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PAL GOMBAS, IN MEMORIAM

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IN 1971, the life of Professor Pal Gombas, Doctor of Sciences, was unexpectedly cut short. He was a most important Hungarian physicist, a great friend of Soviet physicists, and an active member of the Hungarian Academy of Sciences. The life of Pal Gombas was one of uninterrupted work, research and scientific creativity in the course of more than 40 years, and this not only placed him in the front ranks of Hungarian physicists, but also won him international fame.

Gombas' youth was a difficult one and full of deprivation. After receiving his Ph.D. degree from the University of Budapest in 1932, he was accepted into the Institute of Theoretical Physics under conditions very typical of the time—a position without pay. Only great love for physics and research and only exceptional strength of will and purpose helped him live through this difficult period, during which, in addition to scientific and pedagogical work, he had to give private lessons to provide for his family and himself.

In 1938, Gombas was appointed lecturer and worked for a year as an assistant at the University of Budapest. After this came international recognition of his scientific achievements and he was made Associate Professor of the University of Szeged, and in 1941, Professor and Director of the Institute of Theoretical Physics of the University of Kolozsvar. From 1944 to the end of his life, Pal Gombas directed the Physics Institute of the Budapest Polytechnic.

In the beginning of the 1950's, the government of the Hungarian Peoples' Republic earmarked many resources for the development of science. Namely, the Central Scientific Physics Research Institute was founded then and Gombas directed its Division of Theoretical Physics. From 1954 on he was director of the Research group in Theoretical Physics of the Hungarian Academy of Sciences.

Pal Gombas had highly diverse scientific interests. In the very beginning of his scientific activity, his interest was concentrated on statistical theory of the atom. His student years coincided with the appearance of the brilliant works of Fermi and Dirac. This predestined to a large degree the direction of his interests and he worked on the further development and application of the statistical theory. Gombas was the first to take correlation into account in statistical theory. The statistical model he developed on this basis received universal recognition and was referred to in scientific circles as the Thomas-Fermi-Dirac-Gombas model, a much better model than earlier models for the study and explanation of the properties of valence electrons.

Gombas also worked out a perturbation-theory computation method for the statistical model of the atom with allowance for the influence of the external field and the external perturbed atom. For a long time, he studied the possibilities of a more exact treatment of kinetic energy. The correction for inhomogeneity, which was discovered by him and his co-workers, made it possible to get a very good value of total energy and the density distribution. His work on the application of the statistical model to the description of

the shell structure of the atom led to the creation of a more perfect model which grouped electrons according to principal and magnetic quantum numbers.

From the very beginning, Gombas was certain that the statistical theory with its wide possibilities would make possible the solution of many problems that are almost impossible to solve by the methods of common quantum mechanics. He developed a statistical theory of matter under high pressure and derived relations between the pressure and the density distribution.

A very important property of the statistical method is its clarity, manifest in the fact that the statistical method employs a three-dimensional density function that explains very clearly the properties of atoms, ions, molecules and solids, whereas in the case of Schrödinger's equation the many-body problem is much more complex, since the wave function is defined in a multidimensional configuration space.

The appearance of Gombas' book "Die statistische Theorie des Atoms und ihre Anwendungen" (Statistical Theory of Atoms and Its Application, Vienna, Springer-Verlag, 1949) was not only the culmination of the first stage of development of the statistical theory, but also a strong stimulus for its further development. This extraordinary book, written in a simple, clear, easy-to-understand language, represented a systematic, consistent and complete statement of the theory and a detailed survey of the results received with the aid of the statistical model. With that, special attention is paid to a critical evaluation of the merits and faults of the developed method. Until the appearance of Gombas' book, there were no special books on this subject. It combined all the best features—the clarity of a textbook, the completeness of a monograph and the accuracy of a reference work—and it is therefore not by accident that it became a most valuable part of the world's literature on Physics. A whole generation of physicists throughout the world drew its knowledge about the statistical method from this book. The number of scientific papers which have used and cited this book as its main source has reached several thousands and is constantly increasing. A second great achievement of P. Gombas in this area is his magnificent monograph published in Vol. 36 of Handbuch der Physik (Berlin, Springer-Verlag, 1956), "Statistische Behandlung des Atoms (The Statistical Treatment of the Atom), where the material is presented in an exceptionally clear and compact form.

Already long before, Gombas turned his attention to the possibility of studying separately in the atomic system the valence electron and the core electrons. This led to the idea of using pseudopotentials to describe the influence of the core electrons, after which he derived a number of formulas for the local expression of pseudopotentials of various interactions. The pseudopotential takes into account the part of the kinetic energy of the valence electron in a potential form and thus simplifies appreciably the study of the valence electrons. The use of the pseudopotential for the solution of the problem, on the one hand, decreases by several orders of magnitude the dimensionality of the configuration space in which the operations are performed, and on the other hand it speeds up the convergence of the method. It should be noted that on going to heavier atoms the advantages of the method of pseudopotentials become more and more considerable, and the pseudopotential method itself (based on statistical premises) becomes more exact. From the physics standpoint, the greatest advantage of the method is that the formulation of the problem and the description of the phenomenon become clearer and more obvious.

Gombas' pioneering works in that area laid the foundation for much research and received universal recognition by the physicists. This stage of research reached its conclusion in his book Pseudopotentiale (Pseudopotentials) (Vienna, Springer-Verlag, 1967). An especially important and valuable quality of the book is that together with the presentation of the theory, it also systematically analyzes the use of the theoretical results to solve practical problems and obtain numerical results.

In the very beginning of his scientific activity, Gombas began conducting experiments on the structure of ionic crystals, and afterward developed a unified bond theory for alkali and alkali-earth metals. One of the most important assumptions here was that the bonds of the atoms in these metals can be described by the free-electron wave function, for when the atoms unite to form metals only the eigenfunctions and energies of the valence electrons is essentially changed, and the wave functions of the core electrons remain practically unchanged. Another great achievement was his generalization of this theory to include precious metals. Even today, Gombas' theory is the most general foundation for explaining the metallic bond and the corresponding properties of metals.

Gombas formulated a statistical theory of the nucleus, in which he successfully showed that properties of the nucleus can be explained by means of the statistical theory on the basis of very simple assumption. He showed in this research that besides the unique interaction of the Yukawa type it is essential to include other types of interaction, for example an exponential or Gaussian type of interaction. Not long before his death, he completed an investigation of the structure of pseudonuclear molecules and neutron stars.

All of Gombas' scientific activity was basically connected with the investigation of atomic structures. His first published work (Zeitschrift für Physik, 87, 57 [1953]) was devoted to the explanation of the diamagnetic susceptibility of atoms. After the formulation of the theory of pseudopotentials, he, together with his co-workers, achieved great successes in the investigation of the optical terms of atoms with one and two valence electrons and in the theoretical determination of their electron affinity.

Working together with the members of the theoretical group, Gombas developed several atomic models which were distinguished by simplicity and a relative non-complexity of calculations. The best of these models was published in the book "Solution of the simplified Self-Consistent Field for all Atoms of the Periodic System of Elements from $Z = 2$ to $Z = 92$" (Akademiai Kiado, 1970). Despite its simplicity, this model approximates surprisingly well the results obtained with the aid of the Hartree-Fock self-consistent field method. Gombas' book "Theorie und Lösungs-

methoden des Mehrteilchenproblems des Wellonmechanik (Theory and Solution Methods of the Many-Body Problem in Wave Mechanics, Basel, Birkhauser, 1950) should also be mentioned here. It gives an analysis of the then-known quantum-mechanical methods of analysis of the structures of atoms and molecules.

Gombas published nearly 130 scientific articles, and these, like his books, are all written extremely clearly and simply. Thanks to his publications, Gombas is the best known and most widely cited Hungarian physicist in the world today.

Professor Gombas' pedagogical work was a very important aspect of his activity. His systematic character, clarity of presentation, and exacting nature made him exceptionally suitable for this role. All of these virtues together, along with a deep feeling of responsibility which was always present in him, made his lessons easily understood, full of meaning, and a real source of inspiration for scientific work. Gombas' pedagogical activity can best be evaluated through the survey of his books which he wrote to that end. Already in 1943, at the time of his stay in Kolozsvar, he published the monograph "Bevezetés az atomfizikai többtestprobléma kvantummechanikai elméletébe" (Introduction to the Quantum-Mechanical Theory of the Many-Body Problem in Atomic Physics), which appeared as the 14th volume of the Proceedings of the Kolozsvar University. Other important books are "Bevezetés az atomelmeletbe (Introduction to the Theory of the Atom, Budapest, Mernoktovabbkepzo Intezet, 1947), "Bevesetés a hullámmechanikába és alkalmazásaiba" (Introduction to Quantum Mechanics and Its Applications) (Budabest, Alademiai Kiado, 1967; also translated into German and English). Gombas was not destined to live to see the publication of his monograph on theoretical physics.

After the end of World War II, P. Gombas' scientific achievements received quick recognition in Socialist Hungary. In 1946 he was elected corresponding member and later a full member of the Hungarian Academy of Sciences, and in the period from 1949 until 1958 he was vice president of the Hungarian Academy of Sciences. For his achievements, P. Gombas twice received the Lajos Kossuth Prize, in 1948 and 1950. In 1951, he was awarded the Decoration of the Hungarian National Republic, 3rd degree; and in 1969, on the occasion of his 60th birthday, Gombas was awarded the golden Order of Labor.

Gombas took active part in the work of the Hungarian Physics-Mathematics Society, and later, when the Society split, he took part in founding the Lorand Eotvos Physics Society and was its chairman.

Gombas was the chief editor of the widely-known Hungarian journal "Acta Physica Academiae Scientiarum Hungaricae" from the day of its founding in 1949 to the last day of his life, and managed his editorial work exceptionally attentively, precisely, and with singleness of purpose.

During the time of his activity, Gombas founded a whole school of science. He consistently imparted diligence, humility and a high code of scientific principles to his students and his followers.

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Translated by J. G. Adashko