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Can we carbon-date the universe?

Carbon dating is a method common in archeology or in estimating the age of fossils. Astronomers recently took a similar path to fix the age of the universe, says **S.Ananthanarayanan.**

The origin of the universe is now accepted as being in the 'big bang', or an extremely hot fireball at the start of everything. But how long ago this happened, we can only conjecture, with the lower limit at 10 billion years, which is the time it takes for light to reach us from the farthest visible stars. Astronomers have used data about the present day ratio of heavy metal content in ancient stars to work out their age.

Carbon dating in archeology

Atoms of an element can exist with different nuclear structures but still behave like the same element. This is because the different forms, or 'isotopes', differ only in the number of 'neutrons', or neutral particles in the nucleus of the atom, which does not affect the element’s chemical properties.

Naturally occurring Carbon is in two forms, C_{12}, which has twelve particles in the nucleus, and C_{14}, with fourteen particles. 98.9% of all carbon is C_{12}, which is stable. But the small amount of C_{14} is radioactive, continuously decaying to Nitrogen.

Because the processes that give rise to C_{14} have struck a balance with the rate of decay, the actual quantity of C_{14} in the world stays constant. Living things, like insects, animals, plants, which breathe, consume and excrete carbon compounds, also contain the two 'isotopes' of Carbon in the same, constant ratio.

This is so long as the organism is alive. But once an insect dies, and becomes a fossil, or a tree is chopped, the exchange of Carbon with the atmosphere stops and the carbon atoms become fixed.

Now, as the years pass, the C_{14} component keeps decaying and is never replaced. After centuries, as a result, the article would contain a lot less radioactive Carbon than a similar but fresh sample.

Measuring the radioactivity in the old article then makes it possible to work out its age, as the rate of decay of C_{14} is known.

Radioactivity in ancient stars

The current theory also implies that only *lighter* elements were formed in the first few minutes of the Big Bang. This suggests that the oldest stars would be poor in heavier elements, like metals. Scientists have thus looked at 'metal-poor' stars, which may be the oldest stars, in a recent attempt to tell the age of the universe, This is possible because metal-poor stars also do contain small quantities of very heavy, radioactive metals. And there is a way of working out the *ratio* of the quantities, albeit small, of Uranium and Thorium (both heavy metals) that such a star should have set out with. Because the elements are radioactive and undergo 'decay', these starting quantities would keep reducing with time. But the relevant thing is that, the rate of decay is different for each element. Thus after time, one metal would have decayed more than the other and their ratio would change.

Analysing the light emitted by these stars tells the scientists the present ratio of the elements in the stars. From which it is straightforward to estimate how much time has passed.

The results are 12.5 billion years, which pushes up the earlier minimum age by 2.5 billion years.

Measuring the radioactivity in the old article then gives away its age, as the rate of decay of C_{14} is known.
