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OF THE WEEK

RESEARCH NOTES

ARTICLES

DEPARTMENTS

COVER: Various rockets point skyward under the transparent roof of their new home, the National Air and Space Museum. The Smithsonian's latest addition to the Washington Mall has an open, airy quality that enhances the sense of flight and adventure for this, the largest assembly of rockets, planes and satellites ever displayed. See p. 29. (Photo: John H. Douglas)

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SCIENCE NEWS OF THE WEEK

The aging universe

The universe keeps getting older and older. Not only do the present moments that fleet by us with such dismaying speed continually add to the past, but the length of the past already gone keeps getting longer, according to scientists.

For a long time, the generally accepted estimate of the age of the universe was held at 10 billion years. Calculations based on radioactive decay of uranium to thorium estimated 14 billion years. Then Allan Sandage, with his reworking of the Hubble constant, supplied grounds for believing in an age about 15 to 17 billion years. The latest estimate is 20 billion years, and it comes from the determination of a new cycle of radioactive nuclear decay by John C. Browne and Barry L. Berman of the Lawrence Livermore Laboratory. Their argument appears in the July 8 NATURE.

The new method dates the universe by the time involved in the decay of the radioactive nucleus rhenium 187 to the stable nucleus osmium 187. The use of this method for cosmological timekeeping had been suggested in 1963 by D. D. Clayton of Rice University, who showed theoretically that it would be sounder than the commonly used uranium-to-thorium method. Both these techniques attempt to measure the age of nucleosynthesis, that is, the length of time that nuclear-physics processes have been going on in the universe using the known present abundance of the mother and daughter nuclei and the rate at which the mother decays.

The reason astrophysicists were unable to use the rhenium-osmium method before now is that there are two other reactions by which osmium 187 can be created and depleted. Because of the rarity of osmium 187, the rates of these had never been measured. The two processes, which happen in stars, involve the capture of a neutron by osmium 186 to make osmium 187 and the capture of another neutron by osmium 187 to make osmium 188. What Browne and Berman did was to measure the rates of these other processes.

To make the measurement, Browne and Berman had to obtain the largest and purest samples ever made of osmium 186 and 187. They amounted to a few grams of each isotope and were specially made at Oak Ridge National Laboratory.

The experiments used neutrons with energies comparable to those found in stars with a temperature about 300 million degrees K. When the osmium nucleus captures a neutron, it gives off a characteristic pattern of X-rays, and from the rate at which these X-rays appear, the probability of capture can be calculated.

With this knowledge, and the already known rate of decay of rhenium 187 to osmium 187, Browne and Berman could calculate the age of nucleosynthesis. They used the abundances of rhenium 187 and osmium 187 found in meteorites and took for granted the generally accepted figure of 4.6 billion years for the age of the solar system. They find that nucleosynthesis began about 18 billion years ago. Cosmologists generally agree that there was a period of two billion years between the big bang that created the universe and the beginning of nucleosynthesis. So the total age of the universe under this system comes to about 20 billion years.

The rhenium-osmium method for dating nucleosynthesis has two advantages over the uranium-thorium one. In the first place, the rhenium-osmium decay occurs with a half-life of about 44 billion years, much longer than the age of the universe, which makes it less susceptible to error than uranium-thorium, which has a half-life much less than the age of the universe. Second, the rhenium-osmium decay occurs in a way that is well understood astrophysically, a pathway of neutron-capture events in stars known as the line of beta stability. These processes are well measured and have an important role in stellar nucleosynthesis. In contrast, the astrophysical production rates of uranium and thorium (believed to occur in supernovas) have never been measured and must be estimated from theory alone. ☐