Aleksandr Evgen'evich Chudakov (on his seventieth birthday)

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A. E. Chudakov is an experimental physicist, a full member of the Academy of Sciences of the USSR, an outstanding specialist and an acknowledged leader of a broad field of science unified by the concept "cosmic-ray physics."

He was born on 16 June 1921 in Moscow, into the family of a well-known engineer and scientist, the founder of automobile enterprise in the USSR, academician E. A. Chudakov. A graduate of the physics faculty of the Moscow State University who began his scientific career under the guidance of S. N. Vernov, A. E. Chudakov over a period of forty-five years has been finding and bringing to fruition the most direct, informative and at the same time the simplest methods of investigating physics phenomena, blazing the trail and determining the direction of the development of the physics of cosmic rays.

A. E. Chudakov has developed a methodology and has carried out a broad program of research on cosmic rays with the aid of rocket technology. In a series of experiments in 1947–1951 he measured the intensity of cosmic rays beyond the boundary of the atmosphere, obtained the first limits on the intensity of the gamma-ray flux and data on the nature of the nucleon-nucleon interaction at high energies. This required the creation of completely new apparatus for recording cosmic rays, and methods of transmission and reception of information by radio. In particular here A. E. Chudakov used for the first time the amplitude-time transformation, a code which has become generally accepted in the practice of physics experiments.

The next cycle of investigations beyond the atmosphere A. E. Chudakov carried out in 1957–1959 with the aid of the first Soviet artificial satellites and space rockets. In these experiments the external radiation belt of the earth was discovered, the space structure and the dynamics of the radiation belts were studied, the composition and the energy spectrum of the particles composing them were investigated. For the discovery of the external radiation belt of the earth and its investigation A. E. Chudakov (together with S. N. Vernov) was awarded the Lenin Prize (1960).

In 1949, A. E. Chudakov noted that at high energies a reduction in the ionization produced by e^+e^- pairs should be reduced due to the mutual screening of the fields of the electron and positron near the points of their creation. This effect has now been incorporated in many physics encyclopedias under the name of "Chudakov effect."

In 1953 A. E. Chudakov confirmed experimentally the existence of the effect of transition radiation and in a series of papers in 1953–1960 carried out a detailed investigation of it in the optical range.

In 1953–1957 A. E. Chudakov carried out the first in the world investigations of the Cherenkov radiation from charged particles in the atmosphere. In these papers he put into practice the idea of calorimetric measurement of the energy of a cascade and determined the relationship between the energy of the cascade and the observed number of particles.

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In 1960–1963 A. E. Chudakov carried out a pioneering experiment on the search for localized sources of hard gamma quanta by the method of recording Cherenkov radiation in the atmosphere. The limitation on the intensity of the flux of gamma quanta with energies above $2.5 \cdot 10^{12}$ eV from the sources investigated obtained in this experiment served as an incontrovertible argument against the hypothesis of the secondary origin of electrons in radio-nebulas. The methodology developed by A. E. Chudakov for searching for the localized sources of hard gamma quanta is now widely used in many laboratories of the world.

In 1963 a decision was adopted with the active participation of A. E. Chudakov concerning the creation of a set of underground laboratories for the study of the natural flux of neutrinos and muons in cosmic rays. Since then the activity of Aleksandr Evgen'evich is practically completely associated with the Baksan neutrino observatory of the Institute of Nuclear Research of the Academy of Sciences of the USSR (until 1971 this was the neutrino scientific station of the P. N. Lebedev Physics Institute of the Academy of Sciences of the USSR).

Under the guidance of A. E. Chudakov unique detectors were created—"Kover," intended for the study of extended atmospheric showers, and also the Baksan underground scintillation telescope. Putting them into operation—the exploitation of the former began in 1974 and

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of the latter in 1978—immediately raised to a new level the investigation of an entire class of physics problems. Moreover, due to the universal nature and flexibility of the initial circuits developed by A. E. Chudakov these detectors remain right up to now one of the most effective in the world instruments for investigating a great variety of problems posed by the development of modern physics. Even a simple list of the basic results testifies to the remarkable possibilities of these installations.

In the investigations of extended atmospheric showers with the aid of the "Kover" installation it was shown that at an energy of above 10^{14} eV the cross section for the interaction with high transverse momenta increases in correspondence with the predictions of quantum chromodynamics (1980). The long-term stable operation of this installation has enabled one to measure the anisotropy of cosmic rays with an energy of 10^{13} eV at a level of $6\cdot 10^{-4}$ (1980–1985) and to obtain limitations on the flux of gamma quanta of energy of 10^{14} eV from localized sources (1984–1990). The influence of the electrical field of the atmosphere on the intensity of cosmic rays (electrons and muons) was discovered and investigated. It was shown that in the case of thunderstorms or rain the potential of the middle layers of the atmosphere can exceed the value of 10^{8} V.

At the Baksan underground scintillation telescope from the very moment of its being put into operation investigations are being carried out simultaneously along several directions. Here for the first time the problem was solved of recording muons from the lower hemisphere by the method of measuring the time of flight and a search was initiated for point sources of neutrinos in the celestial sphere. In 1980 during several months of exploitation one of the then best limits was established on the proton lifetime. A new method was put into operation for determining the nuclear composition of primary cosmic rays and a conclusion was drawn concerning its constancy over a wide range of energies 10^{12}–10^{15} eV/nucleon. As a result of measurements over many years of the intensity of muons underground the anisotropy of the primary cosmic radiation with an energy of $2\cdot 10^{12}$ eV was determined. Limitations were obtained of record-setting nature at the present time on the flux of ultraheavy magnetic monopoles ($5.5\cdot 10^{-16}$ $cm^{-2}s^{-1}sr^{-1}$) and on the parameters of neutrino oscillations. From 1980 a continuous search is being carried on for bursts of neutrino radiation accompanying gravitational collapse of stars. The data of the Baksan underground scintillation telescope obtained on 23 February 1987 accompanying the explosion of the supernova SN1987a, have turned out to be useful for the analysis of the world compilation of data.

This list of first-class results could be continued further. However, it is no less important to note that at the present time A. E. Chudakov together with his collaborators has begun a large-scale modernization of the operating installations which will confer on them a new quality and will enable to extend significantly the range of physics phenomena being investigated.

A scientist of world reknown, a leader of the laboratories created by himself in the Institute of Nuclear Research of the Academy of Sciences of the USSR, a professor of the Moscow State University, a chairman of the Science Council of the Academy of Sciences of the USSR on the complex problem "Cosmic Rays," a member of the Presidium of the Academy of Sciences, a man who by the scale of his talent and his personality has exerted a tremendous influence on the development of physics of cosmic rays in the postwar time, A. E. Chudakov arrives at his seventieth anniversary retaining the enthusiasm of a true investigator.

His comrades, colleagues and numerous pupils wish to Aleksandr Evgen'evich to preserve this invaluable quality and new successes.

Translated by G. M. Volkoff