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VIKTOR AMAZASPOVICH AMBARTSUMYAN

(on his 60th Birthday)

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VIKTOR Amazaspovich Ambartsumyan, an outstanding astrophysicist of the USSR and one of the most prominent world astronomers, will be sixty on September 18, 1968.

The exceptional gifts of V. A. Ambartsumyan became apparent very early in his life. Already as a schoolboy, he became proficient in the theory of relativity, and he published his first scientific paper in astronomy when he was seventeen.

Upon graduation from the Leningrad University, V. A. Ambartsumyan did postgraduate work under Academician A. A. Belopol'skiĭ at the Pulkovo Observatory. He then came back to the University, where he founded and headed the Department of Astrophysics. He also was the director of Astronomical Observatory of the Leningrad State University and dean of Elabuga branch of the University during the second world war.

V. A. Ambartsumyan came to Erevan in 1943 and soon became the president of Armenian Academy of Sciences. He directed the construction of Byurakan Astrophysical Observatory near Erevan. As a director of the Observatory, he guided the work on very important scientific problems which brought wide reputation to the Observatory.

V. A. Ambartsumyan is considered to be, by right, the founder of Soviet theoretical astrophysics. In addition, he carried out basic work in stellar astronomy and cosmogony. In recognition of outstanding research, he was awarded a State Prize in 1946 for the work on theory of diffusion of light, and in 1950 for discovery and study of stellar associations, V. A. Ambartsumyan was elected a member of the USSR Academy of Sciences in 1953 and also a member of many foreign academies and scientific Societies. He was a president of the International Astronomical Union for a number of years.

Scientific activity of V. A. Ambartsumyan began in late twenties when the newly developed quantum theory led to a rapid progress of theoretical astrophysics. His research contributed appreciably to this progress. The first series of his investigations was devoted to physics of gas nebulas. The luminescence of a nebula is a result of the ultraviolet radiation of the star. Research of the ultraviolet radiation transfer through the nebular shell is therefore important. Ambartsumyan was first to solve this problem by separately investigating the nebular radiation region outside of the Lyman series and the region responsible for the emission of the Lyman-α line. A characteristic feature of gas nebulas is the presence of strong forbidden lines in their spectrum. Ambartsumyan determined the exact conditions required for appearance of forbidden lines in the spectrum of a given object (nebula, nova, comet). He also proposed a simple method to determine the electron temperatures of nebulas from the intensity of the forbidden lines due to electron excitation. This method is now in wide use in astrophysics.

The general problem of radiation transport was treated by Ambartsumyan in another series of investigations. This problem is very important in astrophysics because radiation transfer in the atmosphere of a star determines the type of its spectrum. Various problems of radiation displacement theory were normally treated by solving certain integral equations that define the emissivity of a unit volume of the atmosphere. Ambartsumyan treated these problems very differently. He solved them by reducing them to functional equations that determine directly the radiation intensity of the medium. The radiation field within the medium could then easily be found if this intensity was known. The methods used to obtain the functional equations were

based on "invariance principles." In a simple case of semi-infinite medium, one of such principles states that the reflectance of the medium remains constant if a layer of infinitesimally small optical thickness is added to the medium. Study of the processes in this layer leads to equations for intensity of radiation emanating from the medium. The methods and equations of V. A. Ambartsumyan are very important in the modern theory of multiple scattering of radiation. They are also used in other branches of mathematical physics.

Ambartsumyan is credited with outstanding contributions to stellar astronomy. He was first to suggest a concept of patchy structure of the absorbing matter in the Galaxy. He then developed a theory of brightness fluctuation of the Milky Way. Comparison of the theory with observations made it possible to determine the optical properties of absorbing clouds.

Ambartsumyan achieved also remarkable results in the study of stellar systems. Prior to his work, the astronomers were applying the kinematic theory of gases to stars. In reality, the stars interact in accordance with Newton's law and special physical statistics should be used for investigations of stellar systems. V. A. Ambartsumyan laid the foundations of such statistics and applied it to multiple stars and star clusters. He determined the distribution of elements of binary-star orbits at equilibrium and suggested that such state has not yet arrived. He also studied the process of star cluster disintegration due to escape of high-velocity stars and discovered that the process did not yet go too far. This led to a conclusion that the age of the galaxies is less than 10^{10} years. It was assumed previously that the stars were much older. Ambartsumyan firmly proved the "short scale" of galactic life in a dispute with the known British astronomer Sir James Jeans.

Later, Ambartsumyan discovered a new type of stellar system called a stellar association. He gave this name to groups of stars that differ from the surrounding stars by having a greater partial density (i.e., density of stars of a given spectral class). Ambartsumyan predicted the expansion of the associations, which was later observed. Study of the associations revealed that they are very unstable (their energy is positive) and should disintegrate rapidly. From the fact that they did not disintegrate until now, it was concluded that they are not more than few million years old. This conclusion about the youth of stars contained in associations is supported by a number of other features of associations.

From the very existence of the associations, Ambartsumyan derived two conclusions: 1) stars are born in groups, 2) the process of star creation continues also at the present time. These two conclusions are of extraordinarily great importance for cosmogony.

The ideas and research work of V. A. Ambartsumyan had great influence on the research progress in the area of extragalactic astronomy within the last ten-fifteen years. He was first to show that the so-called radiogalaxies are not a result of accidental collision of two gigantic star systems, but represent a definite stage of internal evolution of galaxies of very high luminosity. "Activity" of galaxies, which manifests in their radio emission, is intimately connected with new formations, such as jet ejections extending from the galactic nucleus (e.g. Virgo A), spiral arms, and new star systems emerging within the old Galaxy.

Ambartsumyan was also first to call attention to the instability and activity of galactic cores. The basic facts related to this instability are as follows:

1) Outflow of neutral hydrogen from the central regions of our Galaxy, revealed by measurements of radio emission of the Galaxy at a wavelength of 21 centimeters, and also by analogous facts in other galaxies. Most striking thereby is the very high velocity of the outflow, which is difficult to reconcile with the mass of the galaxies.

2) The emission lines of many galaxies with the largest energy release (the so called Seyfert galaxies) are extremely broadened by fast motion of the gas at velocities of several thousand km/sec. Such velocities appreciably exceed the escape velocity and lead to powerful and rapid outflow of gases and their dispersion in space. As pointed out by Ambartsumyan, the so called blue galaxies, whose cores radiate emission lines, possess analogous properties.

3) Jets, ejected at great distances and escaping from the nuclei at high velocities, are observed in radio galaxies. Condensation in the jets is observed in a number of cases and represents a source of radiation, probably due to presence of relativistic electrons.

4) The presence of two nuclei in radio galaxies (radio galaxies Cygnus-A, Centaurus-A), observed in some cases, indicates, apparently, a recent process of nuclear fusion.

5) In a number of gigantic galaxies, the jets emanating from the nuclei are themselves blue galaxies of very high luminosity.

These and other considerations led to the natural conclusion that the formation of spiral arms in galaxies is also a result of activity and, possibly, explosion of their nuclei. Analogous conclusions were later made by A. R. Sandage and C. R. Lynds, who found convincing evidence of the recently occurred explosion in the galaxy M8.

It is difficult to overestimate the importance of the deduction that the activity of the galactic nuclei determines the most significant processes in the evolution of galaxies. Indeed, the correctness of Ambartsumyan's general conception was corroborated by the subsequent discovery of quasi-stellar radio sources—quasars—which are starlike objects of exceptionally high luminosity at cosmological distances. These objects exhibit extraordinary violent processes including very fast fluctuation of luminosity, jet ejection, and high motion velocities of luminescent gases. There is very likely a close connection between galactic nuclei and quasars. Formation of developed structure of galaxies is, apparently, connected with their nuclei (or, possibly, with quasars). The formation is such an unusual process, that it is difficult to foresee subsequent development of extragalactic astronomy and those effects which it will have on our view of processes occurring in universe.

Great credit belongs to V. A. Ambartsumyan for founding a school of numerous Soviet physicists who successfully work under his immediate guidance at Byurakan Astrophysical Observatory and also in other cities and observatories.

Translated by W. V. Chumakov