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Fingerprints of a later day big bang

The big bang theory is that the universe started as an intense fireball, whose energy gave rise to all the elements, some 15 billion years ago, says S.Ananthanarayanan.

The theory is now considered ‘confirmed’, largely because scientists have found a faint microwave radiation pervading the universe, which they see as the ‘smoking gun’ or evidence that yes, the universe was once very hot!

Investigating Hiroshima

Scientists at the University of Munich, Germany have succeeded in unearthing similar remains of the first man-made nuclear explosion in Hiroshima, 1945. The explosions of 1945 were the first and purely military application of a technology then barely understood. The scale of destruction and the chain of consequences were as unexpected as they were appalling and eye opening. The reaction immediately after was to render medical help and rehabilitation of victims, and pure researchers did not move in for many years.

The result was that objective assessment of the levels of radiation, which would have aided treatment of survivors, was not made in the early aftermath of the explosions. But important parameters have now been estimated, using roundabout evidence, of how much of an isotope of nickel is found in various bit of metal that were exposed to the explosions.

Neutron damage

The main radiation emitted by the explosions was gamma rays, which are a form X Rays, only even more powerful and damaging, and neutrons. The high-energy neutrons, like the gamma rays, are electrically neutral particles and have long ranges. This makes them deadly to human cells. Knowing what level of exposure to neutrons the present 60,000 survivors of the 1946 bombs were subjected to could help ease their remaining years. More important is that this knowledge could help understand the long-term effects of radiation on people now working in power reactors and laboratories.

The first estimates of the level of neutron radiation were from the scraps of phosphorus collected at the site of the explosions. Neutrons convert phosphorus atoms into radioactive forms and checking how much of these forms were produced indicated how many neutrons there were. But radioactive phosphorus decays fast and by the time the researchers got in, much of the evidence had disappeared. The estimates were thus not reliable.

More durable traces

What the University of Munich scientists have now done is to collect samples of metallic things from the site – bits of lightning conductors, the roof of a shrine, to follow a more enduring trail that neutron radiation leaves in bits of nickel or copper that these metallic things contain.

Nickel is most prevalent in Ni^{58}, the form that has 28 protons, or positive particles, in the nucleus and 30 neutrons. Other stable forms are with 32, 33, 34 and 36 neutrons. But when nuclei of nickel or copper (Cu^{63}, which has 29 protons) are struck by high-energy neutrons, a new, radioactive form of nickel, Ni^{63}, with 28 protons and 35 neutrons, gets produced. When the nuclear bombs went off in Hiroshima and Nagasaki, the spray of neutrons produced Ni^{63} all over the area the explosions affected. Like the forms of phosphorus, Ni^{63} is also radioactive and further, it stays active for a long time, getting half as active only in 96 years. The samples that contain Ni^{63} thus preserve an enduring record of the flood of neutrons that spread out from the spot of the explosion.