

***WERNER HEISENBERG***  
***A BIBLIOGRAPHY OF HIS WRITINGS***

Compiled by

David C. Cassidy

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## Introduction

Most bibliographies of the writings of scientists, especially scientists of the twentieth century, have concentrated upon their technical research reports. Yet most influential twentieth-century scientists have, owing to their scientific stature, exerted considerable influence upon the culture, politics, and social standing of science through their numerous writings aimed at general readers. In this bibliography of the works of the German physicist Werner Heisenberg (1901-1976), all of his published writings, as well as references to all re-publications and translations of them, have been included. Interviews are also included, since Heisenberg granted a considerable number of interviews and occasionally used interviews as vehicles for reaching the public quickly and directly.

This is the second edition of *Werner Heisenberg: A Bibliography of His Writings*, first published by the Office for History of Science and Technology, University of California, Berkeley, 1984 (*Berkeley Papers in History of Science*, vol. IX). This second edition, which is prepared in celebration of the centenary of Heisenberg's birth, includes many new publications as well as a host of reprints and new translations since 1983, attesting to the continued public interest in Heisenberg and his science. The approach and presentation continue to follow the style of the other bibliographies in the *Berkeley Papers* series.

Since the publication of the first edition, Heisenberg's published works referenced in the first edition of the bibliography have been collected and republished in facsimile in the 10-volume *Heisenberg Gesammelte Werke/Collected Works* (Springer-Verlag and Piper Verlag), edited by W. Blum, H. P. Dürr, and H. Rechenberg. These volumes also include first publications of previously unpublished manuscripts, many from the Heisenberg files. Significant among the new publications are the 22 declassified research reports authored or co-authored by Heisenberg on German nuclear fission research during World War II (see 1989a). In this second edition of the bibliography, a reference to the location in the *Collected Works* is provided under each entry in the bibliography that represents a first publication. Works published for the first time in the *Collected Works* are listed in the year the volume appeared.

Although bibliographies are compiled to be consulted, not read, significant insights into Heisenberg's scientific and cultural activities may be gained from a perusal of the items listed here. In statistical terms, the list contains a total of 1165 entries, including the listed members

of collections. Of these 1165 entries, over half (587) are first publications. Divided into decades, the most technical research reports (55) appeared during the 1920s (30) and 1930s (25) as Heisenberg helped to formulate quantum mechanics and to apply it in many areas of research. The most non-technical writings for general audiences (209) appeared during the postwar decades, the 1960s (114) and 1950s (95). The postwar era also witnessed the greatest exploitation of Heisenberg's writings through numerous reproductions, translations, translations of translations, and excerpts. The latter have turned up in such diverse locations as desk calendars (1949p), prayer books (1972z, 1979b), and readers for Japanese school children (1967k, n). Such attention to Heisenberg's writings probably derived less from Heisenberg himself than from a phenomenal fascination with the wisdom of scientists in the nuclear age and from efforts to cash in on the resulting market. A peculiar fascination with the fateful but seemingly incomprehensible aspects of science also motivated such activity. The learned editors of the *Frankfurter Hefte* declared upon reprinting Heisenberg's non-technical sketch of the early history of quantum theory, delivered to a general meeting of German scientists and doctors (GDNA) in 1950: "We are publishing this lecture although we are convinced that not 5% of our readers will understand it. Even we have not understood it and do not understand it, for we are no specialists in physics. But we hold this manuscript to be a classic document showing what is occurring in our world today and on what our fate can depend" (1951j, p. 395).

An indication of the topics treated in these writings, and of the audiences to which they were delivered, may be gathered from the index. The technical works follow fairly closely the problems of quantum physics, with a sprinkling of other subjects such as hydrodynamics. Quantum mechanics and its interpretation occupied Heisenberg's attention during the 1920s; quantum field theory, nuclear and cosmic-ray physics during the 1930s; nuclear energy production, particle physics, turbulence, and superconductivity during the 1940s; and unified field theories of elementary particles thereafter. Many of the technical works of the late 1940s originated during his internment at Farm Hall in England at the end of the war.

The subjects of Heisenberg's writings directed at educated audiences of non-specialists tend to display the epistemological concern found in the works of other physicists of the time. Although interest today in the meaning and implications of the so-called uncertainty principle is high, owing in part to the recent play "Copenhagen," Heisenberg wrote surprisingly little directly on this subject, even for general audiences. Those audiences were apparently

eager to hear less about technical principles than about broader issues surrounding the impact of physics on the human condition and on our outlook on the natural world in the quantum and nuclear age.

Beginning in the 1930s Heisenberg's writings for general, educated audiences also increasingly reflected the fate of German science. When Heisenberg and theoretical physics fell under ideological disfavor during the Third Reich, he attempted to convince scientific and lay audiences that the new quantum and relativity theories were not superfluous obfuscations introduced by a foreign or Jewish "spirit" in science (as claimed by Nazi ideologues), but rather products of continuous, reasonable scientific research and tradition extending over centuries. The first edition of his most popular essay collection *Wandlungen* (1935i) contained two such historical accounts. This theme remained in his historical writings long after 1945 (see 1973q). In addition, Heisenberg never failed during the 1930s to inform wider audiences immediately of any new advances in physics, and of the likelihood of more if German physicists were only left alone, and even given more support (1939g)—themes that recurred thereafter in his works. That German audiences were eager for such information is indicated by the fact that Hans Geiger, co-inventor of the Geiger counter, had to repeat his non-technical lectures in Berlin two or three times to audiences of over 1000.

In the postwar period, Heisenberg's non-technical works continued to reflect the situation in German science. Max Planck, approaching ninety, had effectively retired, and Heisenberg, taking his place, pleaded the case for science at the seats of power. His approach to the public took an even more direct and oral character than earlier. The majority of his non-technical publications after 1945 originated as popular public addresses. While offering a variety of epistemological and historical surveys of recent physics, Heisenberg took up the political cause through lectures on the necessity of German federal support of research and through a successful memorandum to the new Bundestag (1949m). Two of his most frequently republished essays, 1946h and 1949o, on international relations in science and the need for a well-rounded education, stem from the same period. (See *The Essential Heisenberg*.)

Beginning in 1953 Heisenberg's political writings reflected a new task as the western allies prepared to grant full sovereignty to the German Federal Republic and to remove all restrictions upon German nuclear research. Heisenberg and many of his colleagues launched a public campaign for a crash program on nuclear-energy development. At the same time they sought (successfully) a renunciation of German nuclear weapons possession and research

(1955x, 1957r). Interviews and press statements on such topics abound in this period. During this period Heisenberg also produced a considerable number of obituaries and contributions to Festschriften. As president of the Alexander von Humboldt-Stiftung, he authored many conference addresses and forwards to foundation publications. For more information on Werner Heisenberg and his times, see D. Cassidy, *Uncertainty: The Life and Science of Werner Heisenberg* (New York: W.H. Freeman, 1992), and the World-Wide Web site *Heisenberg and the Uncertainty Principle* at <http://www.aip.org/history/heisenberg>.

The first edition of this bibliography drew upon two earlier listings, one prepared by Heisenberg's long-time secretary Frau Annemarie Giese, the other compiled by Henry Lowood. It made extensive use of Heisenberg's papers and files, currently housed in the Werner Heisenberg Archive at the Werner Heisenberg Institute for Physics of the Max Planck Institute for Physics and Astrophysics in Munich. I thank Dr. Helmut Rechenberg and the late Frau Elisabeth Heisenberg for granting me access to this collection. My thanks to Dr. Rechenberg and to Dr. Gerald Wiemers, Archive of the University of Leipzig and Saxon Academy of Sciences, for their continuing advice and support. I am sincerely grateful to the following for their generous support and assistance: the Alexander von Humboldt-Stiftung, the Werner Heisenberg Institute for Physics, the Center for History of Physics of the American Institute of Physics, the Office for History of Science and Technology of the University of California-Berkeley, and Whittier Publications, Island Park, NY.

A Web version of this bibliography may be found through a link on the Heisenberg Web site given earlier.

*David C. Cassidy*

## ***The Essential Heisenberg***

Reprints of the following and locations in HGW are indicated in the bibliography as indicated below. Further translations into English and other languages are also indicated under each reference in the bibliography.

### ***Top Ten Scientific Papers***

1. Uncertainty Principle, 1927c
2. Quantum Mechanics, 1925d
3. Molecular Exchange force, 1926d or 1926e, 1927b
4. Neutron-proton model of the nucleus (3 parts), 1932c, 1932d, 1933a
5. Quantum field theory (2 parts), 1929a, 1930a
6. Ferromagnetism, 1928a
7. Hydrodynamics, 1924b, 1948a,
8. S-matrix theory (4 parts), 1943a, 1943b, 1944a, 1989a.23 (previously unpublished)
9. Multiple processes, 1936b, 1938a, 1949c
10. Non-linear field equations, 1953a, 1955a, 1957a, 1957b.

### ***Work Cited in Award of Nobel Prize for Physics (1933 for 1932)***

Molecular exchange force, 1926d or 1926e, 1927b

### ***Top Ten most Popular Essays for General Audiences***

1. "Wandlungen der Grundlagen der exakten Naturwissenschaft in jüngster Zeit." 1934e.  
English: "Recent Changes in the Foundations of Exact Science," in 1979c.  
Talk delivered to German Scientists and Physicians in Hannover, 17 Sep 1934.
2. "Gedanken der antiken Naturphilosophie in der modernen Physik." 1937d.  
English: "Ideas of the Natural Philosophy of Ancient Times in Modern Physics," in 1979c.
3. "Wissenschaft als Mittel zur Verständigung unter den Völkern." 1946h  
English: "Science as a Means of International Understanding," in 1979c.  
Address to Göttingen students, 13 Jul 1946.
4. "Naturwissenschaft und humanistische Bildung," 1949o.  
English: "Classical Education, Science and the West," in 1970i.  
Address delivered to celebration of 100th anniversary of the Maximilians-Gymnasium, Munich, 13 Jul 1949.
5. "Atomphysik und Kausalgesetz." 1952i.  
English: "Atomic Physics and Causal Law," in 1970i.  
Lecture in the series "Die neue Weltschau" delivered to Handelshochschule, St. Gallen, Switzerland, Feb 1952.
6. "Das Naturbild der heutigen Physik." 1953e.  
English: "The Idea of Nature in Contemporary Physics," in 1970i.  
Lecture to meeting of Bayerische Akademie der Schönen Künste, Munich, 17 Nov 1953.
7. "Die Plancksche Entdeckung und die philosophischen Grundfragen der Atomlehre." 1958j.  
English: "Planck's Discovery and the Philosophical Problems of Atomic Theory," in 1974g.  
Lecture delivered to Verband Deutscher Physikalischen Gesellschaften on occasion of 100th birthday of Max Planck, on 25 Apr 1958 in Berlin.
8. "Ὁ φυσικὸς κόσμος καὶ ἐδομητῶν τῆς οὐλῆς." 1964e.  
English: "Natural Law and the Structure of Matter," in 1974g, 1981d.  
Lecture delivered on Pnyx in Athens, 3 Jun.

9. "Die Bedeutung des Schönen in der exacten Naturwissenschaft." 1971d.  
English: "The Meaning of Beauty in the Exact Sciences," in 1974g.  
Address delivered to annual meeting of the Bayerische Akademie der Schönen Künste in Munich, 9 Oct 1970.
10. "Die Abstraktion in der modernen Naturwissenschaft." 1960d.  
English: "Abstraction in Modern Science," in 1974g.  
Address upon the receipt of the Ordre pour la mérite, 1960.

### ***Most Popular Monographs and Essay Collections***

1. *The Physical Principles of the Quantum Theory*. Chicago: University of Chicago Press. 1930c.  
Lectures on the new quantum mechanics, University of Chicago, 1929.
2. *Wandlungen der Grundlagen der exakten Naturwissenschaft*. Leipzig: S. Hirzel. 1935i and later expanded editions.  
English: *Philosophical Problems of Quantum Physics* (Formerly: *Philosophical Problems of Nuclear Science*). 1952g.
3. *Das Naturbild der heutigen Physik*. Hamburg: Rowohlt. 1955n.  
English: *The Physicist's Conception of Nature*. 1970i.
4. *Physics and Philosophy: The Revolution in Modern Science*. New York: Harper and Row. 1958r.  
Gifford Lectures at the University of St. Andrews, Scotland, winter 1955-1956.
5. *Introduction to the Unified Field Theory of Elementary Particles*. New York: Interscience; London: Wiley and Sons. 1966e.  
Lectures at the University of Munich in summer semester 1965.
6. *Der Teil und das Ganze: Gespräche im Umkreis der Physik*. Munich: R. Piper. 1969e.  
English: *Physics and Beyond: Encounters and Conversations*. 1971l.  
Memoirs written in dialogue form.
7. *Schritte über Grenzen: Gesammelte Reden und Aufsätze*. Munich: R. Piper. 1971u.  
English: *Across the Frontiers*. 1974g.

8. *Tradition in der Wissenschaft. Reden und Aufsätze.* Munich: R. Piper. 1977h.  
English: *Tradition in Science.* 1989b.

### ***Format and Abbreviations***

Under the first appearance of each item are references to every later appearance in the bibliography; and, under every later appearance, a reference to the first. One can easily reconstruct the printing history of each item. At the first appearance of a collection all of its articles are listed and assigned a decimal number. For example, if “1935i” is a collection, then “1935i.1” is its first member.

A reference to the location in the *Collected Works* is provided under each item in the bibliography that is the source for a work contained in the *Collected Works*. As described below in the list of abbreviations, the reference HGW: A1, 134-158, for instance, indicates that the paper is included in the *Collected Works* (HGW), in series A, volume 1, pages 134 to 158. Locations of further information on each volume are indicated in the list below. However, only first publications are listed separately under each reference to a volume of the *Collected Works*.

An asterisk (\*) designates an item I have not yet seen, a double asterisk (\*\*) missing information. I have provided descriptions when possible and appropriate, but I have not tried to identify variants in any detail.

The following abbreviations are used:

*AP* *Annalen der Physik*

*AW* Akademie der Wissenschaften

*DW* *Die Welt*

*FF* *Forschungen und Fortschritte*

GDNA Gesellschaft Deutscher Naturforscher und Ärzte

HGW xy, z Heisenberg, *Gesammelte Werke / Collected Works*

x = series, y = volume, z = pages

Series A: *Original Scientific Papers*, 3 vols. (vol. 1: 1985a; vol. 2: 1989a; vol. 3: 1993a)

Series B: *Scientific Review Papers, Talks, and Books*, 1 vol. (1984a)

Series C: *Philosophical and Popular Writings*, 5 vols. (vol. 1: 1984b; vol. 2: 1984c; vol. 3: 1985b; vol. 4: 1986a; vol. 5: 1989b)

<i>Mt</i>	<i>Mitteilungen</i>
<i>NC</i>	<i>Il Nuovo Cimento</i>
<i>Nwn</i>	<i>Die Naturwissenschaften</i>
<i>PB</i>	<i>Physikalische Blätter</i>
<i>PZ</i>	<i>Physikalische Zs</i>
<i>SZ</i>	<i>Süddeutsche Zeitung</i>
<i>UFN</i>	<i>Uspekhi fizicheskikh nauk</i>
<i>Un</i>	<i>Universitas</i>
<i>Vh</i>	<i>Verhandlungen</i>
<i>WH</i>	Werner Heisenberg
<i>ZaC</i>	<i>Zs für angewandte Chemie</i>
<i>ZN</i>	<i>Zs für Naturforschung</i>
<i>ZP</i>	<i>Zs für Physik</i>
<i>Zs</i>	Zeitschrift

The following language codes are used:

<i>Ab</i>	Arabic
<i>Ch</i>	Chinese
<i>Cn</i>	Castilian
<i>Cz</i>	Czech
<i>Dn</i>	Danish
<i>Dr</i>	Dravidian (India)
	Dr:K Kanarese
	Dr:M Malayalam
	Dr:T Telugu
<i>Du</i>	Dutch
<i>En</i>	English
<i>Fr</i>	French
<i>Ge</i>	German
<i>Hu</i>	Hungarian

It	Italian
Jp	Japanese
Nw	Norwegian
Pg	Portugese
Po	Polish
Rm	Rumanian
Ru	Russian
Sb	Serbocroatian
Sp	Spanish
Tk	Turkish