedia, and www.nahste.ac.uk

TELLER ROCK

Linking magma to quakes



Rock crystals formed during the 1980-1986 eruption of Mount St. Helens.

Active volcanoes shake, rattle and roll; scientists can't always be sure whether such activity indicates that molten rock is rising. Now, volcanologists have linked earthquake swarms at Mount St. Helens in Washington state with fresh magma pulses. A team led by Kate Saunders of the University of Bristol in England studied more than 300 rock crystals formed during the 1980-1986 eruption of Mount St. Helens.

These crystals (one shown), of a mineral called orthopyroxene, grow in zoned "rims," each formed as fresh magma arrives from below and cools. Saunders' team calculated when the crystals grew and compared that with the timing of small earthquakes shaking the mountain. In many cases the crystal rim growth and seismic swarms matched, the team reports in the May 25 Science. Studying crystals erupted from other volcanoes could help scientists better understand how often new magma arrives, Saunders says.

GOD PARTICLE

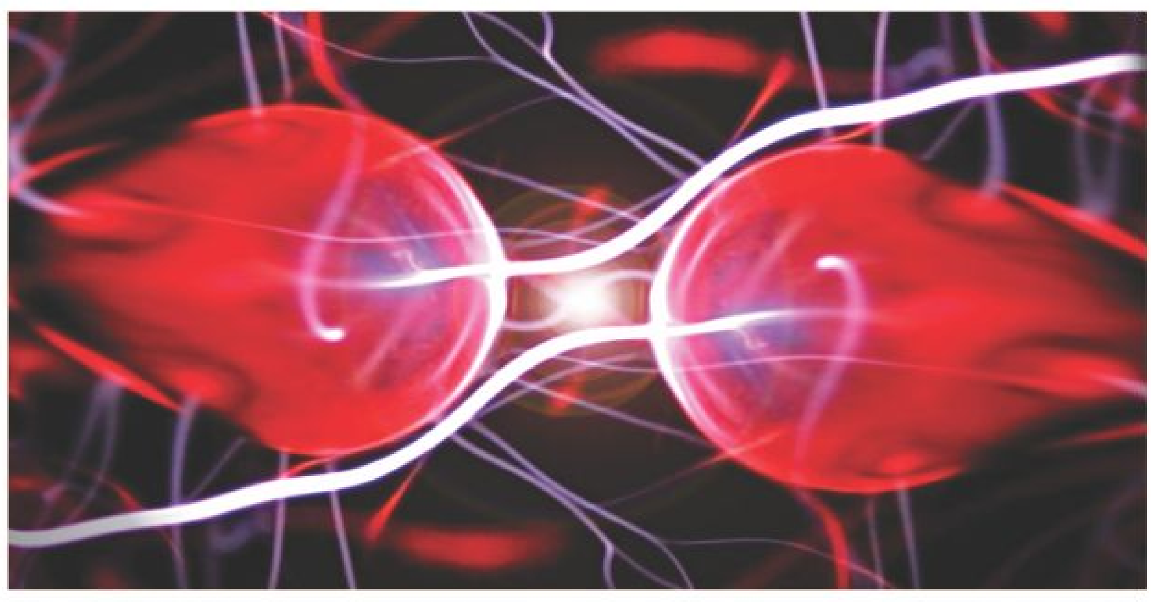
What Is the Higgs Boson?

In 1964, the British physicist Peter Higgs wrote a landmark paper hypothesizing why elementary particles have mass. He predicted the existence of a three-dimensional "field" that permeates space and drags on everything that trudges through it. Some particles have more trouble traversing the field than others, and this corresponds to them being heavier. If the field later dubbed the Higgs field really exists, then Higgs said it must have a particle associated with it: the Higgs boson.

Fast forward 48 years: On Wednesday (July 4), physicists at the Large Hadron Collider (LHC), the world's largest atom smasher in Geneva, Switzerland, announced they had discovered a Higgs-like particle at long last. If the new particle turns out to be the Higgs, it will confirm nearly five decades of particle physics theory, which incorporated the Higgs boson into the family of known particles and equations that describe them known as the Standard Model.

The search for the Higgs gained a level of public attention unusual for physics partly thanks to the physicist Leon Lederman's 1993 book "The God Particle" (Dell Publishing). Lederman gave the Higgs its godly nickname because the particle is "so central to the state of physics today, so crucial to our final understanding of the structure of matter, yet so elusive," he wrote in the book. However, he quipped that the second reason was that "the publisher wouldn't let us call it the Goddamn Particle, though that might be a more appropriate title, given its villainous nature and the expense it is causing."

Indeed, the Higgs boson eluded detection through the construction and shutdown of two expensive high-energy particle colliders built partially for the purpose of detecting it. In these colliders, particles are accelerated through a tunnel and then smashed together, producing an excess of energy that sometimes takes the form of new and exotic particles. Only the Large Hadron Collider at CERN Laboratory, the most powerful particle collider ever built, turned out to probe energies high enough to generate a Higgs particle, which is roughly 125 times the mass of a proton. [What If You Put Your Hand in the LHC Beam?]



Artist's conception of a particle collision.

But what does the Higgs particle actually do? How does it, and the Higgs field associated with it, give things mass?

In physics, when particles interact with fields, the interaction must be mediated by a particle. Interactions with the electromagnetic (EM) field, for example, are mediated by photons, or particles of light. When a negatively charged electron is pulled by the EM field toward a positively charged proton, the electron experiences the EM field by absorbing and emitting a constant stream of "virtual photons" photons that momentarily pop in and out of existence just for the purpose of mediating the particle-field interaction. Furthermore, when the EM field is "excited," meaning its energy is flared up in a certain spot, that flare-up is, itself, a photon a real one in that case.

Along the same lines, the Higgs particle mediates interactions with the Higgs field, and is itself an excitation of the Higgs field. Particles are thought to trudge through the Higgs field (thereby acquiring mass) by exchanging virtual Higgs particles with it. And, the thinking goes, a real Higgs particle surfaces when the field becomes excited, flaring up with energy in a certain spot. Detecting such a flare-up (i.e. the particle) is how physicists can be sure the field itself exists. At the LHC, they managed to bash atoms together hard enough to generate, for a fleeting instant, a 125 giga-electron-volt excitation of what was likely the Higgs field. The flare-up had all the trappings of a Higgs boson.

Source: Live Science

NO MAN'S LAND

Cosmic Censorship Hypothesis

Ultimate mystery

OBAIDUR RAHMAN

What is cosmic censorship? It is a hypothesis, developed in 1969 by British physicist Roger Penrose. It states that the Universe contains no singularities that are visible to the faraway observer, especially from the vicinity of a black hole. All the familiar singularities are located at the center of a black hole, which are hidden behind the event horizon that makes it invisible. Since what goes on in the region of singularity (a point in space-time at which the space-time curvature becomes infinite) is completely hidden from observation, we cannot see the comic events that take place inside that region. And this cosmic "unseeing" is referred to as cosmic censorship hypothesis and the singularities are called naked singularities.

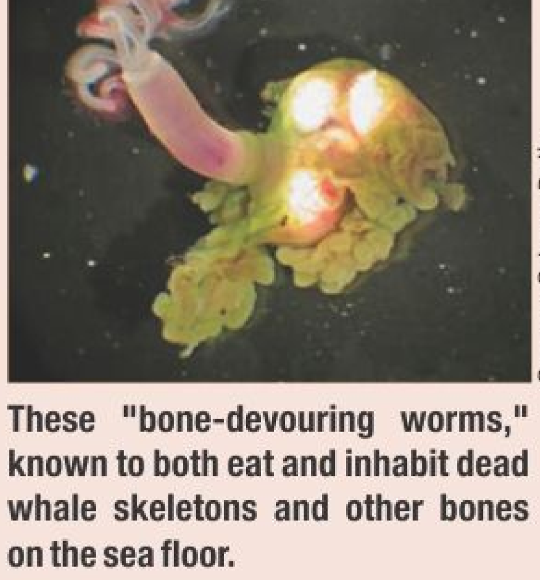
At the singularity, the laws of science and our scientific ability to predict the future break down. And when an observant is stationed outside the black hole, the observer won't be affected by this failure of predictability as neither light nor anything whatsoever will reach him/her from the singularity. And when these naked singularities produced by a gravitational collapse, a celestial-type editing takes place that makes what truly takes place inside the black holes unknowable.

There are actually two kinds of cosmic censorship hypothesis, weak and the strong one. The weak cosmic censorship hypothesis states that no naked singularities other than the singularity created by the Big Bang itself ever existed in the Universe. The argument is: singularities definitely need to be hidden from an observer by the event horizon of a black hole. The strong cosmic censorship hypothesis, which is much more complicated states that given suitable data on a space-like hyperspace (a mathematical object that generalizes the concept of surface from 3-dimentional Euclidean space to hyperspace) is available, the laws of Einstein's general relativity should be able to determine the future evolutionary process of the Universe. The argument here is that while strong cosmic censorship is enforced for all black holes residing in asyndetically flat space-time, it is violated for some other black holes residing in non-asyndetically flat space-time. Scientists suggest that the semi-classical general relativity might enforce strong cosmic censorship hypothesis.

The contributor is a freelance science writer

BONE CHUCK

Acid-wielding worms



Source: Science Daily

These "bone-devouring worms," known to both eat and inhabit dead whale skeletons and other bones on the sea floor.

Tiny 'bone-devouring worms', known to both eat and inhabit dead whale skeletons and other bones on the sea floor, have a unique ability to release bone-melting acid, scientists at Scripps Institution of Oceanography, University of California, San Diego have recently discovered.

The work is being presented at the Society for Experimental Biology's 2012 meeting in Salzburg, Austria.

Dr Sigrid Katz, a postdoctoral researcher working with Greg Rouse and Martin Tresguerres, said: "These worms are unique in using bone as a habitat and nutrient source. We have learned a lot about these worms in the past 10 years, but one of the most intriguing questions has been how they penetrate bone and take up nutrients."

The worms, whose official genus name is Osedax, are up to 3-4 cm long and were discovered on a whale carcass in 2002.

DID YOU KNOW?

Who coined the term Big Bang?

Fred Hoyle

English astronomer and mathematician Sir Fred Hoyle FRS (24 June 1915 20 August 2001) and noted primarily for his contribution to the theory of stellar nucleosynthesis was a strong critic of the Big Bang. He is responsible for coining the term "Big Bang" on BBC radio's Third Programme broadcast at 1830 GMT on 28 March 1949. It is popularly reported that Hoyle intended this to be pejorative, but the script from which he read aloud shows that he intended the expression to help his listeners.