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VLADIMIR ALEKSANDROVICH FOCK

(In Honor of his 70th Birthday)

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VLADIMIR Aleksandrovich Fock is one of the world's most eminent theoretical physicists.

The principal milestones in his life are described in an article honoring his 60th birthday as well as in the biographical book by Veselov.[1] At present Fock has authored approximately 200 articles and 5 monographs, some of which are listed in[1].

There hardly exists any book on quantum mechanics, field theory or mathematical physics that does not mention the "Fock method," "Fock space," "Fock theory," "Fock's formulas," "Fock's transform," "the Klein-Fock equation," etc. This fact alone clearly points to Fock's essential contribution to theoretical physics. However, the significance of his works is not exhausted by their specific contents. These works have largely determined the orientation and manner of the mentation of theoreticians, and in this sense Fock can be said to exert a definite influence on the development of the entire present-day theoretical physics.

In a brief article it is not possible to provide a properly detailed idea of the significance of Fock's works to theoretical physics. We shall point out only the most characteristic aspects of his creativity and illustrate them with individual examples.

The profound influence which Fock's ideas had on the development of theory is exemplified by his three following works: First, the widely known method of the self-consistent field with allowance for exchange in atomic theory[2]—the so-called Hartree-Fock method. Second, his study of second quantization in configuration space.[3] The approach developed in these works proved to be highly fruitful in the construction and elaboration of the theory of many-particle systems and the field theory. Both these works and their continuations turned out to be so significant that Fock can be rightfully considered one of the founders of the quantum theory of many-particle systems.

By way of the third example, let us cite Fock's "The Hydrogen Atom and Non-Euclidean Geometry."[4] The direct motive prompting this work was the comparatively specialized question of the so-called random degeneracy in the hydrogen atom. However, the approach developed by Fock in this work, relating the properties of the system to a particular symmetry group, proved to be extremely profound and applicable to a much broader range of problems than the theory of the hydrogen atom alone. At present highly important results in the theory of elementary particles have been obtained by this method.

Speaking of the influence of Fock's works on the development of theoretical physics and the formation of ideas and methods, mention should also be made of the unique fate of these works. Many of them have begun to be properly studied and actively used only many

years after their first publication, sometimes after as many as 20–30 years. This happened, e.g., with the method of functionals, developed by Fock for boson systems with variable number of particles as far back as in 1934. It was only many years later that the ideas underlying this method began to be used in the theory of elementary particles under the name of the Tamm-Dankov method.

Let us cite yet another example pertaining to the problem of "general relativity." There exists a widely known statement by Fock, namely, that a careful distinction must be made between physical reality, i.e., "the statement of the existence of corresponding processes in reference systems of a definite class," and the covariance of the equations. According to Fock, "the general principle of relativity is not feasible as a physical principle applying to arbitrary reference systems. But this principle is likewise not necessary to substantiate the requirement of the covariance of the equations. The covariance of equations can also be substantiated per se. This is a self-evident purely logical requirement." This formulation of the problem is cited from the second edition of his book, Prostranstvo, vremy i tyagotenie (Space, Time and Gravity), which was published in 1961, but the roots of this view can be found even in much earlier articles dating from 1939 and 1947.

As is known, the above views of Fock concerning the general theory of relativity initially met with objections. But Wigner in 1963, in his Nobel Prize lecture,[5] as well as later in an article,[6] supported Fock's view of the problem of invariance in the general theory of relativity. At the Symposium in Honor of the 400th Anniversary of the Birth of Galileo, held in Italy in 1964, a number of physicists also championed Fock's views, as can be seen from the published proceedings. Thus these views are gradually winning recognition and it can be hoped that in the not distant future they will become accepted by the theoreticians.

Special mention and discussion is deserved by Fock's talents as a mathematician. When the young Fock came to Goettingen in the late 1920s, he made a great impression on the theoreticians working there (and Goettingen in the 1920s was one of the world's principal physico-mathematical centers). He was nicknamed there "the big gun of mathematics," In fact, already in his youth he had succeeded in solving problems which among the mathematicians had the reputation of being insoluble, e.g., the problem of the conformal mapping of a quadrange with zero angles onto a half-plane.[7]

A highly indicative example of Fock's prowess as a mathematician is his cycle of studies of the diffraction of radio waves.[8]. He succeeded in completely solving a problem which at one time was given up by such scientists as Sommerfeld and Watson. (A propos, in his study of the diffraction of radio waves around the earth's surface Fock broadly employed spherical functions with a complex index to transform a series in terms of partial waves into an integral, i.e., he had actually used the same technique which had subsequently proved to be so fruitful in the hands of Regge and others in the theory of particle scattering.) It can be stated without exaggerating that an entire stage in the diffraction theory is associated with Fock's name.

In all of his studies, as a rule, Fock either employs the most general and effective mathematical method (if it exists) or develops a new method if needed. He is gifted with an astounding mathematical insight which enables him to determine unerringly the mathematical method or object most appropriate to a given physical problem. All this stamps his works with a special style which may be characterized as "taking the bull by the horns." In this field, too, Fock has largely proved to be ahead of his times. The emphasis on sophisticated mathematics encountered in Fock's work as early as in the 1930's and 1940s has only comparatively recently become an aspect of articles on theoretical physics. (Let us emphasize that we are referring to problems in which this mathematics is essential.)

A highly important part of Fock's scientific creativity are applied problems. This refers to the calculation of the thermal resistance of multicore cable, the skin effect in a ring of circular cross section, the theory of luminosity of surfaces of arbitrary shape, and many other works.

It is difficult to find another example of a theoretician with such an enormous range of interests and, what matters most, accomplishments.

Fock attaches great importance to the philosophic problems of physics. He devotes special attention to the methodology of quantum mechanics and takes an active part in discussions of the fundamental problems of quantum mechanics and relativity theory. The conduct of discussions of this kind sometimes is not easy. Nevertheless, he displays an enviable persistence in reconsidering again and again the most fundamental concepts, striving for the maximum clarity and unambiguity of their interpretation.

Here it should be mentioned that he always emphasizes the influence of the ideas of theoretical physics on philosophy, pointing to the new aspects that should inevitably be included in the circle of the concepts and definitions of philosophy, and that he actively opposes vulgar materialism in the name of genuinely scientific materialism. At present this side of his activities is meeting with recognition not only among the physicists who understand the importance of these problems, but also among a number of materialist philosophers.

Speaking of methodological problems, Fock's study of the fundamental significance of approximation methods should also be mentioned.[9] Although this study was published as early as in 1936, it remains topical to this very day. Thus, e.g., recently in a scientific discussion on the pages of Uspekhi Fizicheskikh Nauk, that article[9] was ardently recommended to readers, since "its contents essentially pertain exactly to the general developmental paths of physics and are of a significance broader than its title implies.[10]

Fock's outstanding abilities, his extraordinary thoroughness of approach manifesting itself in whatever he does, the wide-ranging versatility of his interests, his fundamental contributions to science, have long ago won for him universal esteem and recognition. He has been awarded a number of orders and has won the most meritorious prizes in this country, and also he is a member of a number of foreign academies. However, the most genuine reflection of his accomplishment is, as we have pointed out at the beginning of this article, that there is no book on quantum mechanics, classical and quantum field theory, or mathematical physics that does not, in one way or another, employ methods developed by Fock or the results obtained by him.

[1] M. G. Veselov, Usp. Fiz. Nauk **66**, 695 (1958) [Sov. Phys.-Usp. 1, 321 (1959)]; V. I. Smirnov, Akademik V. A. Fok (Academician V. A. Fock), L., 1956.
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[3] V. Fock, Zs. Phys. **75**, 622 (1932).
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[6] E. Wigner, Physics Today **17**, 34 (1964).

[7] V. Fock, Zh. Leningr. Matem. Obshch-va (Journal of the Leningrad Mathematics Society) **1**, 147 (1927).

[8] V. Fock, Electromagnetic Diffraction and Propagation Problems, Pergamon Press, 1965 (Russian edition is also being prepared by the Sov. Radio Press).

[9] V. Fock, Usp. Fiz. Nauk **16**, 1070 (1936).

[10] Ya. B. Zel'dovich and Ya. A. Smorodinskiĭ, Usp. Fiz. Nauk **89**, 734 (1966).

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