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Skobeltsyn and the early years of cosmic particle physics in the Soviet Union

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ABSTRACT

D.V. Skobeltsyn was the first physicist to put a Wilson cloud chamber in a magnetic field and to show that cosmic rays are high energy particles. Also he observed the multiple particle generation by a cosmic particle for the first time. He initiated the cosmic ray research in Leningrad and Moscow and he has brought up a pleiad of distinguished cosmic ray physicists. He is the acknowledged founder of the Soviet, and Russian cosmic ray investigations.

1. Introduction

Dmitry Vladimirovich Skobeltsyn (Fig. 1) is the acknowledged founder of Russian cosmic ray (CR) research. In Russia, almost all people involved nowadays in CR study have been taught by former students of Skobeltsyn, or the students of his former students. For a long time, Skobeltsyn was a leader of the Soviet cosmic ray physics. He initiated the CR research at the St. Petersburg Physical Technical Institute, Lebedev Physical Institute (Moscow) and at the Moscow University. He is a founder of the Institute of Nuclear Physics of the Moscow State University, which bears his name since 1993.

The discovery of CRs by Victor Hess was a consequence of rapid progress in science during 1900s, it was preceded by numerous experiments in laboratories, on mountains, in the atmosphere on balloons and underwater [1]. In 1912, Victor Hess proved that "the Höhenstrahlung" existed, and it increased with altitude [2]. Soon it was decisively confirmed by Kolhörster [3]. Intensive efforts were undertaken to explore features of a newly discovered radiation. The main problems were the following. (1) Does a source of the Höhenstrahlung exist in the atmosphere, such as atmospheric electricity or natural radioactivity, or does the radiation come from the extraterrestrial space? (2) Has the Höhenstrahlung a gamma-ray or a corpuscular nature? (3) What is the inherent energy in the Höhenstrahlung? The experimental results were variable and sometimes controversial. Distinguished scientists, such as D. Pacini, V. Hess, A. Gockel, W. Kolhörster, J. Clay, R. Millikan, and others, were involved into the discussion [1,4]. Actually the first work on CR in the USSR was undertaken by Lev Myssovsky with coworkers. Since 1924, Lev Myssovsky and Lev Tuwim, from the State Radium Institute (now the Khlopin Radium Institute, St. Petersburg) fulfilled a series of experiments on the Höhenstrahlung. Under the leadership of Myssovsky the following features of the Höhenstrahlung were examined: absorption in water and Pb, including transition effect, angular distribution, and barometric effect [5–8]. Myssovsky proposed the thick photo-emulsion method for cosmic ray study [9]. He also was the first to observe neutrons produced by cosmic rays [10]. The results of Myssovsky were highly estimated by scientific community [1]. Unfortunately, Tuwim died in 1933 and Myssovsky died in 1939. Their deaths brought an interruption to their work. It was D.V. Skobeltsyn who continued long and successful history of cosmic ray research in the USSR.

2. Early years and education

Dmitry Skobeltsyn was born in St. Petersburg on 12 (24 new style) November 1892. The Skobeltsyn family had a very long documented history, starting from the 15th century, under Tsar Ivan the Third. The Skobeltsyns were mentioned in annals of the 16th century under tsar Ivan the Terrible, under his successor, tsar Feodor, and later. Some of Dmitry Skobeltsyn's ancestors were acquainted with the poets, A.S. Pushkin and P.A. Vyasemsky. The D.V. Skobeltsyn's father, Vladimir Vladimirovich Skobeltsyn, was a physics professor in the St. Petersburg Polytechnical Institute (now Polytechnical University). In 1911–1917 he was the director of this Institute and among many other important achievements there he introduced A.F. Ioffe, "the father of Soviet physics". V.V. Skobeltsyn was a brilliant experimenter and an eminent lecturer. He influenced the development of his son, throughout his entire life.

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Fig. 1. D.V. Skobeltsyn (1892–1990).

Dmitry Skobeltsyn received a fundamental education. He attended the prestigious Tenishevsky School in St.Petersburg. The poet Osip Mandelstam, the writer Vladimir Nabokov, and the prominent philologist Victor Zhirmunsky, were educated there at about the same time. In 1915 D.V. Skobeltsyn graduated from the Petrograd (now St. Petersburg) University and entered the Polytechnical Institute as a professor-assistant and a student teacher. In 1925 he became a research fellow of the Leningrad Physical Technical Institute (now Ioffe Institute). It should be noted that his native city changed it's name twice: in 1914, from St. Petersburg to Petrograd, and in 1924, from Petrograd to Leningrad. In 1991, after the death of Skobeltsyn, the city again was called St. Petersburg.

3. Early investigations (1920s to early 1930s)

D.V. Skobeltsyn developed an interest in nuclear physics and in 1923 he started his experiment on the study of Compton electrons originated in the interactions of the gamma rays from a RaC source. For his experiment Skobeltsyn constructed and built a Wilson cloud chamber (Fig. 2). In 1925, he came up with the idea of putting a Wilson chamber in a magnetic field (1500–1700 G).

Charged particles passing through a Wilson chamber deflected under the influence of a magnetic field. The curvature radius depends on the particle momentum P and the magnetic field strength H as:

$Pc(\mathrm{eV/z}) = 300\, H(\mathrm{Gauss})\rho\ (\mathrm{cm})$.

Skobeltsyn has taken stereoscopic photos of the chamber interior just after switching on of the impulsive magnetic field. Measuring the curvature radius of a particle trajectory in the known H enabled Skobeltsyn to find a particle momentum from the photographs of the particle tracks. The Skobeltsyn's research aimed to verify the Klein–Nishina formula, so he studied the recoil electrons knocked out of the gas in the Wilson chamber by gamma quanta. In this experiment Skobeltsyn confirmed the hypothesis of the quantum nature of the Compton effect [11,12].

Among the tracks of recoiled electrons of a Ra source on photo plates Skobeltsyn has noticed the tracks of much more energetic particles than from the radioactive source (several hundred keV). For the first time, they were mentioned in the paper of 1927 [13] as tracks of particles "of unknown origin with extremely high energy, certainly more than 20 MeV". Further Skobeltsyn found rather many such tracks and named the discovered energetic particles the "sehr schneller β-strahlen". He estimated their energy as

Fig. 2. D.V. Skobeltsyn near his cloud chamber (1924).