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INTERNSHIP OF GEORGE GAMOW IN GOETTINGEN UNIVERSITY: AN IMPORTANT STEP IN "BIG" SCIENCE

The article describes G.A. Gamov's internship at Goettingen University, one of the leading centers of the quantum mechanics development in the first half of the XXth century, his work in the direction of the atomic nucleus theory and research of the alpha-particles decay problem, in particular, which is a type of radio activity. Gamov applied the quantum mechanics for the explanation of interaction between alpha-particles with atomic nuclei and theorized the quantum tunneling of alpha-particles through the barrier which potentially holds the particles inside atomic nuclei. The new idea of potential barrier of atomic nuclei, formulated by Gamov ("the tunnel effect") made a revolution in nuclear physics.

Key words: *George Gamow, history of physics, period of life lived in Goettingen.*

George Gamow (1904–1968) is a famous physicist, astrophysicist and promoter of science originally from Ukraine. He was a member of USSR Academy of science from 1932 to 1938 (reinstated in 1990). After the scientist didn`t return in 1933 from business trip abroad, his name was erased from scientific literature for half a century. The researches connected with his life and scientific works haven`t been made. You could find some general information about physicist in encyclopedias and references: "Astronomers. Biographical directory" [1, p. 63–64], "Big Soviet encyclopedia" [2], "Physicists. Biographical directory" [3].

The purpose of this article is to highlight one of George Gamow` periods of life and work, which is his scientific business trip to the University of Goettingen. This

trip made the biggest influence in the life of future scientist. He went to Goettingen as unknown student and came back already as a well-known European scientist.

Before starting the general statement of the material, we need to highlight some biographical facts of George Gamow. The physicist was born in Odessa (Ukraine), after graduating in 1920 from secondary school he went to mathematic faculty of Physical and Mathematical Institute. In 1920 The Novorossia University was eliminated the same as all Universities in Ukraine and it was renewed in 1933 as Odessa University. The Physical and Mathematical Institute was located in major building of the University (Petra Velykogo str., 2) and as lecturers, it had University professors. George Gamow was studying there only one year, he was visiting lectures of the famous mathematicians as S. Shatunovskyy and V.Kagan. However, Gamow wasn`t satisfied with the level of teaching in Novorossia University because of influence of Civil War, this fact had a huge impact on the organization of study, for example, the electricity could be switched off and there was no special equipment).

In year 1922, George Gamow decided to go to Leningrad (Petrograd in that moment). Here is what he was writing about that: "…I decided to leave my native city and to go to Leningrad, where, as I knew, physical science started to develop after slow period of revolution…" [4, p. 12].

In the beginning of XX - century the Petrograd University with physical-mathematical faculty was one of the best universities and scientific institution. Young people who wanted to cover physics depth should go to this University, that`s why George Gamow followed the tendency and went to Petrograd to study physics.

In September 1922, he started his journey as a student of Petrograd University [5]. Gamow demonstrated such qualities as talent and hardworking, what was noticed by his teachers so he was sent for traineeship to the Goettingen University – the center of theoretical physics. In June, 1926 Gamow came on board of the ship to Swinemunde(Germany).

In his own biography "My world line" appeared after his death, Gamow was describing some changes in his life, which pushed him to go on his first trip abroad

without any scientific merits: “an unexpected change in my career happened at this moment (summer, 1928). The old professor Orest Hvolfson, who was already reteired and who`s lectures I was “listening” (however, I didn’t visit it at all), recommended me to spend couple of month in Universities abroad, he mentioned that he would like to advise my person to direction of Leningrad University for summer trip 1926 to the famous Goettingen University which was the center of development in quantum mechanic.

The Hvolfson`s recommendation was signed by Krutkov (Jurij Krutkov was scientific advisor of postgraduate Gamow) and some of the other professors who was impressed by my scientific abilities, so in the beginning of June I came on board of the ship to Swinemunde(Germany)” [6].

Let`s mantion some information about Goettingen University. In 1727 when king George II came to govern he became a ruler of Hannover. Trying to attract German people especially intelligentsia, king George II decided to build the university. So in year 1737 the University was built in beautiful city Goettingen in the Southern part of Lower Saxony on the river Leine, this university was to play a huge role in human`s history. King George was elected to be a director of the University, he was investing a lot it it`s development. There was bought the best equipment, huge library was organized, the best lecturers were invited to teach in this University. Around 40 scientists who reaches The Nobel prize graduated Goettingen University [7].

In June 1928, Gamow came to Goettingen, when he met Max Born - the leader of theoretical pysics` team. For 22-year-old George Gamow there was everything new and exciting in southern Saxony. This nice and cozy city lived in the “University” lifestyle. The sign on Town Hall says: “Nowhere is better life than in Goettingen”. The students of the oldest European universities were children of titled persons including Russian gentry.

Only famous and respected scientists were leading the lectures: Max Born, Albert Einstein, Max Planck, Marie Curie, Norbert Wiener, Niels Bohr. Student are

singing «Gaudeamus igitur» and to pass exams successful, they are kissing the bronze girl Lisa, which stands with bronze ducks on the Town Hall Square.

Gamow came to Goettingen in that period called the "Goettingen period" of development of physics. He was actively involved in the hot scientific discussions that took place at that moment. In 1920, Max Planck receives the Nobel Prize for developing quantum theory, in 1922 the Nobel Prize was given to Niels Bohr for developing the theory of the structure of the atomic nucleus. Problems in quantum mechanics and nuclear physics were at the center of attention of physicists. The only tool of research of atomic nuclei were alpha particles emitted by some elements in the decay.

Deciding to engage in any unsolved theoretical problem, Gamow chose as the main direction of the theory of the atomic nucleus, and in particular, the problem of alpha decay, one type of radioactivity. Applying the idea of quantum - mechanical wave function penetration of alpha particles through culosi barrier (tunnel effect), he was able to show that even particles with very high energy can have a chance to fly out of the nucleus. It was the first successful explanation of the behavior of radioactive elements with quantum theory. Gamow puts forth the theory of quantum tunneling of alpha particles through the barrier, potentially holds together the particles inside atomic nuclei.

With his theory, Gamow was able to estimate the size of the nuclei (about 10–13 cm) and to give a theoretical derivation of the empirical law of Geiger – Attalla that relates the energy of the alpha particle that is emitted with a characteristic time of alpha decay (with a half-life of the nuclei)[8]. In July, Gamow finished his article and sent it to the journal "Zeitschrift für Physik", his theory gained recognition very soon, and his success made Gamow widely known in the scientific world.

Gamow proposed a new view on the potential barrier of atomic nuclei ("tunnel effect"), which have revolutionized nuclear physics. The results of his research Gamow was highlighting in famous seminar, created by Max Born. This message caused a sensation and made the 24-year-old Gamov an outstanding scientist in the field of theoretical and nuclear physics. [9]. Gamow`s researches forced the Patriarch

of atomic physics Ernest Rutherford to start the construction of the proton accelerator. Gamow was directly involved in the formulation of experiments and, once he came back to the USSR, he initiated the construction of a proton electrostatic accelerator at the Leningrad Physical-technical Institute. Tunneling phenomenon opened by Gamow, is the basis of thermonuclear reactions, many processes in quantum electronics as semiconductivity, superconducting contacts, in plenty of physical phenomena, etc.

After a term of Gamow`s three-month stay in Goettingen finished, Niels Bohr contributed Gamow to Carlberg`s summer scholarship to work in Institute of theoretical physics of the Danish Academy of Sciences, which at that time was the Mecca of theoretical physicists. Then Ernest Rutherford provided Gamow a scholarship of the Rockefeller Foundation to work at the Cavendish laboratory of Cambridge University.

Here's how Nikolay Delone, Professor, doctor of physical-mathematical Sciences, leading researcher of Institute of General physics RAS evaluates Gamow`s opening of the tunnel effect. He is a specialist in the field of atomic and laser physics, the author of several books of the interaction of laser radiation with matter, many reviews and more than 150 scientific papers:

"Gamow`s theory allows to describe with reasonable accuracy the periods of decay of different nuclei all over the huge range of their values. Further refinement of this theory has led to small amendments. In the beginning of our century, during the creation of quantum mechanics, the success of the theory of tunneling of a-particles from nuclei was a convincing argument in favor of the fairness of the foundations of the new quantum physics, first and foremost, the corpuscular-wave nature of elementary particles" [10].

The ability to work in the centres of the global physical science, creative dialogues with outstanding theoretical physicists and researchers for were very essential for George Gamow. In a short period of time, he published eight serious researches, provided the first scientific monograph "The structure of the atomic nucleus and radioactivity", published in 1930 in the series "New currents of scientific

thought" in German, English and French. Then this monograph has been published in the Soviet Union.

Making conclusions we should admit that the scientific internship of George Gamow to the University of Goettingen played decisive role in the formation of the Gamow – scientist. His business and scientific contacts with leading European scientists, attending lectures of famous specialists in physics, his participation in scientific seminar created by Max Born, this contributed to the formation of Gamow – scientist.

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