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# Analysis of Informational Ties Dynamics in Early Quantum Mechanics (1925-1927)

The rise of quantum mechanics (QM) has been already investigated fairly well.[1)] In these studies, however, the main attention has been usually paid to the conceptual development of the theory and to the way the ideas appeared in the minds of scientists, so the process has been considered in the third and second Popper's worlds. But there exists also the world of socium (society) and its consciousness, which differs from that of individuals. In this world the development of scientific theory should be considered as a process of the spread of information, the perception of new ideas, the formation of scientific community. This is the subject of the present paper.

To describe such features of the theory as a whole, as, for instance, the scientific consensus, or the paradigm, one usually seeks for individual views, which can be treated as "typical examples". In doing so, Mehra and Rechenberg [2)] present the perception of QM in a series of concrete cases of how the scientists became involved in the new theory. We try another approach and do not restrict ourselves to the analysis of few, let it be even the most typical examples.

Instead we will base our investigation on the study of the complete array of publications of QM and we will try to supplement qualitative and intuitive estimations by quantitative ones.

The chronological frames of this work are July 1925, just the very beginning of the theory, and February 1927. The whole array contains about 200 articles and books. [3]

There exists also the problem of demarcation. Although we paid much attention to citations, references to the main papers on QM were not sufficient for us to include the publication into examination. It was necessary that QM in one of its forms (wave or matrix) was considered by the author as a paradigm for his own scientific work. We do not include the pure experimental papers, if they did not contain theoretical part - quantummechanical calculations. But the papers, which are wrong from the modern point of view, as well as those, which go beyond the framework of conventional QM (relativistic generalisations, 5-dimensional theories and so on) are presented here. We also take into consideration reviews, books and discussions of philosophical implications of the theory.

## § 1. Quantitative growth and spread of information

We date the papers by the moment, the work was finished, not by the date of publication. Then the total number of references from July 1925, when the first article by Heisenberg was written, till March 1927 is 203. The corresponding growth in time is depicted of Fig. 1. 80 Authors from 14 countries made their contribution to the theory.

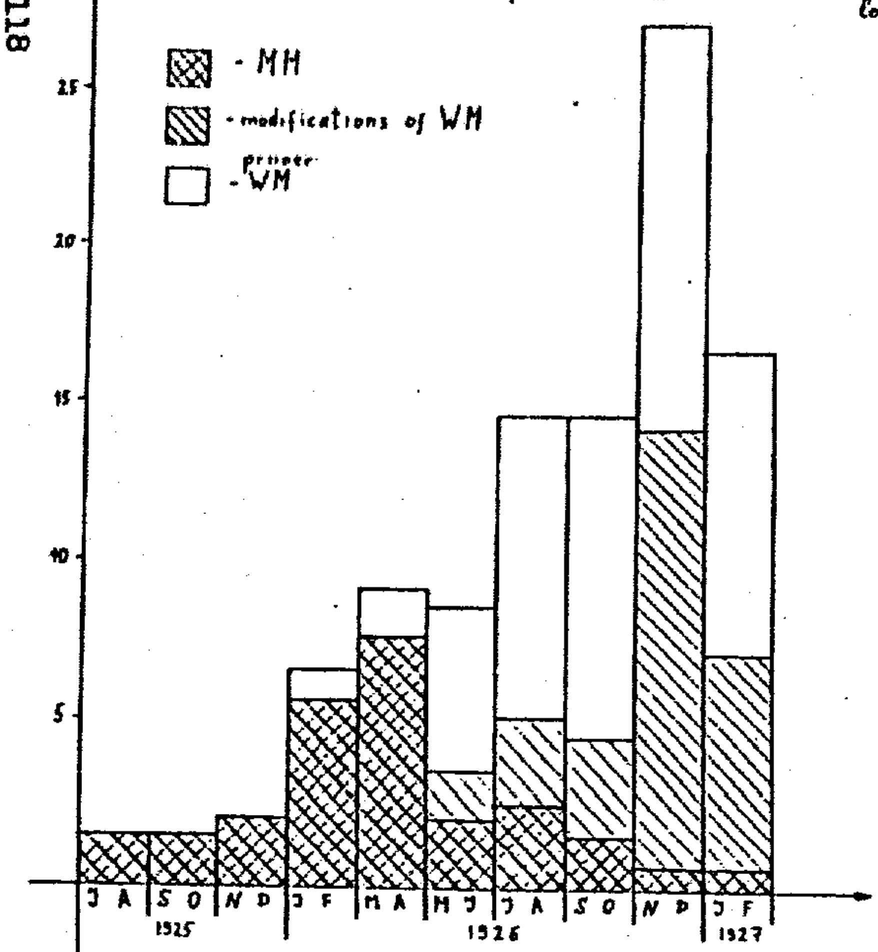
Such an intense development looks quite extraordinary even from the modern point of view, and 60 years ago it was unprecedented. Even the most important papers, as Planck's in 1900, Einstein's in 1905, Bohr's in 1913 did not result in such explosion. The amount of publications on QM doubled every two-three months (see the characteristic parameters in fig. 1 b), and after a year QM became a noticeable part of physics, constituting up to few percent of the current publications.[4] Let us leave for a while the possible causes of such an enthusiasm and discuss only the technical possibility of this rapid spreading of information. We will try to estimate some important parameters.

a) The rapidity of publications in journals. For most of the papers we know the dates of the receipt of the article by editors and the "Redaktionschluss". The typical difference between them is less than 2 months. Adding the time for print and mail, we can conclude, that the European reader got the papers something about 3 months after they were finished and sent to the editors. An additional half a month was required for the readers in the USSR, and about a month for those in the USA.[5]

b) The rapidity of response. One or two months were often sufficient time to invent and prepare an article. The most active participants prepared one paper per two months. Even quite new ane unusual ideas were accepted rapidly and the scientists usually received a response to them soon after the publication. There are some characteristic cases in Fig. 2, when information was transmitted throught publication in journals without personal contacts.

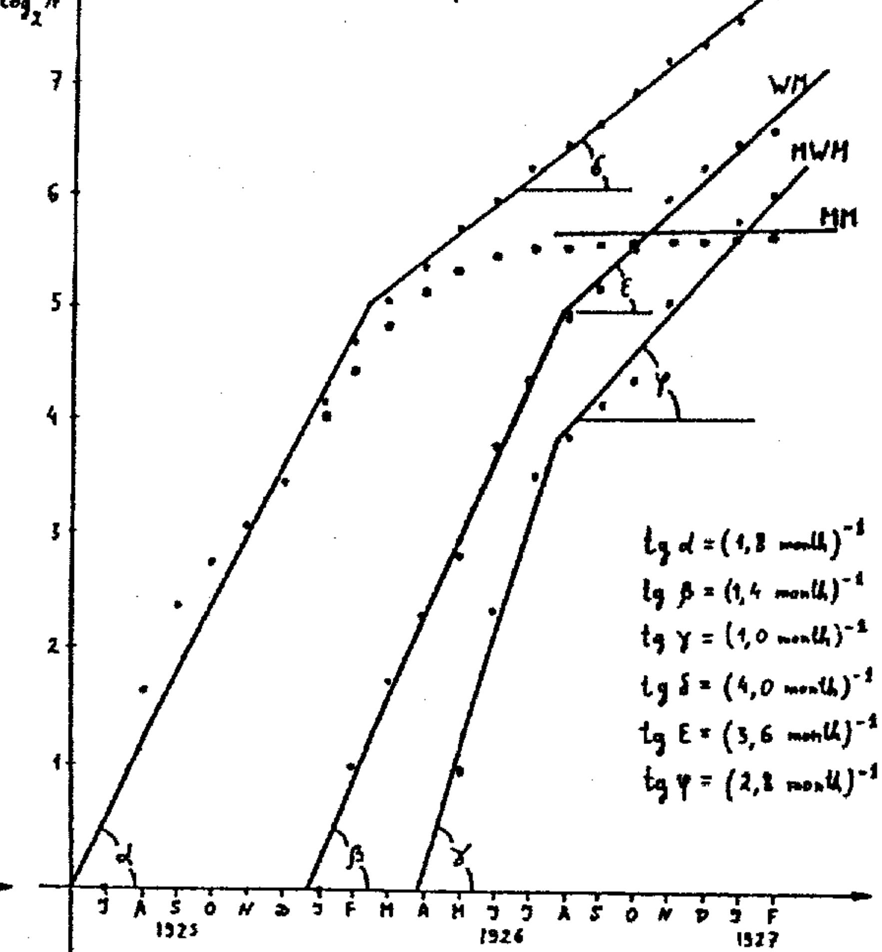
Thus the whole round from the preparation of an article, through its publication to the preparation of article--response sometimes could be finished in 4 months, and important papers received a rather wide response in a characteristic time about 5 or 6 months.[6]

Fig. 1a. Publications per month.




| | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1925 | | | | | | 1926 | | | | | | | | | | | | 1927 | |
| MM | 1 | 2 | 2 | 1 | 2 | 2 | 6 | 5 | 7 | 8 | 2 | 2 | 5 | 0 | 2 | 1 | 1 | 0 | 0 | 1 |
| WM | | | | | | | 1 | 1 | 1 | 2 | 2 | 6 | 7 | 8 | 7 | 13 | 12 | 14 | 12 | 7 |
| MWM | | | | | | | | | | | 2 | 3 | 5 | 4 | 3 | 3 | 15 | 12 | 5 | 8 |
| Σ | 1 | 2 | 2 | 1 | 2 | 2 | 7 | 6 | 8 | 10 | 6 | 11 | 17 | 12 | 12 | 17 | 28 | 26 | 17 | 16 |

Fig. 1b. Growth of publications.




| | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1925 | | | | | | 1926 | | | | | | | | | | | | 1927 | |
| MM | 1 | 3 | 5 | 6 | 8 | 10 | 16 | 21 | 28 | 36 | 38 | 40 | 45 | 45 | 47 | 48 | 49 | 49 | 49 | 50 |
| WM | | | | | | | 1 | 2 | 3 | 5 | 7 | 13 | 20 | 28 | 35 | 48 | 60 | 74 | 86 | 93 |
| MWM | | | | | | | | | | | 2 | 5 | 10 | 14 | 17 | 20 | 35 | 47 | 52 | 60 |
| Σ | 1 | 3 | 5 | 6 | 8 | 10 | 17 | 23 | 31 | 41 | 47 | 58 | 75 | 87 | 99 | 116 | 144 | 170 | 187 | 203 |

Fig. 2

| initial paper | received by editor | Redaktionsschluss | led to article | which was received by editor |
|---|---|---|---|---|
| Born-Jornad | 27.09.35 | 28.11.25 | Lanczos | 22.12.25 |
| Born-Heisenberg-Jordan | 16.11.25 | 4.02.26 | Schrödinger | 18.03.26 |
| Schrödinger | 27.01.26 | 13.03.26 | Eckart | 31.05.26 |
| Schrödinger | 27.01.26 | 13.03.26 | Fock | 11.06.26 |
| Born | 21.07.26 | 14.09.26 | Slater | 26.11.26 |
| Heisenberg | 11.06.26 | 10.08.26 | Wigner | |
| Dirac | 26.08.26 | 1.10.26 | | 12.11.26 |

c) Personal contacts. The publications in journals and private communications were the supplementary routes of information, their role was of the same order of magnitude. [7] It seems, that the role of personal contacts was extremely important in the spreading of rumors about the new perspective field, which drew attention to the latter. Of course, the texts were necessary for a detailed study of the theory, but for this purpose also the reading of manuscripts of proof-sheets was in practice. (The references in the articles often inform about such things).

However, personal contacts not always leave their traces in the resulting texts, so it is necessary to invoke biographical data to estimate more properly their significance. We were able to do so in the case of Matrix mechanics (MM). Personal contacts connected 15 scientists out of 22, who comprehended MM in its first year. [8] The special role was played by Born's visit to America, Heisenberg's influence on visitors in Copenhagen, as well as Born's in Göttingen.

Schrödinger seemed to display less activity in the distribution of his ideas. However those ideas were popularized by such prominent scientists as Debye and Sommerfeld, but we have not enough information to conceive their role.

## § 2. The pattern of approaches and controversy of interpretations

Let us now put aside 10 publications, which we consider as reviews. They will be discussed later on. We will not also consider now the translations to other languages and preliminary communications of the results as independent works. The total number of papers then reduced to 166, they are all indicated in fig. 3.

We indicate there the abbreviations of the names of the authors, and the date, when the article was finished, with an accuracy to a month. Sometimes this date is pointed out by the author himself in the text of an article, otherwise, we took the date, when the article or the preliminary publication was received by the editorship of the journal. Only in few cases none of this dates is known and it was necessary to estimate date according to characteristic time, required for publishing procedures and other available information. In the references inside the text we will also indicate the author and the month. This information allows one to find unambiguously the work in the bibliography and in fig. 3.

Most of the papers are united in groups described below. The lines show the influences of such a group (paper) on another group (paper). These influences were found out with the help of citation analysis taking into account also the content of the papers. Of course not all, but only essential influences are depicted.

Fig. 3 enables us to form a general impression of the structure of trends of scientific research and its evolution

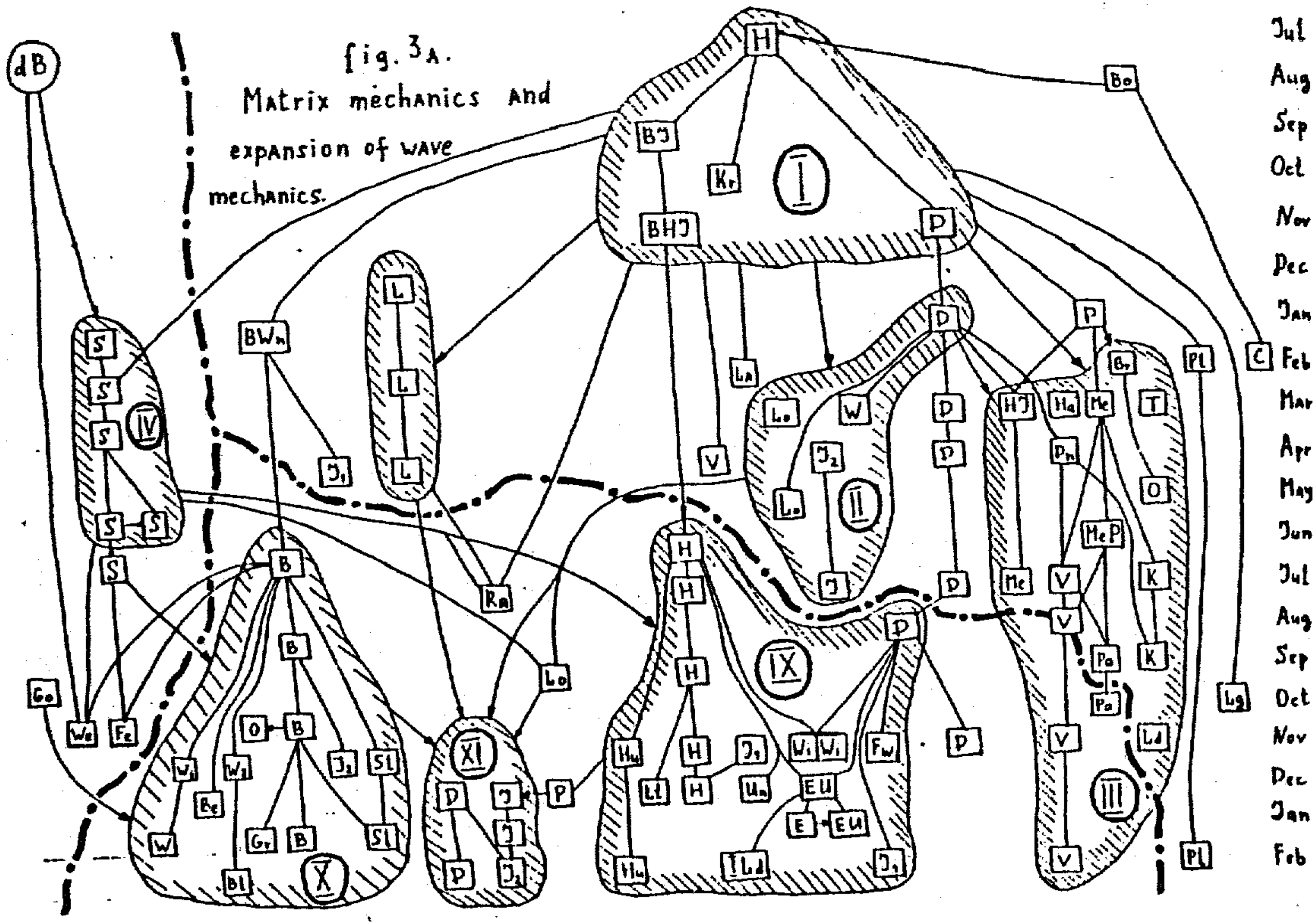



fig. 3A. Matrix mechanics and expansion of wave mechanics.

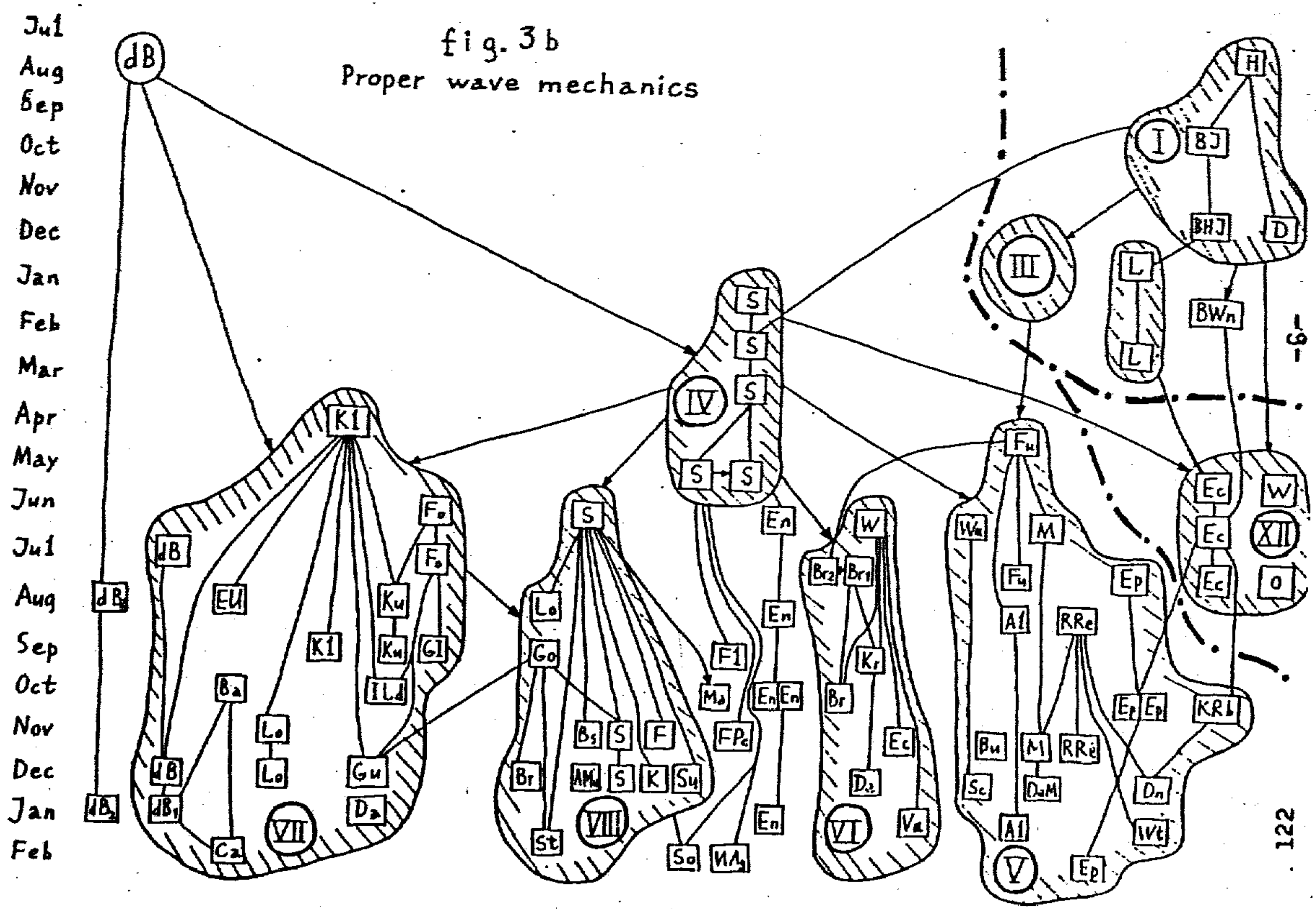



fig. 3b
Proper wave mechanics

in time. Let us describe the main parts of the picture. (I) - the general foundations of matrix mechanics (MM), which were created by Heisenberg, Born, Jordan and Dirac. Only two subject fields had enough time to develop inside MM: investigation of canonical transformations (II) and various applications (the hydrogen spectrum, diatomic molecule, rotator) (III). Dicar (April) made the first step towards relativistic generalisation of the theory. There were also suggested some reformulations of MM - field interpretation (lanzcos - December), operator approach (Born, Wiener - January), algebra of q-numbers (Dirac, July). It is easy to see that, contrary to the common belief, MM was not an esoteric theory. Already since March 1926 it spread outside the circle of the original group of its creators and received a rather wide recognition. Its reputation as a sophisticated and obscure theory is a slight exaggeration. Moreover, nothing indicates the crisis of MM, M. Beller wrote about. [9] If it were not for the expansion of wave mechanics (WM), MM could probably develop further.

The foundations of WM were formulated by Schrödinger (IV). He also demonstrates the mathematical equivalence of two theories. Very soon in the framework of WM also appeared a group of papers concerning various applications (V), similar to (III) in MM. They both shared almost equal spectrum of problems, but in a majority of cases the methods of WM turned out to be more useful. The groups (III) and (V) are connected very closely by citations, but it was difficult to show these influences of fig. 3. A separate group of articles deals with quasiclassical approximation (the so-called WKB-method) (VI). Canonical transformations in WM were studied by London (September) (see Fog. 3a).

A large group of papers discussed the relativistic generalization of WM and the Klein-Gordon-Fock equation (VII) many of them were more influenced by earlier (1924 - 1925) ideas of de Broglie, than those of Schrödinger. [10] That is why we depicted symbolically de Broglie's paper of Fig. 3, despite the fact, that it lies outside the chosen chronological framework and does not belong to QM.

New interpretations of WM were suggested by Madelung (October), de Broglie (August) and by Schrödinger himself (June). The latter formulated the so called "electrodynamical interpretation of wave function", it was supported by a number of papers (VIII), dealing mostly with the questions of radiation.

New fields of application were connected with conceptual developments of the whole theory. Serious reformulations came from the leaders of MM, who adopted the formalism of WM, but not its interpretation. Heisenberg and Dirac considered the many-body problem, and after their works quantum statistics and classification of spectra on the symmetry properties began to develop (IX). Born suggested his statistical interpretation of wave function, which was applied by him and other scientists to the description of scattering phenomena and interaction of atom with radiation (X). Further development of this interpretation was attained in Pauli's article (December), and in Dirac-Jordan transformation theory (XI), which gave the first completed mathematical formalism of the whole QM. It is worth to mention also several articles (XII), which used Schrödinger's methods as mathematics to calculate matrix elements, which they later interpreted in the sense of MM.

Fig. 3 is divided into three large areas, where correspondingly MM, orthodox WM with its "anschaulich interpretation" and modifications of WM incompatible with this interpretation predominate. [11] Into the same parts the columns of the diagramm fig. 1 are divided. The triumphal victory of WM over MM is evident, the decisive months were May-July 1926. Taking into account that writing a paper took usually one or two months, in the minds of the scientists this victory occurred a little earlier. Fig. 3 enables us to discuss the causes of this victory.

First of all, it was not a triumph of wavemechanical interpretation - even for a short period of time "proper WM" did not achieve an overwhelming prevalence. It is unlikely also that MM became less popular, than WM, because of its complicacy and incomprehensibility. We have seen already that it began to spread very intensively and falled because even its representatives, who understood it well, turned to WM. And among the first, who began to use WM, were the leaders of MM. The fact, that they were not entirely satisfied with Schrödinger's physical ideas did not prevent them to accept completely mathematical methods of WM. Just the fact that wavemechanical methods were more powerful, than that of MM, is the most probable reason for the victory. [12)]

The statistical interpretation won gradually, slower than WM. By the end of the period under consideration we observe an approximate parity of the number of publications on "orthodox WM" and "modifications of WM". But the publications of the leaders of "orthodox WM" became less frequent and the relative number of publications from peripheral authors from USA and USSR increased. This indicates the future decline of "orthodow WM". Analogous process took place at the decline of MM.

## § 3. The formation of scientific community

Our method enables us to make some conclusions on the consolidation of scientific community in QM.

1. Since autumn 1926 the exchange of information (as reflected by citations) tied the papers on QM in a strongly connected graph. The number of citations to QM papers exceeds the number of other citations. [13)]

2. Having become more intensive, exchange of information led to some changes in the type of scientific research. The activity of almost every scientist depended strongly upon the others, who worked on QM, because he received from them quick response to his ideas and initiative impulses for further work.

3. Informational ties began to play a decisive role in the development of the theory. Even the leaders, like Heisenberg and Schrödinger discovered with some disappointment that the theory got free out of their control. Its development then became a result of collective scientific research.

4. The members of the community worked out their own language. Some terms (first of all - the name of the theory) were used as catchwords, signs for adherents: most of the papers included in their title the words like "new quantum mechanics" of "Schrödinger's theory" and so on.

5. The scientists perceived these processes. They understood that QM was a new paradigm, different from the old one. They distinguished adepts from aliens, accustomed to address their work to definite audience.

6. The consolidation of community was delayed by the fact, that there were two forms of the theory, which were considered as mathematically equivalent but physically contradictory. But in winter 1926 - 1927 the predominate tone of publications gradually changed and the feeling of unity instead of that of contradiction began to prevail. For instance the review articles appeared, where both forms had been discussed simultaneously instead of reviews devoted to either MM or WM. It took place despite the fact that the logical unity had not yet been achieved. (Strictly speaking, it was achieved in the papers by Dirac (December) and Jordan (December - January), but their results had not become yet widely known).

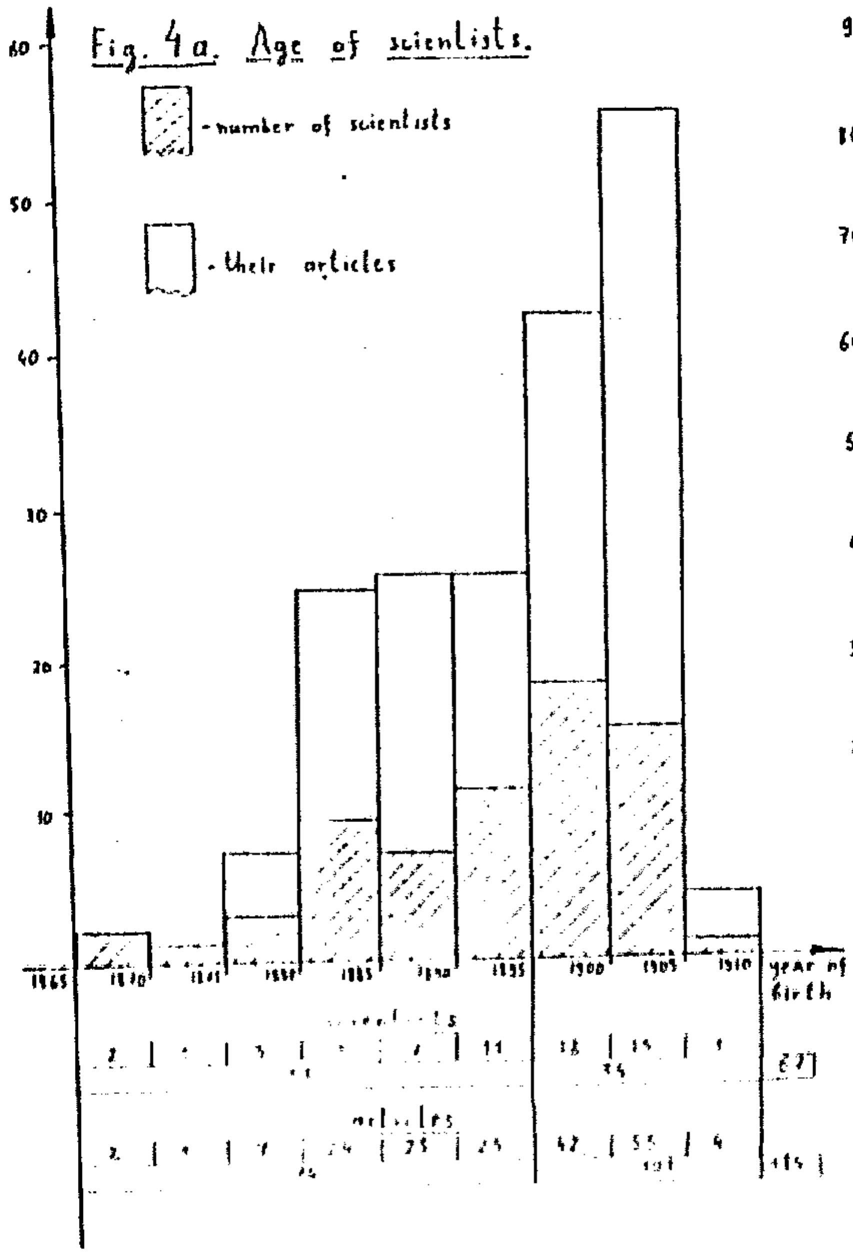



Fig. 4a. Age of scientists.

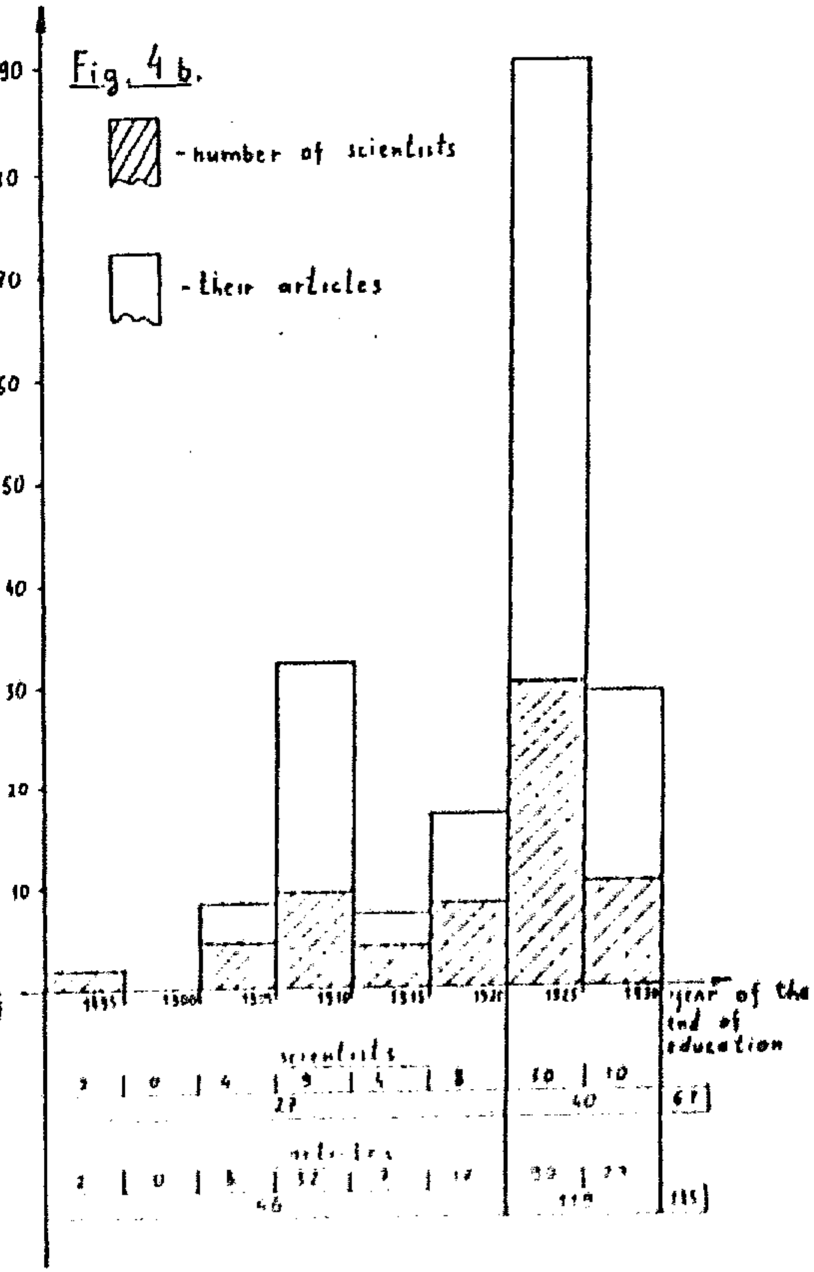



Fig. 4b.

Thus the scientific community in QM was established by the end of 1926. Let us consider it in detail:

Who were the members? We have some biographical data about 67 out of 80 authors. (These data are obtained mostly from Poggendorf). More than half of them were born after 1895 and were under their 30 at the beginning of 1926 (see Fig. 4a). 60 % of the scientists finished their education after 1920. [14] These authors wrote about 65 % of all papers on QM (Fig. 4b). Pauli was evidently right when he called QM "Die Knabenphysik". The majority of the authors worked or were educated before in the old quantum theory tradition. So the QM community was rather homogeneous, it distinguished itself out of the old quantum community. It is necessary to mention, that it happened almost without controversy between the old and new theories, the appearence of QM was welcomed. This situation is rather unusual one. Probably it is because the old quantum theory was already in a crisis and the appearance of something like QM was expected by a majority of scientists.

QM community had its geographical centre - in Central Europe. The physicists from Germany, Austria, Switzerland and to some extent those from Denmark and Netherlands can be considered as a single national community. Its main language was German, its members published papers in the same journals, issued in Germany, they experienced intense personal contacts, met each other frequently, and even easily changed their positions to different country. [15]

This community was the strongest one in physics generally and in QM in particular. Here the new theory was born, and here the trends of its further development were determined. The leading role of German-speaking community is illustrated by Fig. 5.

Fig. 5

| | Number of scientists | Papers, written by them | Papers, written in this country | Papers, published in this country |
|---|---|---|---|---|
| Germany | 19 | 59,5 | 54 | 120 |
| Switzerland | 5 | 17 | 21 | 0 |
| Austria | 5 | 7 | 6 | 0 |
| Denmark | 4 | 7 | 17 | 1 |
| Netherlands | 2 | 4 | 5 | 1 |
| Central Europe totally | 35 | 94,5 | 103 | 122 |
| France | 2 | 12 | 12 | 14 |
| Britain | 6 | 15 | 18 | 30 |
| USA | 19 | 34,5 | 26 | 27 |
| USSR | 11 | 11 | 11 | 9 |
| Italy | 3 | 4 | 4 | 1 |
| Sweden | 2 | 6 | 5 | 0 |
| Other | 3 | 5 | 3 | 0 |
| Total | 81 | 182 | 182 | 203 |
| | | (original papers and reviews) | | (with translations and preliminary notes) |

fig. 5b


Edinburgh
Darwin
Cambridge
Fowler
Dirac
Blackett
Oppenheimer
Van Vleck
Copenhagen
Heisenberg
Bohr
Kramers
Klein
Hund
Kronig
Dennison
Dirac
Bureau
Waller
Sugiura
Leningrad
Fock
Bursian
Landau
Gamow
Iwanenko
Andreev
Moscow
Tamm
Leiden
Ehrenfest
Uhlenbeck
Utrecht
Kramers
Gottingen
Heisenberg
Born
Jordan
Mensing
Oppenheimer
Placinteanu
Hamburg
Pauli
Mensing
Wentzel
Berlin
Gordon
Wigner
Breslau
Rademacher
Reiche
Leipzig
Wentzel
Frankfurt a. M.
Lanczos
Madelung
Stuttgart
London
Munchen
Sommerfeld
Wentzel
Pauling
Unsold
Slack
Tübingen
Landé
Zürich
Schrödinger
Alexandrow
Manneback
Dennison
Debye
Fues
Stratton
Wien
Beck
Flamm
Guth
Halpern
Paris
de Broglie
Brillouin
Pasadina
Epstein
Eckart
Bateman
Minneapolis
Van Vleck
New York
Kronig
Rabi
Van Vleck
Cambridge, Mass.
Slater
Wiener
Vallarta
Stratton
Müller
Allis
Witmer
Born
Rome
Fermi
Persico
Naples
Carrelli

The first two columns show the number of scientists, who contributed to QM, living lastingly in the country and the number of papers, written by them.[16] For Central Europe we see, that there were nearly a half of authors and more than a half of publications. The number of publications will grow, if we take into account papers, written by visitors. Such centres, as Copenhagen, Göttingen, Zürich and München attracted foreigners, willing to complete their education, mostly from America.[1] The effect of the visits like these, or like Born's to America is shown by column 3. Visitors from America sometimes published their works in German, to German journals submitted their papers also physicists from Northern and Eastern Europe, from the USSR (8 articles in QM out of 11, written by Soviet scientists were published in German). So German became the main language of QM, covering 60 % of publications (column 4).

The second language is English (about 30 %). Here, besides the works of English and American physicists, we should note also that some authors, like Born, Bohr, Schrödinger, Ehrenfest, Oppenheimer, sometimes published their papers simultaneously in German and in English.

However, despite a large amount of publications in British journals, we can not speak about the national scientific community in QM there. In Britain, and also in France, QM did not spread very quickly. The contribution of these countries consists of the works of few scientists, like Dirac, Brillouin, de Broglie, of very high qualification and productivity, working, however, almost in solitude.

Just the opposite reception found QM in the USA and the USSR. In these countries the national scientific community in physics was just in the process of formation, and it was much more receptive to new ideas and theories. Communities--extroverts, they were oriented to German physics (Americans also to British), considering themselves as pupils, the scientists even knew the works of their compatriots worse, than those of German authors. Similar in these aspects, the American and Soviet scientists differ by the ways of aquaintance with QM. (The Soviet physicists studied the new theory through publications, and the Americans experienced personal contacts, visiting Europe or inviting German scientists to visit America).

By the beginning of 1927 the number of American physicists, contributing to QM, seems to have exceeded some characteristic quantity, and they began to establish contacts with each other. We see here the national community in QM just before its birth.

As for the rest of the countries, the response to the new theory is small.

The community, established in 1927 was non-formal, based only upon the exchange of information. Later it began to reproduce itself by teaching, established special institutions, journals and so on. But in the period under consideration only a first step was made in this direction - the first reviews appeared (Fig. 6). A few months after original papers serious reviews on MM (Heisenberg, Brillouin, Born) and on WM (Flamm, de Broglie, Schrödinger) were written almost simultaneously in German, French and English, a little later appeared reviews in Russian (Андреев and the volume "Основания новой КМ" ). By the end of 1926 reviews, articles were prepared, where both forms of the theory were discussed, but not its development after Schrödinger. The serious historical review, including the latest works, statistical interpretations and so on was written in Spring 1927. 18)

It does not seem to be a simple coincidence, that German scientists addressed to English-speaking audiences (Born, Bohr, Jordan, Schrödinger), and that the first reviews in English were published by Born and Schrödinger. In France and USSR the scientists wrote reviews themselves. The Russians used to translate also some important papers into Russian (those by Born, Bohr, Heisenberg, Schrödinger, Jordan).

The citations show, that only reviews in English were really used by the beginning of 1927 - the American authors refered to them. Most of the scientists still studied the theory through original papers - as it was natural at early stages of the development of the theory.

## § 4. Considerations on the method

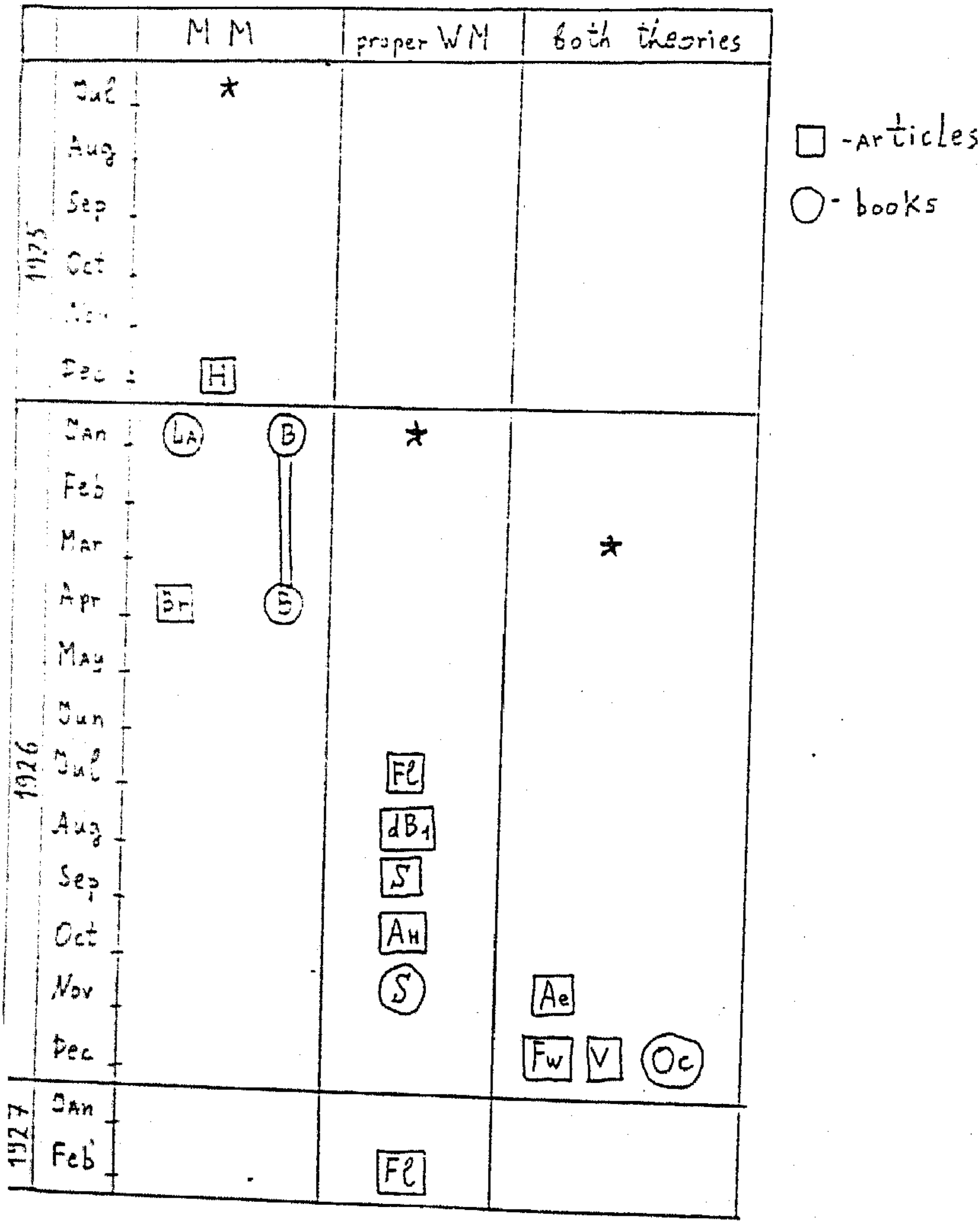
In this article an attempt is made to develop a method of description of the spread and formation of the theory, which is not in such a strong dependence upon the opinions of scientists. It turned out to be convenient to present the theory by means of Fig. 3.

The considerations upon the complete array of publications provided some quantitative conclusions. There are, however, some questions, which can not be answered by the analysis of publications: the pedagogical activities, became part of personal contacts and the leadership, which was established through them (for instance, the authority of Bohr and Pauli) and so on. They require more refined methods.

We combined the quantitative estimations with qualitative analysis, and doing so we violated the idea of accuracy and objectivity, which is demanded by some representatives of scientometrics.[19] But the accuracy, achieved by measurement, so often diminishes in scientometrics because of the difficulties in interpretation, that we decided to look for only such figures, we can interprete inambiguously. And we used not the proper numbers, but estimations to the order of magnitude.

fig. 6.

Reviews.



Let us consider an example of citation analysis. H. Small [20] discussed the citation classics in physics in the 20-s, and among them are the papers, we are very interested in: Heisenberg (July 1925), Born-Jordan (September), Born-Heisenberg-Jordan (November), Schrödinger (January - June 1926). There are two kinds of highly cited works: some of them are cited almost equally through rather a long period of time, and the others have a very high peak of citations, which decreases quickly. The papers on QM belong to this kind, they were highly cited only during a year after publication. [21]

One cannot explain this behavior without taking into account the context of citations. Small supposed, that the reasons for the decrease of them could lie in "obsolescence and replacement by new formulations". [22] Semantically there are two main types of citations: some of them refer to a concrete formula, result or opinion, the others denote the paradigm, or the rival paradigm, they are the signs, that the paper belongs to the special tradition, opened by the paradigmal papers. And apart from obsolescence there is one more influential cause for the decrease of citations - when the work becomes widely known in the scientific community. Now it is not necessary to give a special reference to the paper, but only to mention in the text "Schrödinger method" or "wave equation" or something else of the kind. And the appearance of such latent references also marks the formation of scientific community basing of special paradigm, and this is probably, the easiest way to determine the paradigmal works and concepts.

Both reasons - the replacement by new formulations and the popularity - were important in the case of QM, but the first played a greater role for MM, while the second - for WM. Their joint action led to an almost complete disappearance of the references of "paradigmal type", and decreased essentially the number of references to the concrete results.

NOTES:

1) B. L. Van der Waerden, Sources of quantum mechanics, 1967.
F. Hund, Geschichte der Quantentheorie, 1967.
M. Jammer, The conceptual development of quantum mechanics, 1966.
J. Mehra, H. Rechenberg. The historical development of quantum theory, vol. 1 - 4, 1982.
J. Hendry. The creation of quantum mechanics and the Bohr-Pauli dialog, 1984.

2) J. Mehra, H. Rechenberg loc. cit. vol. 4, part 2.

3) The richest list of the sources of QM, being known to us (Ельяшевич М.А., Успехи физических наук, Т. 122, 1977, с. 673 - 717) mentions about 120 titles of the period we are interested in. This bibliography was considerably enlarged by us.

4) Physics Citation Index (1920 - 1929) mentions about 20,000 srticles, which appeared from 1920 to 1929 in 16 main journals. In these journals in 1926 were about 100 papers on QM, which constitute nearly 5 % of published papers.

5) See J. Mehra, H. Rechenberg, loc. cit. p. 257.

6) See on Fig. 3 the reaction to the articles by Heisenberg (July 1925 and June 1926), Schrödinger (January and June 1926), Klein (April 1926), Born (June 1926), Dirac (August 1926).

7) This question was discussed in the draft version of this paper: Котельников А.Б., Скорость публикаций и её роль в становлении научной теории (на примере квантовой механики) - ВИЕТ, 1987, N 2, с. 86-91.

8) The initial group: Heisenberg, Pauli, Born, Jordan; in Göttingen were involved into the theory Mensing and Placinteanu, in Tübingen - A. Landé, in Copenhagen,

through Heisenberg - Kramers, Dennison, Kronig; in America through Born - Wiener, Eckart, Van Vleck; to Britain the information came through the chain Heisenberg-Fowler-Dirac-Oppenheimer. Without private communications studied the theory Lanczos (Frankfurt a. M.), Brillouin (Paris), Campbell (London), Schrödinger (Zürich), Tamm (Moscow), Halpern (Wien), London (Stuttgart).

9) Beller M. Matrix theory before Schrödinger. - Isis, 74, 469 - 491, (1983).

10) The most frequent reference is: L. de Broglie. Recherche sur la theorie des quanta. (These de doctorat). - Annales de physique, 3, 22 - 128, (1925).

11) This division is, of course, rather conventional. Some authors did not express their preference to any kind of interpretation. There was usually a strong correlation between interpretation, the subject and methods of investigation, but in several cases, however, they came to contradictions: for instance, it would be more accurate to put the papers by Ehrenfest-Uhlenbeck (December - January) in the area "orthodox WM", but their strong dependence on other articles forced us to put them to the "modifications' of M". Despite these uncertainties, this threefold division provides generally correct impression on the relative popularity of interpretations.

It is worth to mention the significance of some key words, for instance, the name of the theory. Those, who shared Schrödinger's interpretation called the theory without exceptions "Wave mechanics" while the other prefered to speak about "quantum mechanics" or "new quantum mechanics". (Note that the term "matrix mechanics" was not in general practice at that time).

12) In the discussion of this and other similar questions we consider it wrong to rely upon the opinions of few important participants of the process, contained in their popular writings. Perhaps more accurate would be a content analysis of the publications: nearly all authors said some words, which can be interpreted as comparing the two forms of the theory, and the analysis of them could reveal the most popular arguments.

13) The others were mostly the references to articles on the old quantum theory, to the experimental results of the references to mathematical works.

14) We take the year when the doctoral degree was obtained or, sometimes, the year of graduating from the university.

15) In fact, Heisenberg and Kramers worked in Denmark, Ehrenfest - in Netherlands, Schrödinger and Debye - in Switzerland.

16) The ambiguity appeared only in two cases: during the period under consideration Kramers changed Copenhagen for Utrecht, and Heisenberg took his place. We attached them to the contries, where they began to work in QM, correspondingly Denmark and Germany.

17) From authors Van Vleck, Dennison, Oppenheimer, Kronig, Pauling and Slack visited Europe in 1926.

18) Jordan P. Die Entwicklung der neuen Quantenmechanik. (Naturwissenschaften 15, 1927. S. 614 - 623, 636 - 648.

19) See, for instance, the requirement of reproductibility of measurements in Хайтун С.Д., Наукометрия. Состояние и перспективы. Москва 1983, с. 29.

20) Small H. Recapturing physics in the 1920-s through citation analysis. - Czech. J. Phys., B 36, 142 - 147 (1986). This article is based on the Physics Citation Index (1920 - 1929), ISI, Philadelphia, 1983. We would like to express our gratitude to Prof. H. Small for sending us this Index.

21) Our calculations give for the first year 40-50 citations to each of the mentioned the papers of Heisenberg, Born and Jordan and 60 - for the first papers of Schrödinger. Those numbers are approximately twice as large as given by Small, because we took into account all literature, whereas he - only main journals. But we share completely his conclusions on the general characteristics of the distribution of citations in time.

22) Small H., loc. cit. p. 147.

## SOURSES

### List of journals

| Abbr. | Name | Place | Number of papers on GM |
|---|---|---|---|
| ZP | Zeitschrift fuer Physik | (Berlin) | 65 |
| AP | Annalen der Physik | (Leipzig) | 20 |
| NW | Die Naturwissenschaften | (Berlin) | 17 |
| N | Nature | (London) | 16 |
| PNAS | Proceedings of the National Academy of Sciences of the USA | (Boston) | 13 |
| PR | The Physical Review | (Minneapolis) | 9 |
| PZ | Physikalische Zeitschrift | (Leipzig) | 9 |
| PRS | Proceedings of the Royal Society of London | (London) | 8 |
| CR | Comptes Rendus hebdomadaire des seances de l'Academie des sciences | (Paris) | 7 |
| JP | Journal de Physique et le Radium | (Paris) | 7 |
| УФН | Успехи физических наук | (Москва) | 6 |
| PCPS | Proceedings of the Cambridge Philosophical Society | (Cambridge) | 5 |
| JMP | Journal of Mathematics and Physics | (Cambridge, Mass.) | 3 |
| NGWG | Nachrichten von der (K.) Gesellschaft der Wissenschaften zu Goettingen. Math.-Phys. Klasse | (Goettingen) | 2 |
| ЖРФХО | Журнал Русского Физико-Химического Общества. Часть физическая. | (Ленинград) | 2 |
| JOSA | Journal of the Optical Society of America | (Menaha, Wisconsin) | 1 |
| MA | Mathematische Annalen | (Leizig) | 1 |

| | | |
|---|---|---|
| DVS | K. Danske Vid. Selsk. math.-phys. Medd. (Kobenhavn) | 1 |
| P | Physica (Amsterdam) | 1 |
| PM | Philosophical Magazine (London) | 1 |
| RL | Rendiconti Lincei (Florenz) | 1 |
| | Books | 5 |
| | TOTAL | 203 |

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In the left margin we indicate the abbreviation of author's name and the month to find the paper in fig. 3

We indicate the country of the author, as it is explained in fig.5 and after each paper - the place, where it was written

Dates of the type: (7.10.-14.10.-13.12.26) mean
- first date - when the paper was finished or when a report was made;
- second - when the paper was received by editor or when it was read at the session of scientific society
- third - date of "Redaktionschluss" or the date, when the issue of the journal appeared

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Al <u>Alexandrow W.</u>

Switzerland

Aug Das Wasserstoffmolekuelion und die Undulationsmechanik. (I. Mitteilung: Die Berehnungsmethode der Energiestufen; die Ionisierungsspannung und das Prinzipielle ueber das Viellinienspectrum.) / AP 81, 603-614. ( 14.08.-18.08.-26.10.26 ) /Zurich/

Jan Das Wasserstoffmolekuelion und die Undulationsmechanik. (Berichtigung und Ergaenzung). / AP 82, 683-688. ( 20.01.-28.01.-22.03.27 ) /Zurich/

Ae <u>Allen H.S.</u>

Great Britain

Nov New quantum theories. / N 119, 77-79. ( ?-15.01.27 )

AMu <u>Allis W.P., Mueller A.</u>

USA

Dec A wave theory of the electron. / JMP, 6, 119-132. ( .12.26-?-..27 )

Ан     Андреев Н.Н.     USSR

Oct     Элементы волновой механики. / УФН 7, 25-46. (?-.02.27)
/Ленинград/

Ba     Bateman H.     USA

Oct     A possible connexion between the wave-theory of matter and electro-magnetism. / N 118, 839-840. (?-11.12.26) /Pasadena/

Be     Beck G.     Austria

Dec     Zur Theorie des Photoeffekts. / NW 15, 74.
(18.12.26-?-21.01.27)     /Wien/
/Wien/
Ibid. / ZP 41, 443-452. (?-27.12.26-21.02.27 )     /Wien/

Bl     Blackett P.M.S.     Great Britain

Feb     The limits of classical scattering. / PCPS 23, 698-702.
(?-5.02., 14.03.-.04.27)     /Cambridge/

Bo     Bohr N.     Denmark

Aug     Atomic theory and mechanics. / N 116, 845-852.
( 30.08.-?-5.12.25 )
Atomtheorie und Mechanik. / NW 14. 1-10.
( 30.08.25-?-1.01.26 )     /Kopenhagen/
Атомная теория и механика. / УФН 6, 93-111 (?-..26).

B     Born M.     Germany

Jan     Problems of atomic dynamics. 1926     /Cambridge, Mass./
Probleme der Atomdynamik. Berlin 1926 (.4.-..26)     /Goettingen/

Jun     Zur Quantenmechanik der Stossvorgaenge (vorlaeufige Mitteilung). / ZP 37, 863-867. (?-25.06.-10.07.26).
Quantenmechanik der Stossvorgaenge. / ZP 38, 803-827.
(?-21.07.-14.09.26 )     /Goettingen/

Aug     Physical aspects of quantum mechanics. / N 119, 354-357.
( 10.08.26-?-5.03.27)     /Oxford/
Quantenmechanik und Statistik. / NW 15, 238-242.
(?-11.03.27)     /Goettingen/

Oct     Das Adiabatenprinzip in der Quantenmechanik. / ZP 40, 167-192 (?-16.10.-6.12.26)

Jan     Zur Wellenmechanik der Stossvorgaenge. / NGWG 1927, 146-160.
(?-14.01-..27)     /Goettingen/

**BJ** **Born M., Jordan P.** Germany

Sep Zur Quantenmechanik. / ZP 34, 858-888. (?-27.09.-28.11.25) /Goettingen/

**BHJ** **Born M., Heisenberg W., Jordan P.** Germany

Nov Zur Quantenmechanik. II. / ZP 35, 557-615. (?-16.11.25-4.02.26) /Goettingen/

**BWn** **Born M., Wiener N.** Germany, USA

Jan A new formulation of the laws of quantization of periodic and aperiodic phenomena. / JMP 5, 84-98. (?-..26)
Eine neue formulierung der Quantengesetze fuer periodische und nicht periodische Vorgaenge. / ZP 36, 174-187. (?-5.01.-12.03.26 ) /Cambridge,Mass.;Goettingen/

**Br** **Brillouin L.** France

Feb Les spectres de rotation, dans la nouvelle mecanique des quanta, avec le calcul des matrices. / CR 182, 374-376. (?-8.02.26-?)

Apr La nouvelle mecanique atomique. / JP 7, 135-160. (?-20.04.-.05.26)

Jul 1 La mecanique ondulatoire de Schroedinger; une methode generale de resolution pas approximations successives. / CR 183, 24-26. (?-5.07.26-?)

Jul 2 Sur un type general de problemes, permettant la separation des variables dans la mecanique ondulatoire de Schroedinger. / CR 183, 270-272. (?-26.07.26-?)

Oct Remarques sur la mecanique ondulatoire. / JP 7, 353-368. (?-15.10.-.12.26)

Dec Les moments de rotation et le magnetisme dans la mecanique ondulatoire. / JP 8, 74-84. (?-17.12.26-.02.27)

**dB** **Broglie L. de** France

Jul Remarques sur la nouvelle mecanique ondulatoire. / CR 183, 272-274. (?-19.07.26-?)

Aug 1 Les principes de la nouvelle mecanique ondulatoire. / JP 7, 321-327. (?-5.08.-.11.26)

Aug 2 Sur la possibilite de relier les phenomenes d'interference et de diffraction a la theorie des quanta de lumiere. / CR 183, 447-448. (?-23.08.26-?)

Dec L'univers a cinq dimensions et la mecanique ondulatoire. / JP 8, 65-73. (?-23.12.26-.02.27)

Jan 1 Sur la possibilite de mettre en accord la theorie electromagnetique avec la nouvelle mecanique ondulatoire. / CR 184, 81-82. (?-4.01.27-?)

Jan 2 La structure atomique de la matiere et du rayonnement et la mecanique ondulatoire. / CR 184, 273-274. (?-31.01.27-?)

Bu Burrau O. Denmark

Nov Berechnung des Energiewertes des Wasserstoffmolekel-Ions (H ) im Normalzustand. / NW 15, 16-17. (22.11.26-?-7.01.27) /Kopenhagen/
Ibid. / DVS 7, N 14 ,18 S. (?-19.03.27) /Kobenhavn/

Bs Bursian V. USSR

Nov Notiz zu den Grundlagen der Dispersionstheorie von E.Schroedinger. / ZP 40, 708-713. (?-19.11.26-2.01.27) /Leningrad/

C Campbell N. Great Britain

Feb Time and chance. / PM 1, 1106-1117. (18.02.-?-.05.26)

Ca Carrelli A. Italia

Feb The spinning electron in wave mechanics. / N 119, 492-493. (6.02.-?-2.04.27) /Napoli/

Da Darwin C.G. Great Britain

Jan The electron as a vector-wave. / N 119, 282-284. (?-19.02.27)

De Debye P. Switzerland

Dec Wellenmechanik und Korrespondenzprinzip. / PZ 28, 170-174. (14.12.-16.12.26-15.02.27) /Zuerich/

DeM Decye P. Manneback C. Switzerland

Dec The symmetrical top in wave mechanics. / N 119. 83. (14.12.26-?-15.01.27) /Zuerich/

Dn Dennison D. USA

Apr The rotation of molecules. / PR 28, 318-333. (27.04-?-.08.26) /Copenhagen/

Dec Wave mechanics and the rotation of homopolar molecules. / N 119, 316-317. (23.12.26-?-26.02.27) /Zuerich/

D Dirac P.A.M. Great Britain

Nov The fundamental equations of quantum mechanics. / PRS A109, 642-653. (?-7.11.-1.12.25) /Cambridge/

Jan Quantum mechanics and a preliminary investigation of the hydrogen atom. / PRS A110, 561-579. (?-22.01.-1.03.26) /Cambridge/

Mar The elimination of the nodes in quantum mechanics. / PRS A111, 281-305. (?-27.03.-1.05.26) /Cambridge/

Apr Relativity quantum mechanics with an application to Compton scattering. / PRS A111, 405-423. (?-29.04.-2.06.26) /Cambridge/

Jul On quantum algebra. / PCPS 23, 412-418. (?-17.07.,26.07.-.10.26) /Cambridge/

Aug On the theory of quantum mechanics. / PRS A112, 661-677. (?-26.08.-1.10.26) /Cambridge/

Nov The Compton effect in wave mechanics. / PCPS 23, 500-507. (?-8.11.,22.11.26-31.1.27) /Cambridge/

Dec The physical interpretation of the quantum dynamics. / PRS A113, 621-641. (?-2.12.26-1.01.27) /Copenhagen/

Feb The quantum theory of the emission and absorption of radiation. / PRS A114, 243-265. (?-2.02.-1.03.27) /Copenhagen/

Ec Eckart C. USA

May The solution of the problem of the simple oscillator by a combination of the Schroedinger and the Lanczos theories. / PNAS 12, 473-476. (?-31.05.-15.07.26) /Pasadena/

Jun Operator calculus and the solution of the equations of quantum dynamics. / PR 28, 711-726. (7.06.-?-.10.26) /Pasadena/

Jul The hydrogen spectrum in the new quantum theory. / PR 28, 927-935. (17.07.-?-.11.26) /Pasadena/

Nov Note on the correspondence principle in the new quantum theory. / PNAS 12, 684-687. (?-16.11.-15.12.26) /Pasadena/

E Ehrenfest P. The Netherlands

Jan Besteht ein allgemeiner Zusammenhang zwischen der wechselseitigen Undurchdringlichkeit materieller Teilchen und dem "Pauli-Verbot"? / NW 15, 161-162. (9.01.-?-18.02.27)
Ibid. (Ein Widerruf) / NW 15, 268. (1.03.-?-.05.27) /Leiden/

Relation between the reciprocal impenetrability of matter and Pauli's exclusion principle. / N 119, 196. (?-5.02.27)
Ibid. : A correction. / N 119, 602. (?-23.04.27) /Leiden/

EU Ehrenfest P.·Uhlenbeck G. The Netherlands

Aug Graphische Veranschaulichung der de Broglieschen Phasenwellen in der fuenfdimensionalen Welt von O.Klein. / ZP 39, 495-498. (.08.-16.09.-26.10.26) /Leiden/

Dec Die wellenmechanische Interpretation der Boltzmannschen Statistik neben der der neueren Statistiken. / ZP 41, 24-26. (?-15.12.26-26.01.27) /Leiden/
Интерпретация Больцмановской статистики наряду с новыми статистиками с точки зрения волновой механики. / ХРФХО 59, 105-108 (?-.03.27)

Jan Zum Einsteinschen "Mischungsparadoxon". / ZP 41, 576-582. (22.01-25.01.-26.02.27) /Leiden/

En Engset T. Sweden

Jun Die Bahnen und die Lichtstrahlung der Wasserstoffelektronen. / AP 80, 823-828. (21.06.-28.06.-21.08.26) /Oslo/

Aug Die Bahnen und die Lichtstrahlung der Wasserstoffelektronen. (Fortzetzung). / AP 81, 572-576. (14.08.-18.08-26.10.26) /Oslo/

Oct 1 Die Bahnen und die Lichtstrahlung der Wasserstoffelektronen. (Fortsetzung). / AP 82, 143-154. (8.10.-21.10.-16.12.26) /Oslo/

Oct 2 Die Bahnen und die Lichtstrahlung der Wasserstoffelektronen. (Schluss). / AP 82, 184-190. (19.10.-23.10.26-10.01.27) /Oslo/

Jan Die Bahnen und die Lichtstrahlung der Wasserstoffelektronen. (Ergaenzende Betrachtungen ueber Bahnformen und Strahlungsfrequenzen). / AP 82, 1017-1924. (27.01.-15.02.-9.05.27) /Oslo/

Ep Epstein P.S. USA

Jul The Stark effect from the point of view of Schroedinger's quantum theory. / PR 28, 695-710. (29.07.-?-.10.26) /Pasadena/

Oct 1 On the evaluation of certain integrals important in the theory of quanta. / PNAS 12, 629-634. (?-22.09.-15.11.26) /Pasadena/

Oct 2 The new quantum theory and the Zeeman effect. / PNAS 12, 634-638. (?-7.10.-15.11.26) /Pasadena/

Feb Two remarcs on Schroedinger's quantum theory. / PNAS 13, 94-96. (?-16.02.-15.03.27) /Pasadena/

F Fermi E. Italia

Oct Zur Wellenmechanik des Stossvorganges. / ZP 40, 399-401. (?-23.10.-8.12.26) /Florenz/

Nov Quantum mechanics and the magnetic moment of atoms. / N 118, 876. (14.11.-?-18.12.26) /Rome/

FPe Fermi E., Persico E. Italia

Nov Il principio delle adiabatische e la nozione dii forza viva nelle nuova meccanica ondulatoria. / RL 4, 452-457. (?-7.11.26-?)

Fl Flamm L. Austria

Jul Die Grundlagen der Wellenmechanik. / PZ 27, 600-617. (.07.-2.08.-15.09.26) /Wien/

Sep Beitraege zur Wellenmechanik in nichtstationaeren Feldern. / PZ 27, 733-735. (.09.-?-15.11.26) /Duesseldorf/

Feb Die neue Mechanik. / NW 15, 569-578. (?-15.07.27) /Wien/

Fo Fock V. USSR

Jun Zur Schroedingerschen Wellenmechanik. / ZP 38, 242-258. (5.06.-11.06.-28.07.26) /Leningrad/

Jul Ueber die invariante Form der Wellen- und die Bewegungsgleichungen fuer einen geladenen Massenpunkt. / ZP 39, 226-232. (24.07.-30.07.-2.10.26) /Leningrad/

Fw Fowler R.H. Great Britain

Nov General forms of statistical mechanics with special reference to the requirements of the new quantum mechanics./ PRS A113, 432-449. (?-3.11.-1.12.26) /Cambridge/

Dec Matrix and wave mechanics. / N 119, 239-241. (?-12.02.27)

Fu Fues E. Germany

Apr Das Eigenschwingungsspectrum zweiatomiger Molekuele in der Undulationsmechanik. / AP 80, 367-396. (.04.-27.04.-22.06.26) /Zuerich/

Jul Zur Intensitaet der Bandenlinien und des Affinitaetsspektrums zweiatomiger Molekuele. / AP 81, 281-313. (?-9.07.-17.09.26) /Zuerich/

GI Gamow G., Iwanenko D. USSR

Sep Zur Wellentheorie der Materie. / ZP 39, 865-868. (10.09.-19.09.-16.11.26) /Leningrad/

Go Gordon W. Germany

Sep Der Comptoneffekt nach der Schroedingerschen Theorie. / ZP 40. 117-133. (?-29.09.-29.11.26) /Berlin/

Gr Gruner P. Switzerland

Jan Kurze Bemerkung ueber das Fuehrungsfeld der Quantenmechanik. / ZP 41,710. (.01.-22.01.-26.02.27) /Bern/

Gu Guth E. Austria

Dec Zur Ableitung der Schroedingerschen Wellengleichung. / ZP 41, 235-238. (.12.-27.12.26-10.02.27) /Wien/

Ha Halpern O. Austria

Mar Ueber die Quantelung des Rotators und die Koordinatenwahl in der neuen Quantenmechanik. / NW 14, 488-489. (.03.-?-25.05.26) /Wien/

Notiz ueber die Quantelung des Rotators und die Koordinatenwahl in der neuen Quantenmechanik. / ZP 38, 8-11. (?-5.06.-24.07.26) /Wien/

H Heisenberg W. Germany, Denmark

Jul Ueber quantentheoretische Umdeutung kinematischer und mechanischer Beziechungen. / ZP 33, 879-893. (?-29.07.-18.09.25) /Goettingen/

Dec Ueber quantentheoretische Kinematik und Mechanik. / MA 95, 683-705. (21.12.-21.12.25-12.04.26) /Goettingen/

Jun Mehrkoerperproblem und Resonanz in der Quantenmechanik. / ZP 38, 411-426. (?-11.06.-10.08.26) /Kopenhagen/

Jul Ueber die Spektra von Atomsystemen mit zwei Elektronen. / ZP 39, 499-518. (.07.-24.07.-26.10.26) /Kopenhagen/

Sep Quantenmechanik. / NW 14, 989-994. (26.09.-?-5.11.26) /Duesseldorf, Kopenhagen/

Квантовая механика. / УФН 6, 425-434. (?-..26)

Nov Schwankungserscheinungen und Quantenmechanik. / ZP 40, 501-506. (?-6.11.-20.12.26) /Kopenhagen/

Dec Mehrkoerperprobleme und Resonanz in der Quantenmechanik.II. / ZP 41, 239-267. (?-22.12.26-14.02.27) /Kopenhagen/

HJ Heisenberg W., Jordan P. Germany

Mar Anwendung der Quantenmechanik auf das Problem der anomalen Zeemaneffekte. / ZP 37, 263-277. (?-16.03.-5.05.26) /Goettingen/

Hu Hund F. Germany

Nov Zur Deutung der Molekelspektren.I. / ZP 40, 742-764.
(?-19.11.26-8.01.27) /Kopenhagen/

Feb Zur Deutung der Molekelspektren.II. / ZP 42, 93-120.
(?-7.02.-1.04.27) /Kopenhagen/

ILd Iwanenko D., Landau L. USSR

Oc Zur Ableitung der Klein-Fockschen Gleichung. / ZP 40,
161-162. (?-8.10.-29.11.26) /Leningrad/

Feb Bemerkungen ueber Quantenstatistik. / ZP 42, 562-564.
(?-12.02.-21.04.27) /Leningrad/

ИЛд Иваненко Д., Ландау Л. СССР

Feb О связи волновой механики с классической. / ЖРФХО 59,
253-260. (?-..27) /Ленинград/

J Jordan P. Germany

Apr 1 Bemerkung ueber einen Zusammenhang zwischen Duanes
Quantentheorie der Interferenz und den de Broglieschen
Wellen. / ZP 37, 376-382. (?-22.04.-5.05.26)
/Goettingen/

Apr 2 Ueber kanonische Transformationen in der Quantenmechanik. /
ZP 37,383-386. (?-27.04,-5.05.26) /Goettingen/

Jul Ueber kanonische Transformationen in der Quantenmechanik.
II. / ZP 38, 513-517. (?-6.07.-10.08.26) /Goettingen/

Nov 1 Ueber quantenmechanische Darstellung von Quantenspruengen.
ZP 40, 661-666. (?-25.11.26-2.01.27) /Goettingen/

Nov 2 Kausalitaet und Statistik in der modernen Physik. / NW 15,
105-110. (?-4.02.27) /Goettingen/
Philosophical foundations of quantum theory / N 119,
566-569. (?-16.04.27) /Goettingen/
Причинность и статистика в современной физике. / УФН 7,
318-328. (?-..27) /Геттинген/

Dec Ueber eine neue Begruendung der Quantenmechanik, / ZP 40,
809-838. (?-18.12.26-18.01.27) /Goettingen/

Jan Ueber eine neue Begruendung der Quantenmechanik. / NGWG 1927, 161-169. (?-14.01.-..27) /Goettingen/

Feb 1 Ueber die thermodynamische Gleichgewichtskonzentration der kosmischen Materie. / ZP 41, 711-717. (?-1.02.-2.03.27) /Goettingen/

Feb 2 Anmerkung zur statistischen Deutung der Quantenmechanik. / ZP 41, 797-800. (?-17.02.-14.03.27) /Goettingen/

Kl Klein O. Denmark

Apr Quantentheorie und fuenfdimensionale Relativitaetstheorie. / ZP 37, 895-906. (?-28.04.-10.07.26) /Kopenhagen/

Sep The atomicity of electricity as a quantum theory law. / N 118, 516. (3.09.-?-9.10.26) /Copenhagen/

Dec Elektrodynamik und Wellenmechanik vom Standpunkt des Korrespondenzprinzips. / ZP 41, 407-442 (4.12.-6.12.26-21.02.27) /Kopenhagen/

Kr Kramers H.A. Denmark, the Netherlands

Oct Eenige opmerkingen over de quantuummechanika van Heisenberg. / P 5, 369-377. (?-.12.25) /Kopenhagen/

Sep Wellenmechanik und halbzahlige Quantizierung. / ZP 39, 828-840. (?-9.09.-16.11.26) /Utrecht/

K Kronig R.de L. USA

Jul The Dielectric constant of diatomic dipole-gases on the new quantum mechanics. / PNAS 12, 488-493. (?-3.07.-15.08.26) /New York/

Sep The dielectric constant of symmetrical polyatomic dipole-gases in the new quantum mechanics. / PNAS 12, 608-612. (?-13.09.-15.10.26) /New York/

KRb Kronig R. de L., Rabi I.I. USA

Oct The symmetrical top in the undulatory mechanics. / N 118, 805. (26.10.-?-4.12.26) /New York/
The symmetrical top in the undulatory mechanics. / PR 29, 262-269. (4.11.26-?-.02.27) /New York/

Ku Kudar J. Hungary

Aug Zur vierdimensionalen Formulierung der undulatorischen Mechanik. / AP 81, 632-636. (.08.-30.08.-26.10.26) /Budapest/

Sep Schroedingersche Wellengleichung und vierdimensionale Relativitaetsmechanik./ PZ 27, 724-725. (?-3.09.-15.11.26)

L Lanczos K. Germany

Dec Ueber eine feldmaessige Darstellung der neuen Quantenmechanik / ZP 35, 812-830. (.12.-22.12.25-26.02.26) /Frankfurt a.M./

Feb Variationsprinzip und Quantenbedingung in der neuen Quantenmechanik. / ZP 36, 401-409. (.02.-1.03.-1.04.26) /Frankfurt a.M./

Apr Ueber die komplexe Beschaffenheit der quantenmechanischen Matrizen. / ZP 37, 405-413. (.04.-23.04.-10.06.26) /Frankfurt a.M./

Ld Landau L. USSR

Nov Zur Theorie der Spektren der zweiatomiger Molekuele. / ZP 40, 621-627. (?-13.11.-22.12.26) /Leningrad/

La Lande A. Germany

Jan Die neuere Entwicklung der Quantentheorie. 2.Auffl. Dresden, Leipzig. 1926. § 27 Ausblick: die neue Quantenmechanik. S. 164-167. (.01.26-..26)

Feb Neue Wege der Quantentheorie. / NW 14, 455-458. (?-14.05.26) /Tuebingen/

Lg Langer R.M. USA

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