

ESSAY

The Hidden Side of Wolfgang Pauli: An Eminent Physicist's Extraordinary Encounter With Depth Psychology¹

HARALD ATMANSPACHER

Max-Planck-Institut für extraterrestrische Physik, D-85740 Garching, Germany

HANS PRIMAS

*Laboratorium für Physikalische Chemie, Eidgenössische Technische Hochschule,
CH-8092 Zurich, Switzerland*

Abstract — Wolfgang Pauli is well recognized as an outstanding theoretical physicist, famous for his formulation of the two-valuedness of the electron spin, for the exclusion principle, and for his prediction of the neutrino. Less well known is the fact that Pauli spent a lot of time in different avenues of human experience and scholarship, ranging over fields such as the history of ideas, philosophy, religion, alchemy, and Jung's psychology. Pauli's philosophical and particularly his psychological background is not overt in his scientific papers and was unknown even to many specialist scholars until a number of enthralling and perplexing documents of a close interaction between Wolfgang Pauli and the psychologist Carl Gustav Jung became publicly available in recent years. Both scholars stressed the inseparability of the physical and the psychical and called upon a sense of more openness toward the unconscious. Decades after his death, Pauli's innovative perspective and his vision of a wholeness of psyche and matter are more than ever before of great relevance.

Keywords: physics — philosophy — psyche — archetype

I. Who Was Wolfgang Pauli?

Wolfgang Pauli (1900-1958) was a most critical theoretical physicist with profound insight as well as a deep thinker. He was a child prodigy — while still a teenager Pauli wrote three erudite papers on general relativity which were highly esteemed by experts like the mathematician, Hermann Weyl (1919):²"But how you at your young age have managed to get access to the intellectual power and freedom of thought required to assimilate the theory of relativity is almost inconceivable to me." His teacher Arnold Sommerfeld

¹This article originally appeared in the *Journal of Consciousness Studies*, Vol. 3, No. 2, 1996 and is reprinted by permission.

²This and all following quotations cited from German text passages have been translated by the authors.

(1868-1951), one of the leading figures in the old quantum theory of the atom, was so impressed by Pauli's mathematical knowledge, physical insight, and his familiarity with the most subtle arguments in the theory of relativity that he transmitted an invitation to write a review article on relativity theory for the *Enzyklopadie der Mathematischen Wissenschaften* from his student, Pauli.

When the twenty-year-old Pauli delivered a five pound manuscript, Max Born (1921) wrote to Albert Einstein, full of praise: "This little chap is not only clever but industrious as well." And Einstein (1922) applauded:

Whoever studies this mature and grandly composed work would not believe that the author is a man of twenty-one. One does not know what to admire most: the psychological understanding of the evolution of ideas, the accuracy of mathematical deduction, the deep physical insight, the capacity for lucid systematic presentation, the knowledge of literature, the factual completeness, or the infallibility of criticism.

In spite of later deep philosophical disagreement, Einstein always held Pauli in high esteem, and in an address in 1946 on occasion of Pauli's Nobel prize the old Einstein called Pauli his spiritual son.

In June 1921 Pauli received his PhD from the University of Munich on a topic of the old quantum theory. After postdoctoral work with Max Born at Göttingen (1921/22), Niels Bohr at Copenhagen (1922/23), and his habilitation in Hamburg (1924), he discovered in 1925 the exclusion principle (the so-called "Pauli-Verbot"), ascribing the spin as a new discrete degree of freedom to the electron. From 1926 to 1928 he was professor for theoretical physics in Hamburg. In 1928 he accepted an offer for a full professorship for theoretical physics at the ETH (Swiss Federal Institute of Technology) in Zürich.

Together with Niels Bohr, Werner Heisenberg, and Paul Adrien Maurice Dirac, Wolfgang Pauli was one of the principal creators of quantum mechanics, relativistic quantum field theory, and the orthodox "Copenhagen interpretation" of quantum mechanics. He became renowned for his fundamental original contributions and brilliant reviews on quantum mechanics and quantum field theory and for his role as "the living conscience of theoretical physics." Pauli was particularly fascinated by the fine structure constant which Sommerfeld had introduced and which has the approximate value $1/137$. The mysterious number 137 haunted Pauli all his life, and he did not get weary of stressing that its theoretical understanding would be crucial, but missing so far.

Wolfgang Pauli was one of the most penetrating and most outspoken of critics, merciless in dismissing work that he considered superficial or inadequate: "Though I have sometimes regarded something right as wrong, I have never regarded something wrong as right" (Pauli, 1984). Also typical for Pauli were phrases like "ganz falsch" ("utterly wrong") and, even worse: "nicht einmal falsch" ("not even wrong"). Remarks like "I don't mind your thinking slowly, but I mind your publishing faster than you think," forced many a scientist to ask themselves: "Would Pauli accept this?" Sometimes Pauli himself signed

his critical letters with "der fürchterliche Pauli" ("the terrible Pauli") or with "die Geißel Gottes" ("god's whip"), but his criticism was almost always sound and fertile.

Pauli was never what our experts in didactics would call a good lecturer. Nevertheless he was an inspiring and intoxicating teacher. In particular when he was not too well prepared — this happened not infrequently — one could experience the spirit *in statu nascendi*, and this was awesome. With his ruthless demand for precision and lucidity, Pauli never intended to hurt his students or colleagues. His sharp tongue notwithstanding, his criticism was always honest and reflected not only his dislike of half-truths but also his demonic depths.

The rational one-sidedness of the young Pauli received a strong blow in his early thirties, a crisis that he later described as his "big neurosis" (Pauli, 1939; 1956a). Together with stem strokes of fate (1927 suicide of his mother; 1930 divorce from his first wife), it was basically his excessively rational attitude which brought Pauli into serious inner conflicts which he could not master intellectually. Following the advice of his father, he asked the psychologist Carl Gustav Jung for help. After an interview, Jung recognized the outstanding scientific training and intellectual capability of Pauli. Jung recounts (Jung, 1935a; of course, without mentioning Pauli's name):

I saw that he was chock-full of archaic material, and I said to myself: Now I am going to make an interesting experiment to get that material absolutely pure, without any influence from myself, and therefore I won't touch it. So I sent him to a woman doctor [Erna Rosenbaum] who was then just a beginner and who did not know much about archetypal material ... [Pauli] was five months with that doctor, and then for three months he was doing the work all by himself, continuing the observations of his unconscious with minute accuracy. He was very gifted in this respect.

During a period of three years, about fifteen hundred dreams of Pauli have been recorded, containing an extraordinary series of archetypal images. Jung used four hundred dreams out of this material for his 1935 Eranos lecture on dream symbols of the process of individuation (Jung, 1936, revised: Jung, 1944, republished in English: Jung, 1968). Other publications by Jung which contain dreams of Pauli are, e.g., his *Tavistock Lectures* (Jung, 1935a), his *Terry Lectures* (Jung, 1937a), and his New York seminars *Dream Symbols of the Individuation Process* (Jung, 1937b). In all these lectures and publications the dreamer's identity has always been kept anonymous by Jung ("a scientifically educated young man," "a great scientist," "a very famous man, who lives today"). It was revealed by the English editors of the transcription of Jung's London seminar *The Symbolic Life* (Jung, 1977).

Pauli finished his analysis in 1934, and married again in the same year. Nevertheless, Jung found his dreams so important that he asked Pauli to continue recording and interpreting his dreams and to stay in contact with him. When the Second World War began, he was not yet a Swiss citizen and got leave-of-absence from the ETH in order to join the Institute for Advanced Study in

Princeton. For five years he was in close contact with Einstein and held intense discussions with him, Kurt Gödel, Bertrand Russell, and many others (Pais 1982). In 1945 Pauli received the Nobel prize for the exclusion principle. One year later he returned to Zurich, and stayed there for the rest of his life. Late in 1958 Pauli fell seriously ill, and on December 14 of that year he died of cancer in room number 137 at the Rotkreuzspital, Zurich.

II. Source Material

Pauli published only few articles dealing with philosophical problems (Pauli 1994) — his technical papers are remarkably free of philosophical comments, but this state of affairs gives an entirely misleading impression of Pauli's wide range of philosophical, psychological and historical interests, including the foundations of science as well as the limits of scientific methodology. He was interested in those phenomena which elude the grasp of reason and in exploring the meaning of scientific enterprise in general. Pauli took Jung's ideas seriously. He did not share the prevalent cheap attitude, "this is all nonsense," but tried hard to understand. In spite of his critical stance, he was certainly not one of these "petty reasoning minds which cannot endure any paradoxes" denounced by Jung (Jung, 1968, Ziff. 19).

Pauli was a compulsive writer, seemingly unable to think without a pen in his hand. He never published his ideas as quickly as possible but preferred to communicate his thoughts in long letters to his friends and colleagues, trying out new ideas. The often colloquial and sometimes speculative style of his letters is in striking contrast to his cautious and refined publications. A considerable portion of Pauli's unpublished writings were released for publication only within the last few years. These consist basically of his extremely rich personal correspondence — many thousands of letters — and a few previously unpublished manuscripts. But a lot of further material which was never intended for publication, remains unpublished, inaccessible or hard to find.

This situation is barely reflected in the papers published by Pauli himself, but is evident from his exchange of letters, particularly in his correspondence with Jung (Meier, 1992) and with his younger colleague, the physicist Markus Fierz. The extensive and exciting Pauli-Fierz correspondence (1943-1958) is not yet published in its entirety. Its first six years are included in the third volume of von Meyenn's edition of Pauli's scientific correspondence (Hermann et al. 1979; von Meyenn 1985; 1993). Further volumes of this comprehensive work are in preparation. Important excerpts from later letters of Pauli to Fierz (but without the responses of Fierz) have been published and commented in Laurikainen's book *Beyond the Atom* (Laurikainen, 1988) and in his article "Wolfgang Pauli and Philosophy" (Laurikainen, 1984). Two letters of Pauli to Hermann Levin Goldschmidt are published in *Nochmals Dialogik* (Goldschmidt, 1990). A lot of additional manuscripts are deposited in the Pauli Letter Collection (PLC) at CERN in Geneva and in the *Wissenschaftshistorische Sammlungen der ETH* in Zurich (for details see Atmanspacher et al., 1995).

III. Carl Gustav Jung and Some Central Elements of His Psychology

When Carl Gustav Jung (1875-1961) had finished school, he had severe difficulties in deciding what faculty to choose at the University. His father complained (Jung, 1963): "The boy is interested in everything imaginable, but he does not know what he wants." He had developed strong interests not only in science — specifically in zoology, paleontology and geology — but also in the humanities and in archeology. Considering that he had to earn his living, he finally started studying medicine at the University of Basel. Jung received his MD at the faculty of medicine of the University of Zurich in 1902 for a thesis on the psychology of occult phenomena. Then he specialized in psychiatry, and after a stay with Pierre Janet in Paris, he became an assistant to Eugen Bleuler, director of Burgholzli, a psychiatric clinic in Zurich. He was fascinated by Freud's psychoanalysis, met Freud in Vienna in 1907, and a close father-and-son-like relationship began to emerge between the two (see McGuire & Sauerlander, 1974). In 1909, Jung moved to his new home in Kusnacht near Ziirich, where he lived together with his family until he died in 1961.

Jung's early work was based on Freud's sexual theory of repression, but later he began to doubt the universal significance of this theory to which Freud attached much emphasis. In 1913, Jung broke with Freud and cut all connections with his psychoanalytic school. In the ensuing period he was virtually isolated, and found that the personal psyche is grounded in archaic and historical roots. In his studies of the unconscious, Jung used anthropological material, the writings of alchemists, and carried out field studies among primitives. He was blessed with tremendous intuitive capabilities and he did not always aim at formulating his profound insights in razor-sharp and intellectually unassailable terms. He refused to reject anything which cannot be phrased in a clear-cut analytical language since he was aware that such efforts would be self-defeating. Realizing that logical contradictions are disastrous only from the restricted viewpoint of pure intellect, Jung took the burden to explicitly accept thinking in paradoxes.

Unlike Freud's conception of the unconscious as a storehouse of repressed emotions, thoughts, and memories, Jung's therapeutic work brought him to consider contents of the psyche which could not be attributed to a person's individual development. In Jung's analytical psychology (also called complex psychology), this deeper realm of non-personal, collective character is called the collective unconscious. Its contents are not individually acquired but inherited. They include instincts and other autonomous driving forces as well as typical modes of apprehension, which Jung, adopting a notion of St. Augustine, called archetypes (Jung, 1935b).

According to Jung, three layers can be distinguished in the human psyche: the conscious, the personal unconscious, and the collective unconscious. The archetypes belong to the contents of the collective unconscious. Jung uses the term archetype to paraphrase the Platonic "forms", the **eidola**. Archetypes are universal dispositions and, like instincts, they are common to all mankind

(Jung, 1935b). Their presence can be demonstrated wherever the relevant records are preserved. Jung considers the collective unconscious as "objective", prior to individual experience, and acting as a source of imagination and creative work. Such a transcendental realm of the psyche was alien to Freud's rather mechanistic conception of the unconscious. In his earlier writings, Jung treated archetypal phenomena as essentially psychic, but later he considered the unconscious as a realm which encompasses non-material and material aspects and denoted the nature of the archetype as "psychoid" rather than psychic (Jung, 1969a):

Since psyche and matter are contained in one and the same world, and moreover are in continuous contact with one another, and ultimately rest on irrepresentable, transcendental factors, it is not only possible but even fairly probable that psyche and matter are two different aspects of one and the same thing.

Archetypes are not directly perceivable. They are logically prior to mental constructs like concepts or images but can manifest themselves in such constructs. Typical examples are the shadow, the feminine in men, the masculine in women, the old wise man, the old wise woman. With respect to the mathematical sciences, the archetype of the natural numbers is of particular importance. The totality of the personality that entails both the conscious and the unconscious psyche is called the "self": an archetype representing the wholeness of man and, moreover, the goal of the process of his psychic development. This process is called individuation in Jung's parlance, and in his treatise *Psychology and Alchemy*, he unfolded the thesis "that there is in the psyche a process that seeks its own goal independently of external factors" (Jung, 1968, Ziff. 4).

For Pauli, the importance of Jung's depth psychology was not only in therapy and analysis but predominantly in its potential to conceive our scientific approach to nature via primordial ideas. Pauli favored the thesis that creative ideas are formed through a correspondence between the outer reality and archetypal images. He believed that "the ideas of the unconscious will not be developed further in the narrow frame of its therapeutic applications, but that their connection with the general development of the life sciences will be decisive for them" (Pauli, 1954a). Similarly, Jung was convinced (Jung, 1968, Ziff. 4) "that the treatment of neurosis opens up a problem which goes far beyond purely medical considerations and to which medical knowledge alone cannot hope to do justice."

Another example of an archetype which Jung considered to be particularly important was the principle of quaternarity, reflected by structures like mandalas, squares, and crosses. According to Jung (1969b), "quaternarity is an archetype of almost universal occurrence. It forms the logical basis for any whole judgment." Quaternarian structures — one could also say: structures based on the number four — can be interpreted as symbols of all concepts of

unbroken wholeness, whatever they may be, in both psychology and in physics, in the internal and in the external world. The historical significance of quaternity in European culture can be traced back to the Pythagoreans where the *tetraktys* was the holiest of the numbers. It is implicitly used in various principles of systematic philosophy (cf. Kant's or Schopenhauer's fourfold classification schemes), and it is clearly seen in many distinctions of every day life: four points of the compass, four seasons, four basic colors, four dimensions of space-time, and so on. Jung's work on psychological functions suggests the four classes of thinking, feeling, sensation, and intuition. Individuation, *i.e.*, the realization of the wholeness of one's self, is thus also meant as an integration of these functions. Quaternity often has a 3+1 structure, in which one of the four elements is of particular significance and creates "a totality" together with the other three. (An example: the dimension of time together with the three dimensions of space provides the four-dimensional space-time structure of general relativity.) Jung's discussions with Pauli have often been about the principle of quaternity as compared to that of trinity, related to the number three.

IV. The Pauli-Jung Dialog: General Aspects

The psychology of the unconscious and modern quantum physics introduced independently new concepts (*e.g.*, complementarity, holism) in a remarkably and peculiarly coincident manner. The corresponding relations between the two fields formed the core of the Pauli-Jung-dialog. Other than most of his physicist fellows, Pauli tried to interpret the scientific revolution that relativity theory and quantum theory implied for the world view of physics not only from a philosophical perspective but also from a psychological one. And other than most psychologists, Jung seriously looked for an objective basis that modern physics might provide for his models of the psyche. Pauli once wrote to Jung (Pauli, 1953a): "As physics strives after completeness, your analytical psychology longs for a home."

From a general point of view, the key topic of the Pauli-Jung-dialog was the problem of psychophysical relationships. In Pauli's words (Pauli, 1952a): "More and more I see the key to the whole spiritual situation of our time in the psycho-physical problem." From the viewpoint of modern natural sciences, one might be tempted to speak of relationships between psyche and matter, across the Cartesian cut between the two. This common denominator notwithstanding, Pauli's and Jung's approaches were different in motivation and method. The articles they published together in the volume *The Interpretation of Nature and the Psyche (Naturerklarung und Psyche, Jung and Pauli, 1952)* illustrate both their agreement and their differences paradigmatically.

Pauli's contribution to the joint book investigated "The Influence of Archetypal Ideas on the Scientific Theories of Kepler" (Pauli, 1952b). The goal of this study was to explore the role of the unconscious in the development of science and of the archetypal background of physical concepts. Pauli intended to



Carl Gustav Jung



Wolfgang Pauli

- Born July 26, 1875 in Kesswil (Switzerland)
 - 1902 MD thesis "Zur Psychologie und Pathologie sogenannter occulter Phänomene" (University of Zurich, Switzerland)
 - 1905 Habilitation at the faculty of medicine of the University of Zurich
 - 1906-1913 Extensive exchange of letters with Sigmund Freud
 - 1907 Jung meets Freud and becomes an adherent of Freudian psychoanalysis
 - 1910 Foundation of the International Psychoanalytic Association with Jung as president
 - 1912 Jung publishes *The Psychology of the Unconscious*
 - 1913 Open break between Jung and Freud
 - 1932-1941 Lecturer at the **ETH** Zurich
 - 1935 Honorary professor **ETH** Zurich
- Born April 25, 1900 in Vienna
 - 1918 Completes his first paper on general relativity
 - 1919-1921 Still a student, Pauli writes his masterly exposition of special and general relativity for the *Encyklopadie der mathematischen Wissenschaften*
 - 1921 PhD thesis *Über das Modell des Wasserstoffmoleküls* under the supervision of Arnold Sommerfeld at the University of Munich
 - 1923 Pauli joins the faculty of the University of Hamburg
 - 1925 Pauli announces the exclusion principle
 - 1928-1958 Professor for theoretical physics at **ETH** Zurich
 - 1930 Pauli suggests the existence of the neutrino

1932-57 Discussions and extensive exchange of letters between Carl G. Jung and Wolfgang Pauli

- a 1935 Jung's lectures *Traumsymbole des Individuationsprozesses* and his later book *Psychologie und Alchemie* include the empirical material of dreams of Pauli
 - 1943 Professor at the University of Basel
 - 1948 Opening of the C. G. Jung Institute, Zurich
- 1940 Pauli derives the exclusion principle from first principles
 - 1940-1946 Sojourn at the Institute for Advanced Study in Princeton
 - 1945 Nobel prize for physics

1952 C. G. Jung and W. Pauli publish the book *Natureerklärung und Psyche* (English translation 1955: *The Interpretation of Nature and the Psyche*).

C. G. Jung,
Synchronizität als ein Prinzip akausaler Zusammenhänge
 (Synchronicity: An Acausal Connecting Principle)

W. Pauli,
Der Einfluss archetypischer Vorstellungen auf die Bildung naturwissenschaftlicher Theorien bei Kepler (*The Influence of Archetypal Ideas on the Scientific Theories of Kepler*)

- 1955 Honorary doctor (Dr.sc.nat.h.c.) at ETH Zurich
 - Died June 6, 1961 in Kusnacht (Switzerland)
- Died December 15, 1958 in Zurich (Switzerland)

Fig. 1. Pauli and Jung Timetable

show how inner images initiate and guide the process of the formation of a scientific theory. This issue clearly relates to what was later denoted as the context of discovery by historians of science, but it goes beyond this concept in explicitly focusing on the "objective" archetypal contents of Jung's collective unconscious. As the archetypal image most relevant for Kepler's work, Pauli found the religious symbol of trinity which operates as a central motivation, and even "explanation", of a number of Kepler's main ideas. For instance, Pauli ascribed Kepler's evidence for the heliocentricity of the planetary system and for the three-dimensionality of space to a trinitarian world view.

Pauli's essay contrasts Johannes Kepler (1571-1630) with his contemporary Robert Fludd (1574-1637), alchemist and Rosicrucian at Oxford, with whom he staged extended and intensive controversies. Fludd's world view was dominated by the symbol of quaternity instead of trinity. It included the concrete and dirty world of matter and evil in addition to Kepler's abstract and clean world of heavenly harmony. Fludd commented on Kepler's narrow perspective with the words: "He has hold of the tail, I grasp the head." Kepler responded: "I hold the tail but I hold it in my hand. You may grasp the head mentally, though only, I fear, in your dreams" (quoted after Pauli, 1952b, p. 155-156). Although Kepler accused Fludd of being unscientific, overly speculative, and a dreamer, Fludd's quaternarian attitude contained insights which Pauli considered useful, *e.g.*, in the sense of a qualitative complementation of Kepler's "scientific", quantitative approach. Another interesting point is that a quaternarian world view symbolically adds another dimension to the "trinitarian" dimensions of space. This is particularly remarkable in regard of the notoriously underrated issue of time and the corresponding misconception of space and time from that period of the history of science until now (Pauli, 1947a, b).

In contrast to the attitude of today's mainstream science, Pauli did not follow Kepler in his unconditional condemnation of Fludd's world view. Pauli realized that presently, four centuries after the Kepler-Fludd-controversy, a reconciliation of trinitarian and quaternarian approaches is appropriate rather than a decision for one of them and against the other. Pauli saw that Fludd was a part of Kepler as Kepler was a part of Fludd, and he himself felt like Kepler and Fludd in one person (Pauli, 1953b). Again and again, this tension turned out to be of strong influence in his scientific work as well as for the development of his personality — in Jungian terms: his individuation (Pauli, 1951). However, beyond these personal, individual aspects, he was also well aware of the collective significance of this same conflict for the difficulties and problems of the present state of mankind as a whole. It would be unpardonable to dismiss these issues as his mere personal matter (Pauli, 1939).

Jung's contribution to *The Interpretation of Nature and the Psyche* is entitled "Synchronicity: An Acausal Connecting Principle" (Jung, 1952), a subject which he first mentioned in an obituary for Richard Wilhelm in 1930 (Jung, 1930). For years Jung hesitated to publish his corresponding ideas. It was Pauli who encouraged him to write this treatise (Jung, 1949), and the final



Fig. 2. Ouroboros (the tail eater). Inscription: en *to pan* (the one, the all) (Codex Marcianus, Venice, 10th/11th century)

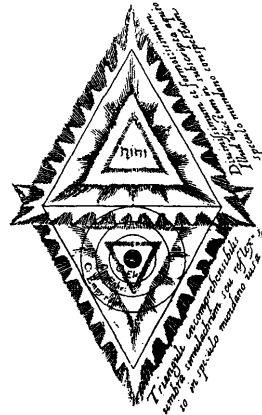


Fig. 3. Fludd's quaternary as doubled trinity (reproduced from Pauli 1952b, p. 148)

version was the result of several revisions inspired by Pauli's numerous comments.

Pauli's interest in synchronicity was not purely theoretical — he was haunted by strange phenomena during his entire life. Pauli lived in a permanent state of tension with our technical world, and he was notoriously clumsy with experimental tools. It is reported that his very presence in the vicinity of a laboratory was sufficient to cause the breakdown of experimental equipment in most inexplicable ways. Pauli's sardonic humor and his sense for the burlesque permitted him to enjoy the countless anecdotes about this so-called Pauli effect (Weizsacker, 1959; Jordan, 1973). Their authenticity is well documented by many independent accounts. Indeed, several experimental physicists became nervous whenever Pauli approached their labs, and one of them, Otto Stern, categorically prohibited his close friend Pauli from ever entering his laboratory (Fierz, 1979). Pauli did not take these phenomena lightly, he considered them as possible synchronistic manifestations of a deep conflict between his rational and non-rational side.

V. A Closer Look on Synchronicity

What precisely is synchronicity? In a few words, two (or more) seemingly-accidental, but not necessarily simultaneous (Jung, 1947) events are called synchronistic, if the following three conditions are satisfied.

- Any presumption of a causal relationship between the events is absurd or even inconceivable.
- The events correspond with one another by a common meaning, often expressed symbolically.

- Each pair of synchronistic events contains an internally produced and an externally perceived component.

Particularly the last one of these criteria makes clear that synchronistic phenomena are psycho-physical phenomena, and that they are intractable by any science dealing with psyche or matter alone. The first criterion indicates a central principle of traditional science which has to be re-evaluated if synchronistic phenomena are to be studied: causality in the narrow sense of a cause-and-effect-relation. The second criterion suggests the concept of meaning as a constructive perspective into this direction. Since synchronistic phenomena are not necessarily "synchronistic" in the sense of "simultaneous", synchronicity is a somewhat misleading term. For this reason Pauli preferred to speak of meaningful correspondences ("Sinnskorrespondenzen") under the influence of an archetypal "acausal ordering". He considered both Jung's synchronicity and the old teleological idea of finality (in the general sense of a process oriented toward a goal) as particular instances of such an acausal ordering which cannot be set up intentionally. Accordingly, the concept of chance (referring to seemingly accidental events) might also be interpretable in terms of meaningful correspondences.

From the viewpoint of the history of science, Pauli suggested to regard such an interpretation as the reverse of what happened when Darwin introduced the concept of chance in order to model biological evolution. In his article "Scientific and Epistemological Aspects of Concepts of the Unconscious," Pauli wrote (Pauli, 1954a, p. 297): "This model of evolution is an attempt to theoretically cling, according to the ideas of the second half of the 19th century, to the total elimination of any finality. As a consequence, this has in some way to be replaced by the introduction of chance." Pauli suggested that the concept of synchronicity might force science to revive the historically repressed concept of finality as a complement to causality. In "Die Vorlesung an die fremden Leute" (part of the very personal essay *Die Klavierstunde*, Pauli, 1953c, Ziff. 41), Pauli speculated about a "third kind of natural law which consists in correcting the fluctuations of chance by meaningful or functional coincidences of causally not connected events." But he hesitated to publish such thoughts. (Pauli, 1953c, Ziff. 45) "If one really would like to make such ideas public, it would be imperative to show something which is verifiable."

Discussing finality and goal-oriented evolution with respect to the question of meaningful correspondences, it is essential to have criteria for the meaning constituting the correspondence. This was one of the big issues of the Pauli-Jung-correspondence between November 1950 and February 1951 (Meier, 1992, p. 56-73). Jung had originally claimed that such a criterion has to be found in the individual response (communicated by language, gestures, or other kinds of behavior) of a subject that understands the meaning. But how can understanding be judged if an individual response is missing or remains unrecognized? Obviously, this point is of importance for early forms of life and, in particular, for so-called inanimate matter.

Postponing the difficult question of "meaning", Pauli and Jung generalized the notion of meaningful correspondence to similarity or mimesis ("Ähnlichkeit"), holistic order ("ganzheitliche Anordnung"), or simply to correspondence. Pauli suggested to start detailed studies of synchronicity in strictly non-psychological situations (e.g., radioactive decay).

Jung, however, favored the reverse approach. He focused on synchronistic events on the fully psychological level (even including psychokinesis) and expected that chance in the sense of physics, reinterpreted in a finalistic manner, would turn out as a special case under certain restrictions (Jung, 1951). While Pauli's approach would allow one to start within the framework of a strict detachment of the psyche of an observer and any observed phenomenon, Jung's would clearly imply that the observer's psyche is implicitly involved in any experimental setup or result.

This difference points to the decades-old and notorious question of observer detachment. In conventional quantum mechanics, the so-called "observer" is always an inanimate observer, that is, an observing apparatus. In spite of the fact that even such an observing apparatus is never completely detached from the observed system, the achievements of modern physics imply that under appropriate circumstances it is possible to place the conceptual cut (the so-called Heisenberg cut) between the two in such a way that the interactions can be minimized with respect to the observables under study. In contrast, an animate observer, e.g., a human observer's psyche, is not at any place part of the standard formalism of quantum mechanics and does therefore play no role as far as a physical description of external material reality is concerned. Although Pauli always stressed the latter point, he was not happy with this state of affairs (compare Pauli, 1956b). In a letter to Fierz (Pauli, 1954b) he expressed doubts that matter is always treated correctly, "if we observe it, as we do in quantum mechanics, namely leaving the internal state of the observer totally out of consideration." However, it must be clearly kept in mind that this statement is an offsprung from his speculative Fluddian side, and must not be taken as more than it is: an honest indication of an important but unresolved problem.

Pauli's compliance with a strictly detached observer psyche corresponds to his scientific Keplerian side. As far as we know today, chance on the non-psychological, purely physical level is "blind chance", hence governed by the empirically reproducible statistical rules of mathematical probability theory. As opposed to this, many psychological experiments suggest the existence of a "decline effect", characterized by decreasing statistical significance with increasing number of "identical" experiments. Pauli and Jung discussed this feature in terms of a possible complementarity of statistical method and synchronistic events, indicating that synchronistic phenomena cannot be corroborated by statistical methods as they are usually applied. They proposed that the triad "momentum-energy, space-time, causality" should be complemented by "synchronicity", thus once more emphasizing a transition from a trinitarian to a quaternarian scheme. During the last decade a number of pertinent investiga-

tions have been carried out in the field of parapsychology, an area of research which Pauli often mentioned as a hopeful candidate for a better understanding of synchronistic phenomena: "If the positive results in the yet controversial field of 'extra sensory perception' can be verified, this could lead to consequences which are totally unforeseeable at present" (Pauli, 1956b).

VI. Matter and Psyche as Two Aspects of One Reality

If synchronicity has to do with some kind of holistic order, then it is a natural question to ask for the ordering factors. Pauli and Jung agreed that matter and psyche should be understood as complementary aspects of the same reality which is governed by common ordering principles: the archetypes (Pauli, 1952b; Pauli, 1953d; Jung, 1953). This implies that the archetypes are elements of a realm beyond matter and psyche. Their influence reaches concurrently into both domains. It is their phenomenological appearance, not their intrinsic status, that refers either to internal psychological or external physical events. The notion of "psychoid archetypes" which Jung used in his later writings reflects this important distinction from a purely psychological relevance.

These concepts — admittedly not easy to grasp for a traditionally educated scientist — have been sketched in a letter from Pauli to Fierz as early as 1948 (Pauli, 1948a):

The ordering factors must be considered beyond the distinction of "physical" and "psychic" — as Plato's "ideas" share the character of a notion with that of a "natural force". I am very much in favor of calling these ordering factors "archetypes", but then it would be inadmissible to define them as contents of the psyche. Instead, the inner images are psychic manifestations of the archetypes, which, however, also would have to create, produce, cause everything in the material world that happens according to the laws of nature. The laws of the material world would thus refer to the physical manifestations of the archetypes...Each natural law should then have an inner correspondence and *vice versa*, even if this is not always immediately visible today.

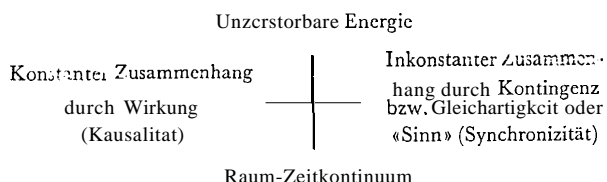


Fig. 4: Quaternality of momentum-energy, space-time, causality, and synchronicity according to Pauli und Jung (reproduced from Jung, 1952, p. 102).

With his strong emphasis on inner images (and symbols), the Platonist side of Pauli can clearly be recognized. But he also knew that Plato's "mysticism is so light that it overlooks large fields of darkness — what we today are neither allowed nor able to do." (Pauli, 1956b) Whatever these fields of darkness might refer to, the lightness of the Platonic world view in this conception reflects itself in the trinitarian attitude of one archetypal level with its two realms of manifestation.

However, this picture alone would be unbalanced with respect to Pauli's other, Fludd-like, quaternarian side. In the context of his corresponding interests, a number of similar ideas have been formulated in his privately distributed essay *Modern Examples of Background Physics* (Pauli, 1948b). Here he advocates the opinion that a complete quaternarian world view

would not show up within physics alone, but it could well be related to the wholeness of physics and psychology.... It would be conceivable, and it even seems plausible to me, that there might be phenomena for which the full quaternity plays an essential role.

Later in the same essay, Pauli emphasizes that physics by definition excludes anything having to do with judgments, feelings, and emotions — psychological forces which also exceed the clean and nice trinitarian frame of archetypes with their manifestations in natural laws and the material world. Alluding to Einstein's claim of an alleged incompleteness of quantum mechanics, he concludes (Pauli, 1948b, p. 192; see also Pauli, 1954b): "However, this does not indicate an incompleteness of quantum theory within physics, but an incompleteness of physics within the totality of life."

This strong statement also confines the sense in which the psychoid realm of the archetypes might be the realm of a neutral, universal language for psyche and matter for which Pauli and Jung have yearned so strongly (compare Pauli, 1948c). Pauli agreed with Jung that in ancient and medieval alchemy one can recognize first steps into such a direction. However, Pauli pointed out "that the alchemistic attempt to establish a psycho-physical universal language failed because it referred to a visible concrete reality," and that such an effort seems to be much more promising if it "would refer to a deeper invisible reality."

While alchemy overemphasized the concrete (Pauli, 1953e; Heisenberg, 1959), today's situation rather seems to be the reverse. If not only abstract intellectual reflection, but also the concrete experience of life is relevant for such a mode of communication, then its essence cannot possibly be covered by something like a final unified theory, a world formula, or a theory of everything. All these attempts at universal models include — in Jungian terms — the potential aspect of an implicit urge toward the exertion of power. At the same time they have a strong flavor of a theory of a stomach that ignores digestion. The cartoon with which Pauli commented his withdrawal from his own and Heisenberg's work on such an approach (a unified spinor theory of elementary particles) expresses this better than a thousand words.

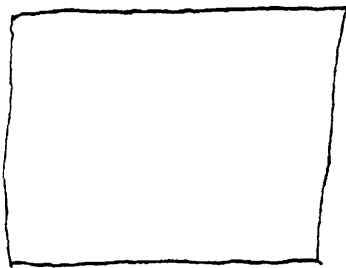
VII. What Does All This Mean For Us Today?

It was a basic tenet of Pauli that the walk on the ridge between psychology and physics is as difficult as the way "between the scylla of a blue dust of mysticism and the charybdis of a sterile rationalism" (Pauli, 1954c). In a letter to Fierz, in which Pauli (1954b) meditates about "holistic relationships between inside and outside which present science does not contain" and which might imply correlations of the inner state of an observer with the observed, Pauli warns (Pauli, 1954b):

I have here reached the limits of what might be knowable in the framework of contemporary knowledge, and I have even approached the realm of "magic" ...I am very well aware that this amounts to the threatening danger of a regression into most primitive superstition, that this would be much worse than Einstein's regressive obligation to classical field physics, and that everything depends on retaining the positive results and values of rationality.

If we take Pauli's views seriously, we have to re-evaluate fundamental questions in natural science and ponder about the repressed concepts and ideas in Western culture. Such a re-evaluation involves cases like the psychological and physical aspects of space and time, the old question of whether the psychic state of the observer be correlated with the external material course of nature, the problem of finality and its relation to chance, the role of meaning in the exact sciences, and the relations between "inside" and "outside". Moreover, such an endeavor requires us to consider additional topics like conscious

"This is to show the world, that I can paint like Titian!"



Only technical details are missing.

W. Pauli

Fig. 5 Pauli's comment in a letter to leading physicists all over the world in response to Heisenberg's radio announcement of a so-called "world formula" in 1958 (Pauli, 1958).

and unconscious, light and shadow, good and evil, and the connections between them. In one or another way all these examples may be put under the common heading of the psychophysical problem, *i.e.*, the problem of the relationships between psyche and matter.

This problem may be one of the crucial issues in a future-oriented science as well as society. Typical scientific aspects (besides those points already raised) are the fields of psychosomatic relationships and the so-called "hard problem" of cognitive science: the interface between psychology and neurophysiology.

Today there is a strong tendency to tackle all these age-old questions afresh, on a basis of scientific knowledge that is more solid and more profound than ever before. The Pauli-Jung-dialog does not solve any of the issues indicated. But it helps to recognize a number of problems more clearly. In this sense it might serve as a starting point to define a reasonable research program. Nevertheless, it would be overly naive and unwise to believe that the psychophysical problem can be ultimately resolved by science alone and to dismiss the non-rational side of the whole as irrelevant. Metaphorically speaking, this would amount to building an amazing complex of thoughts, but living in a barn next door.

Pauli insisted that in the future we can no longer ignore the relationship between our knowledge of the external material world and the inner world of meaning-giving contents of the psyche. We have to acknowledge the rational scientific approach as but one way of seeing and interpreting the world. A complementary approach implies that our investigations of reality must not any more deal with matter and psyche separately but that we have to take both sides into one common account. This is easily said, but it obviously addresses enormously difficult and ambitious problems. The normative principles of contemporary science — often tacit, hence applied without awareness of their meaning and consequences — will have to be specified and criticized more explicitly. In this regard (and others), we need an ecology of mind in addition to an ecology of matter.

Wholeness seems to be an extremely influential archetype in our time — it radiates an immense fascination and naturally triggers rejection to the same extent. Hence not only enthusiasm, but also much resistance is to be expected — against possible misunderstandings and abuses of a holistic science — and by no means will all the objections be simply wrong-headed or pointless. At present it is hard to be specific about details in this regard, but the issue of a humane science with scientists who feel responsible both for their research on its scientific level and also for the way it is practiced on a day-to-day-basis is certainly of utmost significance. Moreover, within a perspective that includes the dignity of human beings and respect for nature, ethical and religious aspects can no longer be left aside as subordinate details.

References

- Atmanspacher, H., Primas, H., and Wertenschlag-Birkhauser, E. (1995). Einführung. In *Der Pauli-Jung-Dialog und seine Bedeutung für die moderne Wissenschaft*. Ed. H. Atmanspacher, H. Primas and E. Wertenschlag-Birkhauser. Berlin: Springer, p.1-8; in particular references [19]-[26].
- Born, M. (1921). Letter to Einstein of February 12, 1921. In: *The Born — Einstein-Letters. Correspondence Between Albert Einstein and Max and Hedwig Born from 1916 to 1955* with Commentaries by Max Born (1971). Translated by Irene Born. New York: Walker, p. 54.
- Einstein, A. (1922). Buchbesprechung: Pauli, W., jun. *Relativitätstheorie. Naturwissenschaften*, 10, 184.
- Fierz, M. (1979). Naturerklärung und Psyche. Ein Kommentar zu dem Buch von C. G. Jung und W. Pauli. *Analytische Psychologie und ihre Grenzgebiete*, 10, 290. Reprinted in: M.Fierz. *Naturwissenschaft und Geschichte*. Basel: Birkhauser (1988). 181-91, here: p. 190.
- Goldschmidt, H. L. (ed.) (1990). *Nochmals Dialogik*. Zürich: ETH Stiftung Dialogik, 23.
- Heisenberg, W. (1959). Wolfgang Pauli's philosophische Auffassungen. *Naturwissenschaften*, 46, 661.
- Hermann, A, von Meyenn, K., Weisskopf, V. F. (eds.) (1979). *Wolfgang Pauli. Wissenschaftlicher Briefwechsel, Band I: 1919-1929*. Berlin: Springer.
- Jordan, P. (1973). Erinnerungen an Wolfgang Pauli. *Physikalische Blätter*, 29,291, here 293.
- Jung, C. G. (1930). Nachruf für Richard Wilhelm. *Neue Zürcher Zeitung*, March 6, 1930. Republished as *Richard Wilhelm: In Memoriam*. In: C. G. Jung. (1966). *Collected Works* 15. Princeton: Princeton University Press, 74.
- Jung, C. G. (1935a). The Tavistock Lectures. Republished in: C. G. Jung, *Collected Works* 18, London: Routledge and Kegan Paul, (1977), Ziff. 402 and 404, 174.
- Jung, C. G. (1935b). Psychologischer Kommentar zum Bardo Thodol. In: *Das Tibetische Totenbuch*. Zürich: hrsg. W. Y. Evans-Wentz, Rascher, 17. English translation republished in: C. G. Jung, *Collected Works* 11 (1958). Princeton: Princeton University Press, second edition (1961), Ziff. 845, 74.
- Jung, C. G. (1936). Traumsymbole des Individuationsprozesses. In: *Eranos-Jahrbuch 1935, Band III*. Ed. by O. Frobe-Kapteyn. Zürich: Rhein-Verlag, 13.
- Jung, C. G. (1937a). *The Terry Lectures (Yale University)*. Republished as *Psychology and Religion* (1958). In: C. G. Jung, *Collected Works* 11, Princeton: Princeton University Press, second edition (1969), 3.
- Jung, C. G. (1937b). *Dream Symbols of the Individuation Process*. Volume 1: Bailey Island Seminar, Sept. 1936; Volume 2: New York Seminar, Oct. 1937. Multigraphed notes, unpublished.
- Jung, C. G. (1944). *Psychologie und Alchemie*. Zürich: Rascher, zweite Auflage (1952).
- Jung, C. G. (1947). Der Geist der Psychologie. In: *Eranos-Jahrbuch* 1946. Ed. by O. Fröbe-Kapteyn. Zürich: Rhein-Verlag, 385.
- Jung, C. G. (1949). Letter to Pauli of June 22, 1949. In: *Wolfgang Pauli und C. G. Jung. Ein Briefwechsel*. Ed. by C. A. Meier (1992). Berlin: Springer, 40.
- Jung, C. G. (1951). Letter to Pauli of January 13, 1951. *Wolfgang Pauli und C. G. Jung. Ein Briefwechsel*. Ed. by C. A. Meier (1992). Berlin: Springer, 70.
- Jung, C. G. (1952). Synchronizität als ein Prinzip akausalen Zusammenhänge. In: *Naturerklärung und Psyche*, ed. by C. G. Jung und W. Pauli (1952). Zürich: Rascher, 1.
- Jung, C. G. (1953). Letter to Pauli of May 4, 1953. In: *Wolfgang Pauli und C. G. Jung. Ein Briefwechsel*. Ed. by C. A. Meier (1992). Berlin: Springer, 114.
- Jung, C. G. (1963). *Memories, Dreams, Reflections*. Collins, 104.
- Jung, C. G. (1968). *Collected Works* 12: *Psychology and Alchemy*. Second edition. Princeton: Princeton University Press.
- Jung, C. G. (1969a). *On the Nature of the Psyche*. Reprinted in: *Collected Works* 8. Second edition. Princeton: Princeton University Press, Ziff. 418,215.
- Jung, C. G. (1969b). *Collected Works* 11: *Psychology and Religion: West and East*. Princeton: Princeton University Press, Ziff. 246, 167 (first edition 1958).
- Jung, C. G. (1977). *Collected Works* 18: *The Symbolic Life*. Routledge and Kegan Paul, London, Ziff. 673,285, footnote 9.
- Laurikainen, K. V. (1984). *Wolfgang Pauli and Philosophy. Gesnerus* 41,213.
- Laurikainen, K. V. (1988). *Beyond the Atom*. Berlin: Springer.

- McGuire, W., and Sauerlander, Wolfgang (eds.) (1974). *Sigmund Freud — C. G. Jung. Briefwechsel*. Frankfurt: Fischer.
- Meier, C. A. (ed.) (1992). *Wolfgang Pauli und C. G. Jung. Ein Briefwechsel*. Berlin: Springer.
- Meyenn, K. von (ed.) (1985). *W. Pauli. Wissenschaftlicher Briefwechsel, Band II: 1930-1939*. Berlin: Springer.
- Meyenn, K. von (ed.) (1993). *Wolfgang Pauli. Wissenschaftlicher Briefwechsel, Band III: 1940-1949*. Berlin: Springer.
- Pais, A. (1982). *Subtle is the Lord.... The Science and the Life of Albert Einstein*. Oxford: Clarendon, 13.
- Pauli, W. (1939). Letter to Jung of May 24, 1939. In: *Wolfgang Pauli und C. G. Jung. Ein Briefwechsel*. Ed. by C. A. Meier (1992). Berlin: Springer, 31.
- Pauli, W. (1947a). Letter to Jung of December 23, 1947. In: *Wolfgang Pauli und C. G. Jung. Ein Briefwechsel*. Ed. by C. A. Meier (1992). Berlin: Springer, 36.
- Pauli, W. (1947b). Letter to Fierz of December 29, 1947. In: *Wolfgang Pauli. Wissenschaftlicher Briefwechsel, Band III: 1940-1949*. Ed. by K. V. Meyenn (1993). Berlin: Springer, 488.
- Pauli, W. (1948a). Letter to Fierz of January 7, 1948. In: *Wolfgang Pauli. Wissenschaftlicher Briefwechsel, Band III: 1940-1949*. Ed. by K. V. Meyenn (1993). Berlin: Springer, 496f.
- Pauli, W. (1948b). *Moderne Beispiele zur Hintergrundsphysik*. Reprinted in: *Wolfgang Pauli und C. G. Jung. Ein Briefwechsel*. Ed. by C. A. Meier (1992). Berlin: Springer, 176.
- Pauli, W. (1948c). Letter to Fierz of August 12, 1948. In: *Wolfgang Pauli. Wissenschaftlicher Briefwechsel, Band III: 1940-1949*. Ed. by K. V. Meyenn (1993). Berlin: Springer, 561.
- Pauli, W. (1951). Letter to Fierz of October 3, 1951. In: K. V. Laurikainen (1988). *Beyond the Atom*. Berlin: Springer, 129.
- Pauli, W. (1952a). Letter to Jung of May 17, 1952. In: *Wolfgang Pauli und C. G. Jung. Ein Briefwechsel*. Ed. by C. A. Meier (1992). Berlin: Springer, 84.
- Pauli, W. (1952b). Der Einfluss archetypischer Vorstellungen auf die Bildung naturwissenschaftlicher Theorien bei Kepler. In: *Naturerklärung und Psyche*. Ed. by C. G. Jung and W. Pauli (1952), Zürich: Rascher, 109. English translation reprinted in: *Writings on Physics and Philosophy*, ed. by C. P. Enz and K. von Meyenn (1994). Berlin: Springer, 218.
- Pauli, W. (1953a). Letter to Jung of May 27, 1953. In: *Wolfgang Pauli und C. G. Jung. Ein Briefwechsel*. Ed. by C. A. Meier (1992). Berlin: Springer, 123.
- Pauli, W. (1953b). Letter to Fierz of January 19, 1953. In: K.V. Laurikainen (1988). *Beyond the Atom*. Berlin: Springer, 89.
- Pauli, W. (1953c). Die Klavierstunde. Eine aktive Phantasie über das Unbewusste. In: *Der Pauli-Jung-Dialog und seine Bedeutung für die moderne Wissenschaft*. Ed. by H. Atmanspacher, H. Primas and E. Wertenschlag-Birkhauser, 1995). Berlin: Springer, 317.
- Pauli, W. (1953d). Letter to Jung of March 31, 1953. In: *Wolfgang Pauli und C. G. Jung. Ein Briefwechsel*. Ed. by C. A. Meier (1992). Berlin: Springer, 107.
- Pauli, W. (1953e). Letter to Jung of February 27, 1953. In: *Wolfgang Pauli und C. G. Jung. Ein Briefwechsel*. Ed. by C. A. Meier (1992). Berlin: Springer, 88.
- Pauli, W. (1954a). Naturwissenschaftliche und erkenntnistheoretische Aspekte der Ideen vom Unbewussten. *Dialectica*, 8, 283.
- Pauli, W. (1954b). Letter to Fierz of August 10, 1954. In: K. V. Laurikainen (1988). *Beyond the Atom*. Berlin: Springer, 144f.
- Pauli, W. (1954c). Letter to Weisskopf of February 8, 1954. In: W. Pauli (1984). *Physik und Erkenntnistheorie*. Braunschweig: Vieweg, XXIII.
- Pauli, W. (1956a). Letter to Jung of October 23, 1956. In: *Wolfgang Pauli und C. G. Jung. Ein Briefwechsel*. Ed. by C. A. Meier (1992). Berlin: Springer, 150.
- Pauli, W. (1956b). *Die Wissenschaft und das abendländische Denken*. In: *Europa — Erbe und Aufgabe*. Ed. by M. Gohring, Franz Steiner Verlag, Wiesbaden, 71.
- Pauli, W. (1958). Letter to Gamov of March 1, 1958. Reproduced in: G. Gamov (1985). *Thirty Years That Shook Physics*. New York: Dover, 163.
- Pauli, W. (1984). *Physik und Erkenntnistheorie*. Vieweg, Braunschweig, XVIII.
- Pauli, W. (1994). *Writings on Physics and Philosophy*. Ed. by C. P. Enz and K. von Meyenn. Berlin: Springer.
- Weizsacker, C. F. von (1959). Erinnerungen an Wolfgang Pauli. *Zeitschr. f. Naturforsch.* 14a, 439.
- Weyl, H. (1919). Letter to Pauli of May 10, 1919. In: *Wolfgang Pauli. Wissenschaftlicher Briefwechsel, Band I*. Ed. by A. Hermann, K. von Meyenn and V. F. Weisskopf (1979). Berlin: Springer, 3.