physical sciences

Closing the universe with massive neutrinos

One of the great problems of cosmology is how to close the universe—how to find enough mass so that the universe will hold together gravitationally and not expand endlessly. A subsidiary question is how clusters of galaxies hold together. In neither case is enough mass visible to do the job.

In the Feb. 15 ASTROPHYSICAL JOURNAL Ramanath Cowsik and John McClelland of the University of California at Berkeley suggest that neutrinos may do it, provided they have a very small mass. Current theory says neutrinos are massless, but attempts to explain the experimental failure to observe enough neutrinos from the sun (SN: 3/10/73, p. 155) have led to speculations that they may have a very small mass.

According to Cowsik and McClelland, the original big bang that started the universe should have created a gas of neutrinos and antineutrinos. Since they interact very little with other matter, they would mostly have remained to the present day. If there are as many as 1,200 in a cubic centimeter and if they have a mass of 4×10^{-33} grams each, they would be enough to close the universe. Cowsik and McClelland calculate the case of the cluster of galaxies in the constellation Coma as an example and find that the massive neutrinos could bind it as well.

SPEARing electrons and positrons

One of the coming forms of physical experiment is that in which two beams of particles moving in opposite directions are made to collide with each other. It can be done with protons and protons, electrons and electrons, or electrons and positrons.

An example of the third category is the electron-positron storage ring called SPEAR at the Stanford Linear Accelerator center. According to an announcement by Wolfgang K. F. Panofsky, director of SLAC, the highest electron- and positron-beam intensities ever obtained in storage rings have been achieved in SPEAR. The SPEAR beams reach a luminosity, as the potential interaction rate is called, of 10^{31} interactions per square centimeter per second. This is about 20 times greater than the intensities attained by SPEAR's closest rival, the Adone ring at Frascati, Italy. The Adone ring requires about four times more current.

The work at SPEAR is done with a rather low current (25 milliamperes) by a technique known as low-beta focusing: Magnet beams squeeze the particle beams tightly near the point of interaction, increasing the potential for hits.

Sizing up a pulsar

Pulsars are supposed to be very small objects. They are so small that observations with a single antenna can give no information about their apparent size. Astronomers are therefore going to very-long-baseline interferometry (VLBI) to see whether pulsars can be resolved.

In the Feb. 15 ASTROPHYSICAL JOURNAL LETTERS a group from the University of Maryland, the Arecibo Observatory and the Naval Research Laboratory report on VLBI observations of the Crab nebula pulsar. They used antennas at Arecibo, Puerto Rico; Green Bank, W. Va., and Sugar Grove, W. Va. At a frequency of 196.5 megahertz they observed no resolution. But at 111.5 megahertz they report slight resolution and an apparent angular diameter of 0.07 seconds of arc. Theory had predicted that the size of pulsar plus interstellar scattering of the signal would give an apparent angular diameter of 0.09 seconds.

lunar science

From our reporter at the fourth annual Lunar Science Conference in Houston

Well-traveled debris from Orientale

Prior to the Apollo 16 landing photogeologists interpreted the Descartes site in the moon's Central Highlands to be a region covered by younger highland volcanism. But the Apollo 16 rocks turned out not to be obviously volcanic. Now C. T. Chao, L. A. Soderblom, J. M. Boyce, Don E. Wilhelms and Carroll Ann Hodges of the U. S. Geological Survey have come up with an alternate hypothesis. They suggest that the Cayley formation—the name of the rock unit that extends over the landing site—is composed of ejecta from the Orientale Basin, the youngest multiringed impact basin on the moon. The Cayley at Descartes did not come from any local source nor does it appear to be ejecta from the impact that created Mare Imbrium. They reached these conclusions after examining craters and noting that the Apollo 14 material from Imbrium is different from the Apollo 16 material.

The material was transported to the Central Highlands 3,000 kilometers from Orientale as part of the suborbital ejecta that was thrown out farther because it had higher ejection angles and velocities.

Apollo 16's rusty rock

The rusty rock (66095) found in the Apollo 16 samples generated great interest because of the lack of water now on the moon. The rock has other unusual characteristics as well. According to M. Tatsumoto of the U. S. Geological Survey, the rock has a very high lead content. Using the uranium-lead dating method, he calculates a two-stage evolution for the rock and an initial formation at 3.77 billion years ago.

But how the rock got rusty is unsettled. The rust could have been formed as a result of fumarole activity (volcanism) but Larry A. Taylor of Purdue University suggests the rock rusted either en route or upon arrival at earth. The sample has chlorine in it associated with a rusty mineral, goethite. This strongly suggests to him the initial presence of the meteoritic mineral lawrencite, which rapidly oxidizes upon entering the earth's atmosphere.

A. El Goresy of the Max Planck Institute thinks the goethite was formed on the lunar surface by either a hydrothermal reaction or similar reactions between troilite and water vapor during a cometary impact.

Impact melts on the moon

One of the problems of studying the lunar rocks is to distinguish between melting of the material (and subsequent crystallization or recrystallization) caused by igneous volcanic activity and melting caused by impacts.

Keith A. Howard and H. G. Wilshire of the U.S. Geological Survey describe the characteristics of lava flows generated by impacts. Fluid lava-like materials that flowed downhill occupy the floors, walls and rims of large impact craters. Some of these lava flows are generated by impacts, particularly if the lava is concentrated on the down-range side of the crater or covers highland areas that have no apparent volcanic vents. They estimate that for craters 50 to 200 kilometers across, the maximum range of impact melt is one crater radius beyond the lip of the crater. In the ejecta blanket from the larger craters where none of these lava-like ponds appear, they think the very hot ejecta was dispersed and mixed with colder material.

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