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Klaus Oswatitsch



Contributions to the Development of Gasdynamics

Edited by Wilhelm Schneider and Max Platzer

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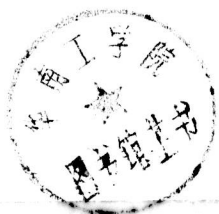
Klaus Oswatitsch

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Selected Papers, Translated on the
Occasion of K. Oswatitsch's 70th Birthday

Edited by Wilhelm Schneider and Max Platzer

With 192 figures



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Klaus Oswatitsch

**Contributions to the Development
of Gasdynamics**

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O. Prof. Dr. Dr. e. h. Klaus Oswatitsch
(Photographer Kobé, Vienna)

Preface

Ever since airplane speeds started to approach the speed of sound, the study of compressible flow problems attracted much talent and support in the major industrialized countries. Today, gas dynamics is a mature branch of science whose many aspects and applications are much too numerous to be mastered by a single person or to be described in a few volumes.

This book commemorates the 70th birthday of a great pioneer and teacher of gas dynamics, Dr. Klaus Oswatitsch, Professor of Fluid Mechanics at the Technical University of Vienna and former Director of the Institute for Theoretical Gas Dynamics, Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt. Several reasons motivated us to prepare an English translation of Oswatitsch's selected scientific papers. First, we hope that a book containing his major papers will be welcome as a valuable reference text in gas dynamics. Oswatitsch's work is frequently used in the literature in one form or another, but it is usually quite time-consuming for the English speaking reader to consult the original texts. As a result, reference to and understanding of his papers is often incomplete. For example, Oswatitsch's formulation of the equivalence rule hardly ever is quoted in recent textbooks, although it preceded declassification of Whitcomb's results by several years. Furthermore, his papers contain much information, which has not yet been fully appreciated in the Anglo-American literature. This is particularly true for his more recent work on analytical characteristics methods. Hence, we hope that this book will provide the reader with an easy access to many now classical results and, at the same time, draw his attention to new methods and insights. Last, but not least, we hope that the book also provides a glimpse at Professor Oswatitsch's career and human qualities. We believe that all those who have the good fortune of knowing him more intimately, especially his students and collaborators, share our appreciation for his exemplary integrity, dedication, enthusiasm and human warmth.

Therefore, it was no surprise to us that our suggestion to collaborate on the translation of Oswatitsch's selected papers was readily supported by our colleagues. We are especially indebted to all the translators listed on page VI. Whereas the galley proofs of the translated papers were corrected by the translators themselves, the proof-reading of the printed papers was done by G. Anestis, H. Pächter, Dr. K. Potsch, J. Riedler, Dr. G. H. Schneider, O. Urbanek and M. Wacławiczek. M. Horvat and Mrs. H. Kasper provided valuable organizational and editorial support. Mrs. A.

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Klaus Oswatitsch: His Scientific Career and Work

Being a former student of Professor Oswatitsch I can hardly avoid including my personal points of view in the following broad outline of my teacher's scientific career and work. To begin with, the very situation Professor Oswatitsch found when he returned to his native country after many years abroad can be described only by my personal impressions. Fluid mechanics, as being traditionally taught in 1960 in Vienna, was to me as well as to most of my fellow students a rather arid science, in which great pains were taken applying hundred and more years old physical laws to problems having almost no relation to modern technological developments.

This changed drastically when Oswatitsch came to Vienna. The fact that he came was quite surprising to most observers of the appointment procedure. They considered Oswatitsch "too great" for Austria, and this opinion proved to be correct in so far as during 18 years, namely until two years ago, Oswatitsch held not only his professorship in Vienna but also remained in charge of a research institute in Germany.

Oswatitsch's first lectures in Vienna strongly impressed the scientifically interested students. Although rhetorically by no means perfect, the lectures were masterpieces with respect to concentration on the essential and were presented with the enthusiasm and the authority of a man who himself has made important contributions to the development of his field of science. How had things come about?

Klaus Oswatitsch was born on March 10, 1910, in Marburg an der Drau, then Austria, the son of a judge of high rank. He studied mathematics and physics in Graz, Austria. Considering the bad economic situation of the time, he took not only purely scientific courses but also passed the examinations for a grammar-school teacher. Nevertheless, the young university graduate was unable to find a suitable job in Austria.

Therefore the 28-year-old Dr. Oswatitsch, equipped with a scholarship of the Deutsche Forschungsgemeinschaft, went to Göttingen to do research work at the Kaiser-Wilhelm-Institut (now Max-Planck-Institut) für Strömungsforschung. This step, taken out of necessity, eventually proved to be a stroke of luck, because the director of the Institute was nobody less than Ludwig Prandtl.

Prandtl had to introduce the graduated physicist Oswatitsch to the knowledge of fluid mechanics of that time; for his new scholar had hardly learned anything about it during his studies. He also had to strengthen the young Oswatitsch's self-confidence, which was rather disturbed at that time. I know from many talks with Professor Oswatitsch that today he rates this human aspect of his apprenticeship under Prandtl's guidance at least as high as the scientific stimulation he received. And from my own experience I know how much Oswatitsch, as a teacher, promotes his students' self-confidence and encourages their self-reliance. In this respect, too, he pursues the tradition of an outstanding scientist.

It is no longer possible to evade the difficult task of appreciating Oswatitsch's scientific work. One should do that as simply as possible by omitting all details, since Oswatitsch himself has often said that the essential of a scientific theory ought to be expressed in simple terms. But describing the work of a scientist of such great productivity one is also faced with a quantitative problem: About 130 publications, among them several books and handbook articles, cannot be disposed of in a few sentences. The reader who wishes to recognize the wide range and variety of Oswatitsch's work may consult the list of publications at the end of this article. Only a very small part (but, hopefully, an important one) of that work could be included in this book, and even less can be mentioned in what follows.

One of the first papers was concerned with the condensation of water vapor in the flow of humid air. The theoretical investigations then performed by Oswatitsch in Göttingen have for decades been of great importance for the development of high-speed wind tunnels, and they are still the basis of our present theories.

In another of the early papers Oswatitsch stated his entropy theorem, which relates the drag of a body to the entropy increase in the flow field. This is already a good example of how Oswatitsch likes to reconsider fundamental aspects of fluid mechanics by shedding new light on classical problems.

Of great technological and economic importance has been the shock diffusor that was developed by Oswatitsch. The recovery of pressure energy from kinetic energy is known to be particularly difficult in supersonic flow. In the shock diffusor, however, it can be done with relatively small energy losses.

After the end of the World War, Oswatitsch had to leave Göttingen. He spent some years in England, France and Germany. Then he came to Stockholm, where he taught from 1949 to 1956 at the Kungl. Tekniska Högskolan and was also engaged as a consultant to the SAAB aircraft and the Stal-Laval Turbine corporations. In this creative period Oswatitsch made great contributions to the formulation of several new laws of similarity and equivalence. His widespread interest covered not only the already classical domains of subsonic and supersonic speeds but also the rapidly developing fields of transonic flow, hypersonic flow, and three-dimensional flows about slender bodies at all Mach numbers. Particular emphasis must, of course, be put on

Oswatitsch's contributions to the theory of transonic flow. Oswatitsch stuck to this difficult but fascinating field for many years, even in a period of time in which it was considered out-of-date. In recent years, Oswatitsch was able to reap the fruits of his persistence. Due to modern developments in passenger aircraft design, transonic flow has again become fashionable.

In the last decade Oswatitsch dedicated a considerable part of his time and of his ideas to the treatment of the processes of wave propagation in gases. A very powerful method for calculating the propagation of waves in gases has been developed by a systematic continuation and extension of the work of various predecessors. This method has been applied by Oswatitsch himself and by several of his students to many problems of practical importance. Sonic boom and acoustic phenomena connected with explosion waves or the supersonic flow around delta wings as well as in cascades of turbines and compressors may be mentioned as some examples.

Klaus Oswatitsch has influenced the development of gas dynamics not only by his research work but also by his books and survey articles. Here, first of all, the book on "Gasdynamik", first published in 1952 in German, has to be mentioned. The book has been translated into English and even into Chinese. Originating from a planned second edition, two new volumes on the fundamentals of gasdynamics and its special fields have been written. Published recently, they give — as the first edition — a unique survey of a difficult subject which is of interest to engineers, physicists and mathematicians alike.

Oswatitsch considers himself primarily a scientist, and he likes to call himself a bad organizer. This self-criticism may even be correct if, following a regrettable trend, one thinks organization is equal to pure administration. From the latter Oswatitsch always kept his distance. This, however, did not prevent him from doing great constructive work. Thus in 1956 Oswatitsch assumed responsibility for the setup and the direction of the Institut für Theoretische Gasdynamik in Aachen. Within a few years he guided the Institute to international reputation, and finally, in a time in which research planning counts more than doing research itself, he fought successfully for the survival of the Institute, agreeing to a reorganization and to a transfer to another place. In Vienna, too, Oswatitsch succeeded in developing teaching of and research in fluid mechanics despite unfavorable conditions with respect to room and money. 32 young scientists did their doctoral theses under Oswatitsch's guidance. Their successful activities in domestic as well as foreign industrial corporations, research institutes, and universities give evidence of the high standard of their scientific education. Oswatitsch's human relations with his students become obvious when one takes a view of his offices in Vienna and Göttingen: Being a patriarch in the best sense of the word, he is surrounded by the photographs of his many "scientific sons" — and of one "daughter"!

Klaus Oswatitsch has been awarded many honors and distinctions in recognition of his work. He is a member of the International Academy of Astronautics in Paris, the Deutsche Akademie der Naturforscher Leopoldina in Halle, and the Royal Swedish Academy of Sciences in Stockholm; he was given honorary doctor's degrees from the Universität Karlsruhe and from the Kungl. Tekniska Högskolan in Stockholm; and he holds the Ludwig-Prandtl-Ring of the Deutsche Gesellschaft für Luft- und Raumfahrt. The latest award was the Technik-Preis der Wiener Wirtschaft. One can be sure that other honors will follow. It is encouraging to know that Professor Oswatitsch himself considers the honors and awards a consequence both of his achievements and of his age.

W. Schneider

Scientific Publications

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English translation (by G. Kuerti), 625 pages, New York, Academic Press Inc. 1956
Chinese translation, 670 pages, Peking, Science Publishing Inc. 1965
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