which $1.35 billion would be spent by the Defense Department and $261 million by the Atomic Energy Commission. The total amount requested is $113 million less than is expected to be spent on research and development during 1954. Two-thirds of the cut is to be borne by the Defense Department with roughly equal reductions in research and development funds for the Army, Navy, and Air Force. The Office of Naval Research, however, is budgeted to receive $60.6 million—an increase of almost $5 million over 1954. An increase of $5 million is also recommended for the actual conduct of research by the Atomic Energy Commission, although the budget calls for a reduction in funds for constructing new research facilities that drops the total for research and development $11 million below the AEC's 1954 expenditures. A requested appropriation of $8 million for the basic programs of the National Bureau of Standards, representing an increase of $2 million over 1954, would bring the NBS budget back to what it was in 1953. The Kelly Committee, it will be recalled, reported that the Bureau's basic programs, in terms of man-years of effort, were then supported at a level about 20% below that required to meet the nation's needs.

Neutrino Hunt

THE TROUBLESOME STATUS of the neutrino was recently summarized by W. F. G. Swann in this way: "the neutrino has never been known to do anything but own energy, and just as it is very difficult to apprehend an ordinary thief who never spends any of his stolen money, so it has been very difficult for science to place its finger upon this neutrino and say: 'Ha, I have caught you in the act,' because the neutrino appears to have no act."

Actually, the neurino should interact very slightly with matter, the reaction neutrino + proton → neutron + positron, for example, having a cross section of about 6×10^{-20} barn ($= 6 \times 10^{-44}$ $cm^2 = 6$ "sheds"). This process has been made use of by F. Reines and C. L. Cowan, Jr. of the Los Alamos Scientific Laboratory in an attempt to detect the free neutrino experimentally, with one of the Hanford reactors being the source and a massive ten-cubic-foot scintillation counter the detector. The scintillator solution was loaded with cadmium to enable neutron detection, since the capture of a neutron by a cadmium atom gives rise to a gamma ray. The above reaction would manifest itself by an initial positron count, followed a few microseconds later by a gamma count from a slightly delayed neutron capture. Elaborate shielding and anticoincidence counter arrangements were employed to reduce background, and runs were made with the pile at zero and at full power. A difference in the counting rate of 0.41 ± 0.20 counts per minute was found, compared with a rough prediction of 0.2 counts per minute. The experiment was described in an invited paper at the New York Meeting of the American Physical Society in January and had previously been reported in the May 1 and November 1 issues of *The Physical Review*.

After Ylem, What?

THE TIMETABLE OF EVENTS that occurred during the first moments of the expansion of the universe is discussed in some detail by Ralph A. Alpher, James W. Follin, Jr., and Robert C. Herman, all of the Applied Physics Laboratory, Johns Hopkins, in their article, "Physical Conditions in the Initial Stages of the Expanding Universe", which has appeared in the December 15th *Physical Review*. Going back three billion years, according to the authors, one would find the primordial matter (the "ylem") to be an extremely hot mixture of neutrons and radiation. As the universe expanded and cooled some of the neutrons decayed into protons, and when the temperature of the universe had decreased sufficiently for nuclei to be thermally stable these protons proceeded to capture the remaining neutrons. Since beta decays can convert a nucleus having too many neutrons into one of higher charge, successive neutron captures and beta decays could thus have been responsible for the formation of the various elements. This interpretation, which agrees with the observed abundances of all but the lightest elements, has become known as the neutron-capture theory, with the stipulation that "for the lightest elements the processes of neutron capture and beta decay, while adequate to explain the formation of the heavier elements, must be supplemented by thermonuclear reactions involving protons, deuterons, and other light nuclei". In this model of nucleogenesis the relative concentrations of protons and neutrons as a function of time in the early stages of the universe "plays a most important role in determining the relative abundances of the nuclear species", and evaluating this ratio was the stimulus for the present calculations.

The Alpher-Follin-Herman analysis gave a proton-neutron ratio lying within the range of about 4.5:1 and 6.0:1. Among other phases of the expanding universe the problem of the neutrinos turned out to be important, since neutrinos interact with other particles substantially only at very high temperatures. Although in equilibrium at such high temperatures, the neutrino component becomes "frozen in" at lower temperatures and expands adiabatically from then on independently of the other components of the universe.

While the nonequilibrium neutron-capture theory seems to be leading the field it has no lack of competition. Chief among the latter are the equilibrium theory, which holds that nuclear abundances can be traced to a "frozen equilibrium" among the various nuclei, and the polyneutron and primeval atom hypothesis. George Gamow, an enthusiastic expositor who was one of the initiators of the neutron-capture theory, has examined these and other related topics at some length in his entertaining book *The Creation of the Universe* (The Viking Press, 1952, $3.75).