

Dual-Aspect Monism à la Pauli and Jung

Harald Atmanspacher

Institute for Frontier Areas of Psychology, Freiburg
Collegium Helveticum, Zürich

Abstract

Dual-aspect monism and neutral monism offer interesting alternatives to mainstream positions concerning the mind-matter problem. Both assume a domain underlying the mind-matter distinction, but they also differ in definitive ways. In the 20th century, variants of both positions have been advanced by a number of protagonists. One of these variants, the dual-aspect monism due to Wolfgang Pauli and Carl Gustav Jung, will be described and commented on in detail. As a unique feature in the Pauli-Jung conception, the duality of mental and material aspects is specified in terms of a complementarity. This sounds innocent, but entails a number of peculiarities distinguishing their conjecture from other approaches.

Contents

1	Dual-Aspect Monism	1
1.1	Dual-Aspect Monism Versus Neutral Monism	1
1.2	Varieties of Dual-Aspect Monism from Science	2
1.3	Complementary Dual Aspects	5
2	The Pauli-Jung Conjecture	7
2.1	Local Realism and Holism in the Material Domain	9
2.2	Consciousness and the Unconscious in the Mental Domain	11
2.3	Archetypes and <i>Unus Mundus</i>	13
2.4	Mind-Matter Correlations and Synchronicity	15

Published in Journal of Consciousness Studies 19(9-10) (2012)

1 Dual-Aspect Monism

1.1 Dual-Aspect Monism Versus Neutral Monism

The classic starting point for most contemporary discussions of mind-matter relations is Descartes' ontologically conceived dualism of the mental (*res cogitans*, thought) and the material (*res extensa*, extended matter). In the history of philosophy, Descartes' position was immediately upgraded, criticized, or replaced by essentially three forms of thought: (i) alternative dualistic approaches (occasionalism, parallelism), (ii) essentially monistic approaches (idealism, materialism), and (iii) approaches combining (i) and (ii) by assuming a monistic domain underlying the mind-matter distinction. An early protagonist of this latter view is Baruch de Spinoza.

Spinoza's monism provides an elegant and robust sense in which mind and matter are related to a "unity of essence". It does so by concatenating an ontological monism with an epistemological dualism, yielding an overall worldview in which both philosophy and the sciences can find appropriate places and mutual relations. This framework began to be explicitly exploited in the mid 19th century, by both philosophers and scientists, and today we can recognize two main reactions to Spinozism, called dual-aspect monism¹ and neutral monism.

Unfortunately, there is no authoritative delineation of the two – the many versions of dual-aspect monism and neutral monism that are around today have a tendency to blend into each other in ways that make clear assignments to one or the other problematic. This can be seen in Stubenberg's (2010) excellent overview, see also Silberstein's (2009) taxonomy and Seager's (2009) discussion, among others. There are important commonalities but also key differences between dual-aspect monism and neutral monism:

1. For neutral monists both mind and matter reduce to an underlying, neutral domain, while for dual-aspect monists mind and matter are two basic and irreducible aspects of that underlying domain. In both frameworks, the underlying, ontic domain (and its elements, respectively), is mostly characterized as *neither mental nor material*.
2. For neutral monists mind and matter are separate insofar as particular configurations of elements of the neutral domain underlie the mental while other, distinct configurations of elements of the neutral domain underlie the material. For dual-aspect monists the underlying, ontic domain manifests itself generally and equally under both aspects, tied together inseparably. (There are different ways in which they are tied together, leading to different types of duality, see Sec. 1.3.)

An interesting implication of these two criteria is that the aspects in dual-aspect monism are not *a priori* given, but depend on epistemic issues and

¹Other terms for dual-aspect monism are dual-aspect theory or dual-aspect approach, and frequently "dual" is replaced by "double". It should also be mentioned that the restriction to two aspects is a matter of simplicity rather than canonical. For instance, for Spinoza the number of possible aspects is infinite.

contexts. Distinctions of aspects are generated by “epistemic splits” of the distinction-free, unseparated underlying domain, and in principle there can be as many aspects as there are contexts. This is at variance with neutral monism where the mind-matter distinction is assumed to be preformed in the neutral domain: particular configurations of neutral elements underlie the mental while other, distinct configurations of neutral elements underlie the material.

Moreover, the two criteria entail an interesting further dividing line between prevalent philosophical inclinations toward the underlying domain. For dual-aspect monists this domain is apprehensible only indirectly, through the aspects, while neutral monists deny this restriction. Therefore, it is natural for dual-aspect monists to nurture metaphysical conceptions of the underlying domain, while neutral monists typically refer to direct, basic, pure, raw modes of apprehending it, for instance experientially or phenomenologically.

Stubenberg’s (2010) review clearly supports this observation. Ernst Mach, William James, and Bertrand Russell, the forefront of neutral monism, refer to “sensation”, “pure experience”, and again “sensation”, respectively, concerning the neutral domain, and these notions are redigested by other neutral monists such as Avenarius, Petzoldt, Perry, Holt, Sayre etc. Their empirical, hence anti-metaphysical, inclination explains why their notions of the neutral domain all bear the risk of confusing the neutral with some mental capacity. Assuming that the neutral can be apprehended directly, how could it be apprehended if not mentally?

By contrast, dual-aspect monists do not hesitate to embrace ontology and metaphysics. Since their underlying domain (substantial or processual) is conceived of metaphysically, it cannot be apprehensible in any direct way but manifests itself in its aspects. Beyond the well-known historical representatives of dual-aspect monism such as Spinoza, Fechner, Schopenhauer, and others, a number of scientists, notably physicists and psychologists, have explored the dual-aspect route since the mid 20th century. Needless to say, none of their attempts has resolved all aspects of the mind-matter relation. In the following some of these approaches will be presented. The subsequent sections will elaborate on one of them, due to Pauli and Jung, and outline how it may be potentially viable.

1.2 Varieties of Dual-Aspect Monism from Science

Scientifically inspired versions of dual-aspect monism have been formulated, discussed and developed, largely unnoticed by philosophers, in the second half of the 20th century. One of them originated from the extensive collaboration of the physicist Wolfgang Pauli and the psychologist Carl Gustav Jung, reviewed in depth by Atmanspacher and Primas (2006, 2009). Another one was proposed by David Bohm, whose collaborators Basil Hiley and Paavo Pylkkänen continue working on it. Related, more recent ideas, are due to Bernard d’Espagnat, a French physicist, Hans Primas, a Swiss chemist, and Max Velmans, a British psychologist.

Remarkably, these approaches are, in one way or another, attached to ideas

and notions that emerged during the development of quantum theory. In addition to the names just mentioned, quite a number of other physicists have been interested in relating physical processes to mental activity. It is impossible to review all of them in this article, hence the reader should consult a review of quantum approaches to consciousness (Atmanspacher 2011) for more details. The present article deliberately focuses on dual-aspect kinds of thinking.

Apart from his unsatisfying attempts to formulate hidden variables for quantum theory, *David Bohm* also proposed a dual-aspect approach to mind and matter. His ideas about explicate and implicate order (Bohm 1980) are particularly relevant in this context. While the notion of an explicate order characterizes an empirically and, thus, epistemically accessible reality, the notion of an implicate order refers to an ontic realm. Bohm refers to the mind-matter distinction at the level of an explicate order, which is based on an implicate order without that distinction (Bohm 1990):

At each level of subtlety there will be a “mental pole” and a “physical pole” ... But the deeper reality is something beyond either mind or matter, both of which are only aspects that serve as terms for analysis.

After Bohm’s death in 1992, *Basil Hiley* has further developed Bohm’s proposal using the formal apparatus of representations (in the mathematical sense) of algebraic structures which can be regarded as explications of an implicate order. Specifying the general idea laid out by Bohm and Hiley (1993), Hiley (2001) works with a pre-space (and pre-time) algebra and attempts to generate space and time by representations of this algebra. *Paavo Pyllkkänen*, a Finnish philosopher, advances the idea that so-formulated implicate and explicate orders are always implicate or explicate relative to a “higher” or “lower” level order, respectively (Hiley and Pyllkkänen 1996, Pyllkkänen 2007).²

In his more recent contributions, *Bernard d’Espagnat* (1999, 2006) has made explicit indications with respect to the mind-matter problem. He uses the notion of “the Real”, an independent primordial reality that is neither mental nor material. It is “veiled” insofar as it is inaccessible to direct empirical experience.³ But d’Espagnat (2006, p. 454) speculates about its influence on the experience of empirical reality:

I believe in the existence of an “extended causality” that acts, not between phenomena but *on* phenomena *from* “the Real”. Clearly, since, due to nonseparability, the said “Real” may in no sensible way be considered constituted of localized elements embedded in spacetime, this causality vastly differs, not only from Kantian causality but also from Einsteinian causality. Of course it does not invoke eventlike efficient causes ... but it may involve structural causes ... which vaguely bring to mind Plato’s Ideas – structures of “the Real”. ...

²This can be compared to an ontological relativity, where levels within reality are always ontic or epistemic relative to “higher” or “lower” levels, respectively (Quine 1969, Putnam 1987, Atmanspacher and Kronz 1999).

³For detailed comments and discussions of d’Espagnat’s “veiled reality” see Bitbol (1998) and Zwirn (2000), both in French.

According to the Veiled Reality conception, “the Real” is prior to mind-matter splitting. This expression of course refers to the coemergence ... of consciousness and empirical reality.

So, “the Real” can be accessed indirectly and fragmentarily from conscious experience and physical empirical reality, with empirical tools of the mental and the material, by carving out unseparated structures of “the Real” (and altering them by this very act). We will see later on (in Secs. 2.2 and 2.3) how close d’Espagnat’s “extended causality of the Real” is to the picture developed by Pauli and Jung.

The interaction of *Wolfgang Pauli* and *Carl Gustav Jung*, from 1932 to 1958, is particularly fascinating because, in addition to its conceptual peculiarities, it demonstrates some practical problems of communication that arise if the mind-matter problem is addressed in concrete interaction among different disciplinary frameworks. I will come back to some of these differences in detail below. A most significant novel feature of the Pauli-Jung conjecture is the suggestion that the dual (mental and material) aspects of the underlying domain should be understood in terms of complementary aspects (Pauli 1952, p. 164):⁴

The general problem of the relation between psyche and physis, between inside and outside, can hardly be regarded as solved by the term “psychophysical parallelism” advanced in the last century. Yet, perhaps, modern science has brought us closer to a more satisfying conception of this relationship, as it has established the notion of *complementarity* within physics. It would be most satisfactory if physis and psyche could be conceived as complementary aspects of the same reality.

And, in a letter to Rosenfeld of April 1, 1952 (von Meyenn 1996, p. 593), Pauli writes:

For the *invisible reality*, of which we have small pieces of evidence in both quantum physics and the psychology of the unconscious, a *symbolic* psychophysical unitary language must *ultimately* be adequate, and this is the distant goal to which I actually aspire. I am quite confident that the final objective is the same, independent of whether one starts from the psyche (ideas) or from physis (matter). Therefore, I consider the old distinction between materialism and idealism as obsolete.

In these quotations, Pauli indicates the conceptual framework that he developed with Jung and at the same time rules out virtually all historical alternatives (cf. (i) and (ii) in Sec. 1.1) to dual-aspect monism. Among the approaches mentioned in this section, the Pauli-Jung conjecture is likely the one that offers most details, mainly in the extensive correspondence between the two and with others. That the Pauli-Jung framework of thinking might indeed be inspiring even for philosophers is testified by Seager (2009, p. 88):

The genesis of Pauli’s dual-aspect theory fundamentally stems from his appreciation of certain insights provided by quantum theory rather than any

⁴This and all other originally German quotations by Pauli and Jung have been translated by the author.

study of the history of philosophy. In fact, I think that Pauli’s quantum approach adds a new and very interesting argument for the dual-aspect account of the mind-matter relation which makes it of real philosophical interest.

At present, there are at least two developments that might lead to genuine progress in the spirit of mind and matter as complementary dual aspects. One of them is the work of *Hans Primas* (2003, 2009), who discusses the mental and material in terms of complementary notions of mental and material time. The other one is the “reflexive monism” of *Max Velmans* (1991, 2009a,b), which explicitly introduced the complementarity of dual aspects for the first time in a psychologically based approach.

1.3 Complementary Dual Aspects

The notion of complementarity was originally coined by William James (1890, p. 206) and adopted by some psychologists, for instance referring to the bistable perception of ambiguous stimuli. Bohr imported it into physics, originally with the purpose of replacing the term wave–particle duality, in his “Como Lecture” in 1927 (Bohr 1928, p. 566). But his extensive later writings about complementarity make it clear (cf. Kalckar 1985, 1996; Favrholdt 1999) that Bohr’s preeminent concern was to extend the idea of complementarity beyond physics. In the same spirit, Pauli (1950, p. 79) advanced the opinion that the “issue of complementarity within physics naturally leads beyond the narrow field of physics to analogous conditions of human knowledge”.

According to Bernays (1948), there are two different types of complementarity already in quantum physics. One of them refers to incompatible observables, formally grounded in the non-commutativity of corresponding operators acting on quantum states. This non-commutativity entails all kinds of typical quantum features such as superpositions, quantum probabilities, indeterminism, uncertainty relations, and the violation of Bell inequalities.⁵

The significant hallmark of this first kind of complementarity is that the sequence in which two operations A, B are carried out makes a difference. This is the case whenever the operation carried out first, A , changes the state on which it acts in such a way that the second operation, B , leads to a result different from what would have resulted had B been carried out first – briefly:

⁵It is obvious that non-commuting operations abound in numerous situations beyond quantum physics. An example is the combined effect of successive rotations of a rigid body with respect to different axes on the orientation of the rotated body. A number of studies of eye movement and body rotation, starting with Hepp (1990), explores this feature as a neuro-physiological application of non-commutative rotations.

A “generalized quantum theory” in this spirit has been introduced by Atmanspacher et al. (2002), see also Atmanspacher et al. (2006). Within this framework, non-commutative operations have been successfully used to model the dynamics of bistable perception (Atmanspacher et al. 2004, Atmanspacher and Filk 2010). Indeed, it is to be expected that mental systems, uncontrollably and irreproducibly changed by virtually every operation, are paradigm examples for non-commutative behavior (cf. Sec. 4.7 in Atmanspacher 2011).

$AB \neq BA$. This is exactly the case for measurements of canonically conjugate observables in quantum physics.

The second kind of complementarity according to Bernays opens up a wider scope. It refers to conceptual issues such as the quantum physical complementarity of wave and particle pictures: Two descriptions are complementary if they mutually exclude each other, yet are both necessary to describe a situation exhaustively. Complementarity in this sense refers to incompatible aspects which cannot be combined in a single description based on a purely Boolean, two-valued logic. This limitation of Boolean descriptions, which is clearly recognized in quantum theory, is also relevant beyond physics.⁶

In a logical system which is not Boolean, the complement of a proposition differs from its negation. Pertinent examples are the complement of belief, namely doubt rather than disbelief (James), or the complement of benignity, namely justness rather than malignity (Bohr). Moreover, it is in principle possible that there is more than one single complement to a given proposition. For instance, one can discuss the theological figure of trinity in terms of three complementary entities. (The spin matrices in quantum theory are complementary in such a threefold fashion as well.)

Formally speaking, descriptions are systems of propositions, and in this sense descriptions can be complementary. Beim Graben and Atmanspacher (2009) have discussed an entire hierarchy of relations among descriptions from complementarity to incompatibility, incommensurability and incomparability (and their opposites). The key to this classification is a description of the behavior of a system based on partitions of its phase space. In this system-theoretical picture, incompatible descriptions arise if partitions are, in a well-defined sense, not chosen in a proper way. Atmanspacher and beim Graben (2007) speculated that the patchwork-kind of disunity of psychology as a science might have to do with this kind of incompatibility.

The feature of complementarity in a non-Boolean logic means that a proposition and its complement pertain to two aspects of a situation that are incompatible. They are both together necessary to describe the situation exhaustively. Neither one of them alone is sufficient, yet observing one of them in a given empirical context excludes observing the other one in the same context. For a dual-aspect monism, where the underlying domain is neither physical nor mental (cf. Sec. 1.1), complementarity thus implies that either the physical or the mental aspect is accessible in a given empirical context, although both of them are necessary for a complete picture.

When Pauli (1952, p. 164) says that “it would be most satisfactory if physis and psyche could be conceived as complementary aspects of the same reality”, he proposes a dual-aspect monism precisely in this sense. Velmans (2009b), who expands on Pauli’s speculation, points out that there are two distinct ways in which events that we normally think of as physical relate to events that we normally think of as mental. Viewed from an external observer’s third-person per-

⁶First applications of this idea to concrete examples are due to Aerts et al. (1993, 1994). For a general account of partial Boolean algebras, i.e. Boolean subalgebras pasted together in a non-Boolean way, see Primas (2007).

spective, phenomena in the external world can be thought of as physical, while from the first-person perspective of a given subject they can also be thought of as mental, being part of the subject’s experiential content – a relationship that can be described in neutral monist terms. In contrast, the relationship between the experiential content of a given subject’s mental state and an external observer’s data about that *same* subject’s corresponding brain activity is considered to be complementary in the sense of dual-aspect monism.

As these relationships are explained in detail in Velmans (2012), I will not elaborate on them here. But I should mention that at the epistemic level, where first- and third-person perspectives are to be distinguished, Velmans’ first (neutral monist) scenario leads to a dual account where empirical access to *both physical and mental* phenomena refers to the same “external” context. His second scenario, on the other hand, yields a complementary account where *either physical or mental* phenomena are empirically accessible due to the asymmetry of “external” and “interior” contexts.

The latter scenario clearly refers to Bernays’ second interpretation: two complementary descriptions mutually exclude each other although both together are needed to describe the situation exhaustively. As emphasized in Sec. 1.1, the underlying ontic level is conceived of as *neither physical nor mental* in both scenarios, irrespective of the epistemic distinction between duality and complementarity.

Primas (2009) suggests replacing mind-matter complementarity as a general relationship with a more restricted focus on mental time and physical time. His picture consists of a timeless domain that splits into a domain with a tenseless physical time, merely a parameter for dynamics, and a second domain with a tensed mental time, with past, present and future. These time domains can be formalized in such a way that they are complementary. A recent article by Filk and von Müller (2007) indicates other interesting candidate topics, in addition to time, for specifying a complementarity of mind and matter.

2 The Pauli-Jung Conjecture

Pauli and Jung began to think about mind-matter relations fairly soon after they first met in 1932, but the intense interaction that led to their version of dual-aspect monism happened after Pauli’s return from Princeton to Zurich in 1946. Their discussions were accompanied by an extensive exchange of ideas that Pauli had with his colleague Fierz at Basel. Fortunately much of this material is today accessible (in German) in von Meyenn’s masterful eight-volume edition of Pauli’s correspondence.

Although neither Pauli nor Jung nor Fierz were strongly inclined to discuss their ideas with contemporary academic philosophers (aside from only a few exceptions), their discussions had a distinctly philosophical flavor. However, their usage of philosophical concepts and notions was unsystematic: It was typical for them to avail themselves of the history of philosophy as they saw something fit their position or intention. Nevertheless, their comprehensive letters yield

valuable information, allowing a fairly detailed reconstruction of their approach in the landscape of philosophical positions. This applies in particular to how their version of dual-aspect monism differs from neutral monism.

Pauli compares his and Jung's views to Mach's in a letter to Jung of March 31, 1953,⁷ and states "fundamental agreements" with Mach's ideas. However, he also distinguishes Mach's neutral monism from his and Jung's approach (von Meyenn 1999, p. 96):

What Mach wanted, but what is not feasible, was the total elimination of everything in the description of nature that is *not* detectable [feststellbar] *hic et nunc*. But then one soon realizes that one does not understand anything: neither that a psyche must be assigned to others as well (detectable is always only one's own) nor that different people talk about the same (physical) object (Leibniz's *windowless monads*). In order to satisfy the requirements of both instinct and intellect, one must therefore introduce *structural elements of a cosmic order* which are *not detectable as such*.

Interpreting "detectable" as (a precondition for) "apprehensible", the term used in Sec. 1.1 to delineate dual-aspect monism from neutral monism, this quotation yields an idea of why Pauli favors the former over the latter. As we will see below, the role of the postulated structural elements is then adopted by the psychophysically neutral archetypes.⁸

In his copy of Russell's book *Human Knowledge – Its Scope and Limits* of 1948, Pauli marked Russell's *credo* (Russell 1948, p. 209):

My own belief is that the *mental* and the *physical* are not so disparate as is generally thought. I should define mental occurrence as one which someone knows otherwise than by inference; the distinction between *mental* and the *physical* therefore belongs to the theory of knowledge and not to metaphysics.

This is a clear formulation of the epistemic nature of the mind-matter distinction. Russell states that the mind-matter distinction does not exist in the ontic domain (metaphysics), so that it does not make sense to speak of mind and matter in this domain. And when, in *The Analysis of Mind*, Russell (1921, p. 144) says that "both mind and matter are composed of a neutral-stuff which, in isolation, is neither mental nor material", he clearly expresses (cf. Sec. 1.1) that the mental and the material emerge only in particular configurations of the "neutral-stuff".

In the following I will sketch the framework of dual-aspect monism à la Pauli and Jung in four parts: (1) the relation between local realism and holism in (quantum) physics, (2) the relation between consciousness and the unconscious in Jung's psychology, (3) the common, psychophysically neutral ground of both

⁷See von Meyenn (1999), pp. 94–102. See also Jung's reply of May 4, pp. 130–136, and Pauli's letter to Jaffé of April 1, pp. 104–105.

⁸Here and for the rest of this paper, I will use the term "neutral" not only for the "neutral domain" in "neutral monism" (as I did so far), but also for the psychophysically "neutral" domain underlying the mind-matter distinction in Pauli's and Jung's dual-aspect monism. The reason is that Pauli and Jung frequently used this term themselves.

the mental, conscious realm and the physical, local realm, and (4) the relation between these realms as a consequence of or as mediated by their common ground.

2.1 Local Realism and Holism in the Material Domain

One of the central problems, if not *the* problem, of quantum mechanics is the process of measurement. Although much progress has been achieved with respect to its understanding since the early days of quantum mechanics, the problem is still not completely solved. However, empirical results and modern formulations of quantum theory allow us to state it in a way that is more precise than ever before. From a conceptual point of view, measurement can be viewed as an intervention decomposing a system constituting an inseparable whole⁹ into locally separate parts.

The empirical cornerstone of our understanding of this decomposition involves so-called nonlocal correlations (Einstein et al. 1935, Bell 1964, Aspect et al. 1982). They are generic in any system requiring a description in terms of non-commuting observables. These correlations can be measured in suitable experiments and indicate *post festum* that the measured system was in a holistic state before measurement. Conceptually, this means that one can indirectly infer knowledge about an unmeasured state by the result of a controlled intervention into that state due to measurement. At the same time, this controlled intervention entails that the observed system changes its state in a basically uncontrollable way (Bohr 1935).

It is tempting to say that such nonlocal correlations correlate everything with everything else, thus suggesting a holistic concept of reality through and through. But this would be misleading without precise qualifications. Quantum holism is only one among two reality concepts that modern quantum theory requires. Equally important is the (“common sense”) concept of a local reality which was considered to be *the* reality for centuries of physicists from Newton to Einstein. As Bohr has emphasized over and over, local realism is unavoidable for a proper description of experiments and their results by Boolean (yes-no) propositions.

Today we know that both concepts together are necessary for a comprehensive description of reality, neither of them is sufficient on its own.¹⁰ In the framework of algebraic quantum theory, the difference between them can be mathematically formalized and clearly understood by two different state concepts: those of ontic and epistemic states. This distinction, originally suggested

⁹The notion of inseparability derives from the fact that, technically speaking, the state ϕ of the system as a whole cannot be represented as a tensor product of the separate states ϕ_1 and ϕ_2 of the parts. A separation of ϕ into states ϕ_1 and ϕ_2 is possible, but this abolishes the former state ϕ of the system as a whole and entails nonlocal correlations between the parts.

¹⁰The core of the well-known Bohr-Einstein discussions in the 1920s and 1930s (Jammer 1974, Chaps. 5 and 6) can be traced down to the belief that only one of the mentioned concepts of reality can be relevant. As far as I know neither Bohr nor Einstein ever explicitly addressed the question of whether different concepts of reality might “simply” have different ranges of relevance.

by Scheibe (1973), has turned out to be powerful and attractive for understanding the differences and similarities of various interpretational schemes in quantum theory. A helpful source for more details in this regard is a comprehensive account of epistemic and ontic quantum realities by Atmanspacher and Primas (2003).

While epistemic states are those states to which epistemic, i.e. empirical access is possible by measurement (and observation in general), ontic states are supposed to characterize the system independent of its observation and our resulting knowledge.¹¹ One may wonder why it is useful to have an ontic level of description for which empirical (or operational) access is no option at all. However, a most appealing feature at this ontic level is the existence of first principles and universal laws that are unavailable in an epistemic description. From such an ontic level, it is possible to deduce proper epistemic descriptions given enough details – contexts as it were – about empirically given situations.

The distinction of ontic and epistemic states provides an important clue to understand the distinction between a holistic and a local concept of reality. Ontic states and associated intrinsic properties refer to the holistic concept of reality and are operationally inaccessible, whereas epistemic states and associated contextual properties refer to a local concept of an operationally accessible reality. The process of measurement represents the link between the two. Measurement suppresses the connectedness constituting a holistic reality and generates approximately separate local objects constituting a local reality.

Although this is a fairly modern picture, it also has a conservative aspect: Quantum theory as of today does not at any place refer to the mental world of human observers, to their cognitive capabilities or psychological condition in general. The standard view in quantum theory is that measurement should be treated in terms of an interaction between an observed system and its environment, including the observing device(s). For instance, Heisenberg (1936) was very explicit about this, talking about a “cut between the system to be observed and the measuring devices”. And Pauli (1957) says: “As Heisenberg has emphasized, quantum mechanics rests on a sharp cut between observer or instrument of observation on one hand and the system observed on the other.”

In general, the idea is that any inanimate environment can be understood as a “measuring device”, though in a non-intentional manner. No consciousness is necessary for measuring a quantum state. On the other hand, as soon as *controlled* experiments are considered, it is clear that issues like the design of an experiment, the choice of observables of interest, or the interpretation of the results of a measurement play crucial roles. They depend on decisions based on the intentions of human observers and are not part of the formalism of quantum theory.

In this context, Pauli speculated in a letter to Fierz of August 10, 1954 (von Meyenn 1999, pp. 742–747):

¹¹In a more comprehensive picture, the concepts of epistemic and ontic states need to be considered relative to a chosen descriptive framework. This leads to the notion of *relative onticity* introduced by Atmanspacher and Kronz (1999).

It might be that matter, for instance considered from the perspective of life, is not treated “properly” if it is observed as in quantum mechanics, *namely totally neglecting the inner state of the “observer”*. (...) The well-known “incompleteness” of quantum mechanics (Einstein) is certainly an existing fact somehow-somewhere, but of course it cannot be removed by reverting to classical field physics (that is only a “neurotic misunderstanding” of Einstein), it has much more to do with *holistic relationships between “inside” and “outside” which contemporary science does not contain*.

However, consciousness is not an ingredient of physical measurements, no matter whether quantum or classical. In his privately distributed manuscript on “modern examples of background physics”, Pauli (1948) emphasized that the measurement problem “does not indicate an incompleteness of quantum theory within physics but an incompleteness of physics within the totality of life.” Pauli’s uneasiness with the status of science in general and physics in particular was not an odd idea but a serious criticism of great relevance. The question is how to turn it into viable research.

2.2 Consciousness and the Unconscious in the Mental Domain

According to Pauli and Jung, the role which measurement plays as a link between local and holistic realities in physics is mirrored by the act in which subjects become consciously aware of “local mental objects”, as it were, arising from holistic unconscious contents in psychology.¹² In this sense, which will be discussed in detail below, they postulate a parallel transition from mental and material holistic realisms to mental and material local realisms. This idea is most clearly elaborated in Jung’s supplement to his *On the Nature of the Psyche* (Jung 1969).¹³ Let me first quote from a letter by Pauli which Jung cites in footnote 130 in this supplement (Jung 1969, par. 439):¹⁴

... the epistemological situation regarding the concepts of “consciousness” and the “unconscious” seems to offer a close analogy to the situation of “complementarity” in physics, sketched below. On the one hand, the unconscious can only be made accessible in an indirect way by its (ordering) influence on conscious contents, on the other hand every “observation of

¹²I use the term of “local mental objects” to emphasize the analogy with local material objects, meaning that neither of them are non-local in any holistic sense. More concretely, local mental objects should be understood as distinct mental representations or categories endowed with a Boolean structure. They can be formally defined in a phase space representation (van Gelder 1998, Fell 2004).

¹³The German original was first published as “Der Geist der Psychologie” in 1946, and later revised and expanded (including the supplement) as “Theoretische Überlegungen zum Wesen des Psychischen” in 1954.

¹⁴This letter is contained neither in the published Pauli-Jung correspondence (Meier 1992) nor in Pauli’s correspondence edition by von Meyenn. Since Jung presents the quotation with the remark that Pauli “was gracious enough to look over the manuscript of my supplement”, the letter is likely of 1954.

the unconscious”, i.e. every attempt to make unconscious contents conscious, has a *prima facie* uncontrollable reaction back onto these unconscious contents themselves (as is well known, this precludes that the unconscious can be “exhaustively” brought to consciousness). The physicist will *per analogiam* conclude that precisely this uncontrollable backlash of the observing subject onto the unconscious limits the objective character of its reality and, at the same time, provides it with some subjectivity. Although, moreover, the *position* of the “cut” between consciousness and the unconscious is (to a certain degree) up to the free choice of the “psychological experimenter”, the *existence* of this “cut” remains an inevitable necessity. Thus, the “observed system” would, from the viewpoint of psychology, not only consist of physical objects, but rather comprise the unconscious as well, whereas the role of the “observing device” would be ascribed to consciousness. The development of “microphysics” has unmistakably led to a remarkable convergence of its description of nature with that of the new psychology: While the former, due to the fundamental situation known as “complementarity”, faces the impossibility to eliminate actions of observers by determinable corrections and must therefore in principle relinquish the objective registration of all physical phenomena, the latter could basically complement the merely subjective psychology of consciousness by postulating the existence of an unconscious of largely objective reality.

This commentary describes Pauli’s position in the framework of objective and subjective aspects of the mental, a distinction that he adopted from Jung quite early. Already in a letter to Kronig of August 3, 1934 (letter 380 in von Meyenn 1985, pp. 340–341), he talks about the “autonomous activity of the soul” as “something objectively psychical that cannot and should not be explained by material causes.” Hence, the “objective reality” at the end of the quote refers to the holistic reality, while the “subjective” relates to its contextual, epistemic appearances.

It is important to emphasize that the relation between holistic and local realms in both mental and material domains is conceived as bidirectional. Unconscious contents can become conscious, and simultaneously this very transition changes the unconscious left behind. Analogously, physical measurement necessitates a decomposition of the holistic realm, and simultaneously this very measurement changes the state of the system left behind. This picture, already outlined in Pauli’s letter to Fierz of October 3, 1951 (von Meyenn 1996, p. 377), represents a genuine interdependence between holistic and local domains. It can entail mind-matter correlations via the holistic realm that occur in addition to those correlations that are due to mere dual epistemic “manifestations” of that realm.

In order to give the reader a sense of how Jung embedded the cited Pauli quote in his text, here is the passage by Jung (1969, par. 439) in which it appears:

The application of statistical laws to processes of atomic dimensions in physics has a remarkable correspondence in psychology insofar as it pursues the foundations of consciousness to the point where they dim out

into the inconceivable and where only effects of *ordering* influences onto conscious contents can be detected [here the above footnote (HA)]. The study of these effects leads to the peculiar fact that they emerge from an unconscious objective reality which, however, at the same time appears to be subjective and conscious. This way, the reality underlying the effects of the unconscious comprises also the observing subject and is therefore of unimaginable constitution. It is in fact both most intimately subjective and most universally true, something that does not apply to conscious contents of personalistic nature. The elusiveness, capriciousness, haziness and uniqueness, with which the layperson connects the conception of the psyche, only applies to consciousness, but not to the absolute unconscious. The efficacious elements of the unconscious, to be defined not quantitatively but only qualitatively, the so-called *archetypes*, can therefore not with certainty be designated as *psychic*.

“... can thereforer not with certainty be designated as psychic”: This peculiarly cautious formulation is understandable due to the shift that Jung’s conception with respect to archetypes underwent from early ideas about (biological) hereditary instincts over (psychological) raw feelings and inner images to his final notion of psychophysically neutral, transcendental (or metaphysical) principles. The early 1950s were the time when this move became visible in Jung’s publications.¹⁵ Since his mature understanding of archetypes embraces both individual subjective consciousness and the impersonal objective unconscious, Jung invented the term “psychoid” to characterize them as structural principles beyond the conscious psyche alone.

2.3 Archetypes and *Unus Mundus*

While the preceding subsections described the way in which Pauli and Jung thought that epistemically accessible physical and mental domains refer to something ontic behind the mind-matter distinction, the present subsection addresses this “background domain” itself. One of its key features is that empirical tools of observation and measurement, as far as they are capable of providing knowledge about it at all, can do this only in an indirect fashion.

From the point of view of physics this “background domain” refers to the holistic state of a system prior to the transition to a measured state. From the point of view of psychology it refers to the mentally unconscious prior to the transition to a conscious state. Both transitions can be described as transitions from a non-Boolean domain to domains with Boolean classifications based on binary alternatives (cf. Primas 2007). In physics these appear as classical states actualized due to measurements; in psychology they appear as actualized distinct mental representations.

The simple but radical idea proposed by Pauli and Jung suggests a non-Boolean background domain from which the mental and the material are sup-

¹⁵The background of this development is an interesting topic in itself, which I cannot go into in detail here. See for instance Roesler (2010), who sketches the conversions and metamorphoses of Jung’s ideas about archetypes.

posed to emerge as epistemically distinguishable. Although physics and psychology point to their common basis in different ways, the basis itself is assumed to be of unitary nature: a psychophysically neutral domain that is neither material nor mental and describable by a non-Boolean neutral language. Of course, this should be understood as a “caricature” of a much more complicated scheme, with many unexplored details left open.

Already in 1948, Pauli expressed his predilection for such a psychophysically neutral domain beneath (or beyond) the mental and the material in a letter to Fierz:¹⁶

*The ordering and regulating factors must be placed beyond the distinction of “physical” and “psychic” – as Plato’s “ideas” share the notion of a concept and of a force of nature (they create actions out of themselves). I am very much in favor of referring to the “ordering” and “regulating” factors in terms of “archetypes”; but then it would be inadmissible to define them as contents of the *psyche*. The mentioned inner images (“dominant features of the collective unconscious” after Jung) are rather *psychic* manifestations of the archetypes which, *however*, would *also* have to put forth, create, condition anything lawlike in the behavior of the corporeal world. The laws of this world would then be the *physical manifestations of the archetypes*. . . . Each law of nature should then have an inner correspondence and vice versa, even though this is not always directly visible today.*

Now, Jung’s psychology hosts quite a selection of archetypes, to which different degrees of unconscious depth can be ascribed. Among Jungians there is agreement that the shadow and the anima/animus complex are the first, and therefore least deep-seated archetypes with whose manifestations individuals typically become acquainted. Candidates for more fundamental archetypes are the self, as the goal of the individuation process, and maybe most basic the archetype of number, expressing qualitative principles like unity, duality, trinity, quaternary, and so forth.

The notion proposed for the ontic, psychophysically neutral domain is the *unus mundus*, the one world, a notion that Jung adopted from the physician and alchemist Gerardus Dorneus (late 16th century). In his *Mysterium Coniunctionis* of 1955/56 Jung writes (Jung 1970, par. 767):

Undoubtedly the idea of the *unus mundus* is founded on the assumption that the multiplicity of the empirical world rests on an underlying unity, and that not two or more fundamentally different worlds exist side by side or are mingled with one another. Rather, everything divided and different belongs to one and the same world, which is not the world of sense but a postulate ...

Replying to a letter with some quite private excursions by Pauli, Jung relates the *unus mundus* to an inner unity of an individual self with the following remarks (letter to Pauli of 15 December 1956; von Meyenn 2001, p. 800):

¹⁶Letter by Pauli to Fierz of January 7, 1948, von Meyenn (1993), pp. 496–497. Note that this early account by Pauli of psychophysical neutrality emphasizes the “ordering” influence of archetypes and disregards the backreaction from the conscious onto the unconscious.

As soon as an individual has managed to unify the opposites within himself, nothing stands in the way of realizing both aspects of the world objectively. The inner psychic dissection becomes replaced by a dissected world view, which is unavoidable because without such discrimination no conscious knowledge would be possible. In reality, however, there is no dissected world: for a unified individual there is one “*unus mundus*”. He must discriminate this one world in order to be capable of conceiving it, but he must not forget that what he discriminates is always the one world, and discrimination is a presupposition of consciousness.

In this sense, making a distinction is a primordial principle of every epistemology, sometimes called an epistemic split.¹⁷ In line with Jung’s quote above, an entirely distinction-free state of affairs must indeed be associated with the radically unconscious, to which there is no conscious epistemic access at all.

When the holistic *unus mundus* is split, correlations emerge between the resulting domains. These correlations are remnants, as it were, of the wholeness that is lost due to the distinction made. Splitting the *unus mundus* as the holistic domain into mind and matter suggests ubiquitous correlations between mental and material states. The next section will be devoted to this topic.

2.4 Mind-Matter Correlations and Synchronicity

Conceiving the mind-matter distinction in terms of a splitting of a psychophysically neutral domain implies correlations between mind and matter as a direct and generic consequence. It is important, though, to stress right at the outset that these correlations are not due to causal interactions (in the sense of efficient causation as usually looked for in science) between the mental and the material. In a dual-aspect framework of thinking it would be wrong to interpret mind (or mental states) as directly caused by matter (or material states) or *vice versa*.

Pauli and Jung discussed such correlations extensively in their correspondence between June 1949 and February 1951 when Jung drafted his article on “synchronicity” for the book that he published jointly with Pauli (Jung and Pauli 1952). In a condensed form, two (or more) seemingly accidental, but not necessarily simultaneous events are called synchronistic if the following three conditions are satisfied.

1. Each pair of synchronistic events includes an internally conceived and an externally perceived component.
2. Any presumption of a causal relationship between the events is absurd or even inconceivable.

¹⁷In somewhat more abstract terms, distinctions can be conceived as symmetry breakings. Symmetries in this parlance are invariances under transformations. For instance the curvature of a circle is invariant under rotations by any arbitrary angle. A circle thus exhibits complete rotational symmetry. Symmetry breakings are a powerful mathematical tool in large parts of theoretical physics, but we do not know better than by pure speculation which symmetries must be ascribed to the *unus mundus*.

3. The events correspond with one another by a common meaning, often expressed symbolically.

The first criterion makes clear that synchronistic phenomena are psychophysical phenomena, intractable when dealing with mind or matter alone. The second criterion repeats the inapplicability of causation in the narrow sense of a conventional cause-and-effect-relation. And the third criterion suggests the concept of meaning as a constructive way to characterize mind-matter correlations.

Since synchronistic phenomena are not necessarily temporally “synchronous” (in the sense of “simultaneous”), synchronicity is a somewhat misleading term. For this reason Pauli preferred to speak of “meaningful correspondences” (“Sinnkorrespondenzen”) 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. In contrast, the mathematical notion of “blind” chance (referring to stochastically accidental events) might be considered as the limiting case of a meaning~~less~~ correspondence.

Similar to their idea of complementary notions of efficient causation and meaningful correspondence, Pauli and Jung discussed a possible complementarity of statistical limit theorems and singular synchronistic events. The upshot of this proposal is that synchronistic phenomena cannot be corroborated by statistical methods as they are usually applied. In a letter to Fierz of June 3, 1952, Pauli wrote (von Meyenn 1996, pp. 634–635):

... synchronistic phenomena ... elude being captured in natural “laws” since they are not reproducible, i.e., unique, and are blurred by the statistics of large numbers. By contrast, “acausalities” in physics are precisely described by statistical laws (of large numbers).

And in his “Lecture to the Foreign People” (Atmanspacher et al. 1995, p. 326), where he sketches some of his ideas about biological evolution, he states his impression that

external physical circumstances on the one hand and corresponding adaptive hereditary alterations of genes (mutations) on the other are not connected causally-reproducibly, but occur – correcting the “blind” chance fluctuations of the mutations – meaningfully and purposefully as inseparable wholes together with the external circumstances.

According to this hypothesis, which differs from both Darwin’s and Lamarck’s conception, we encounter the requested *third type* of natural laws, *consisting of corrections of the fluctuations of chance due to meaningful or purposeful coincidences of non-causally connected events.*

What Pauli here postulates is a kind of lawful regularity beyond both deterministic and statistical laws, based on the notion of *meaning* and, thus, entirely outside the natural sciences of his time and also, more or less, of today. It remains to be explored how this key issue of meaning can be implemented in an expanded worldview not only comprising but rather exceeding both psychology

and physics. A comprehensive substantial account of psychophysical phenomena needs to address them beyond the distinction of the psychological and the physical.

For the mindset of a psychologist like Jung, the issue of meaning is of primary significance anyway. For a long time, Jung insisted that the concept of synchronicity should be reserved for cases of distinctly numinous character, when the experience of meaning takes on existential dimensions. With this understanding synchronistic correlations would be extremely rare, thus contradicting their supposedly generic nature. Only in later years, Jung opened up toward the possibility that synchronicity might be a notion that should be conceived as ubiquitous as indicated above (Jung 1969, par. 440):

As soon as a psychic content transgresses the threshold to consciousness, its synchronistic byproducts disappear. Space and time resume their accustomed sway, and consciousness is again isolated in its subjectivity. This is one of those cases which can best be captured by the term “complementarity”, known from physics. When an unconscious content trespasses into consciousness, its synchronistic manifestation ceases and, conversely, synchronistic phenomena can be elicited by putting a subject into an unconscious state (trance). The same relation of complementarity can be observed in those frequent medical cases in which particular clinical symptoms disappear when their corresponding unconscious contents become conscious. We also know that a number of psychosomatic phenomena, otherwise outside the control of volition, can be induced by hypnosis, i.e. by an attenuation of consciousness.

Meier (1975) has later amplified this idea in an article about psychosomatics from a Jungian perspective.

In this regard, the development of Pauli’s and Jung’s views about archetypes and their role in manifesting synchronicities suggests a distinction between two different kinds of synchronistic events which I suggest to denote as “structural” versus “induced”.¹⁸ *Structural synchronicity* refers to the role of archetypes as ordering factors with a strictly *unidirectional* influence on the material and the mental (Pauli’s letter to Fierz of 1948, see Sec. 2.3). *Induced synchronicity* refers to the uncontrollable backreaction that changes of consciousness induce in the unconscious and, consequently, in the physical world as well. This way, the picture is extended to a *bidirectional* relation (Pauli’s letter to Jung of 1954, see Sec. 2.2).

It is important to keep in mind that even in induced synchronicity, not only in structural synchronicity, there is no direct causal relation from the mental to the physical (i.e. no direct “mental causation”) or vice versa. The problem of an “interaction” between categorically distinct regimes is thus avoided. Moreover, I should stress that the “meaning” connecting synchronistic events, although being subjectively ascribed (by the experiencing subject), is not completely

¹⁸One may ask whether the term “synchronicity” is the best choice for them; as mentioned above, Pauli proposed to replace it by “meaningful correspondence”. I am ready to adopt an improved terminology, should one come up in the future.

arbitrary. It depends on the situation as a whole, including conditions that are not consciously available to the subject.

Insofar as structural synchronicity defines a baseline of ordinarily robust psychophysical correlations (such as mind-brain correlations or psychosomatic correlations), induced synchronicity may be responsible for alterations and impairments above or below this baseline (cf. Jung’s quote above). Correlations above the baseline could be characterized as “salience” phenomena (Kapur 2003, van Os 2009) where coincidences appear overemphasized, while correlations below the baseline are experienced as dissociative with respect to ordinary correlations.

The rich material of extraordinary psychophysiological correlations comprehensively reviewed by Kelly (2007) suggests various concrete applications of this idea. Moreover, a recent statistical analysis of a huge body of documented cases of extraordinary human experiences (Fach 2011) provides significant evidence that such a framework of thinking fits existing empirical material surprisingly well. In the present article, space limitations prohibit a more detailed discussion of this direction of research. However, this will certainly be explored in more detail in the future.

Acknowledgments

I am grateful to Hans Primas, Max Velmans, Karl von Meyenn, and Jiri Wackermann for many inspiring and insightful discussions about the topics of this article.

References

- Aerts, D., and Aerts, S. (1994): Applications of quantum statistics in psychological studies of decision processes. *Foundations of Science* **1**, 85–97.
- Aerts, D., Durt, T., Grib, A., Van Bogaert, B., and Zapatin, A. (1993): Quantum structures in macroscopical reality. *International Journal of Theoretical Physics* **32**, 489–498.
- Aspect, A., Dalibard, J., and Roger, G. (1982): Experimental test of Bell’s inequalities using time-varying analyzers. *Physical Review Letters* **49**, 1804–1807.
- Atmanspacher, H. (2011): Quantum approaches to consciousness, in Zalta, E.N. (ed.), *Stanford Encyclopedia of Philosophy*, <http://plato.stanford.edu/entries/qt-consciousness/>.
- Atmanspacher, H., and Filk, T. (2010): A proposed test of temporal nonlocality in bistable perception. *Journal of Mathematical Psychology* **54**, 314–321.
- Atmanspacher, H., Filk, T., and Römer, H. (2004): Quantum Zeno features of bistable perception. *Biological Cybernetics* **90**, 33–40.
- Atmanspacher, H., Filk, T. and Römer, H. (2006): Weak quantum theory: Formal framework and selected applications, in Adenier, G., Khrennikov, A., Nieuwenhuizen, T.M. (eds.) *Quantum Theory: Reconsideration of Foundations–3*, pp. 34–46, New York: American Institute of Physics.

- Atmanspacher, H., and beim Graben, P. (2007): Contextual emergence of mental states from neurodynamics. *Chaos and Complexity Letters* **2**, 151–168.
- Atmanspacher, H., and Kronz, F. (1999): Relative onticity, in Atmanspacher, H., Amann, A., Müller-Herold, U. (eds.) *On Quanta, Mind, and Matter. Hans Primas in Context*, pp. 273–294, Dordrecht: Kluwer.
- Atmanspacher, H., and Primas, H. (2003): Epistemic and ontic quantum realities. In Castell, L., Ischebeck, O. (eds.) *Time, Quantum, and Information*, pp. 301–321, Berlin: Springer.
- Atmanspacher, H., and Primas, H. (2006): Pauli’s ideas on mind and matter in the context of contemporary science. *Journal of Consciousness Studies* **13**(3), 5–50.
- Atmanspacher, H., and Primas, H., eds. (2009): *Recasting Reality*, Berlin: Springer.
- Atmanspacher, H., Primas, H., and Wertenschlag-Birkhäuser, E., eds. (1995): *Der Pauli-Jung-Dialog und seine Bedeutung für die moderne Wissenschaft*, Berlin: Springer.
- Atmanspacher, H., Römer, H., and Walach, H. (2002): Weak quantum theory: Complementarity and entanglement in physics and beyond. *Foundations of Physics* **32**, 379–406.
- Bell, J.S. (1964): On the Einstein Podolsky Rosen paradox. *Physics* **1**, 195–200.
- Bernays, P. (1948): Über die Ausdehnung des Begriffes der Komplementarität auf die Philosophie. *Synthese* **VII**, 66–70.
- Bitbol, M. (1998): *L’Aveuglante proximité du Réel*, Paris: Flammarion.
- Bohm, D. (1980): *Wholeness and the Implicate Order*, Routledge, London.
- Bohm, D. (1990): A new theory of the relationship of mind and matter. *Philosophical Psychology* **3**, 271–286.
- Bohm, D., and Hiley, B. (1993): *The Undivided Universe*, London: Routledge.
- Bohr, N. (1928): The quantum postulate and the recent development of atomic theory. *Nature (Supplement)* **121**, 580–590.
- Bohr, N. (1935): Can quantum-mechanical description of physical reality be considered complete? *Physical Review* **48**, 696–702.
- Einstein, A., Podolsky, B., and Rosen, N. (1935): Can quantum-mechanical description of physical reality be considered complete? *Phys. Rev.* **47**, 777–780.
- d’Espagnat, B. (1999): Concepts of reality: Primas’ nonstandard realism, in Atmanspacher, H., Amann, A., Müller-Herold, U. (eds.) *On Quanta, Mind, and Matter. Hans Primas in Context*, pp. 249–272, Dordrecht: Kluwer.
- d’Espagnat, B. (2006): *On Physics and Philosophy*, Princeton: University Press.
- Fach, W. (2011): Phenomenological aspects of complementarity and entanglement in exceptional human experiences. *Axiomathes* **21**, 233–247.
- Favrholdt, D. (1999): *Niels Bohr Collected Works. Volume 10. Complementarity Beyond Physics (1928–1962)*. Amsterdam: Elsevier.
- Fell J. (2004): Identifying neural correlates of consciousness: the state space approach. *Consciousness and Cognition* **13**, 709–729.
- Filk, T., and von Müller, A. (2007): Quantum physics and consciousness: The quest for a common conceptual foundation. *Mind and Matter* **7**, 59–80.

- beim Graben, P., and Atmanspacher, H. (2009): Extending the philosophical significance of the idea of complementarity, in Atmanspacher, H., Primas, H. (eds.) *Recasting Reality*, pp. 99–113, Berlin: Springer.
- Heisenberg, W. (1936): Prinzipielle Fragen der modernen Physik, in *Neuere Fortschritte in den exakten Wissenschaften*, pp. 91–102, Leipzig, Franz Deuticke.
- Hepp, K. (1990): On Listing’s law. *Communications in Mathematical Physics* **132**, 285–292.
- Hiley, B.J. (2001): Non-commutative geometry, the Bohm interpretation and the mind-matter relationship, in Dubois, D. (ed.) *Computing Anticipatory Systems - CASYS 2000*, pp. 77–88, Berlin: Springer.
- Hiley, B., and Pyłkkänen, P. (1996): Representation and interpretation in quantum physics, in Peterson, D.M. (ed.) *Alternative Representations*, pp. 180–197, Exeter: Intellect Books.
- James, W. (1890): *The Principles of Psychology. Volume One*. New York: Holt.
- Jammer, M. (1974): *The Philosophy of Quantum Mechanics*. New York: Wiley.
- Jung, C.G. (1969): On the nature of the psyche, in *The Structure and Dynamics of the Psyche. Collected Works, Vol. 8*, pp. 159–236, Princeton: University Press.
- Jung, C.G. (1970): *Mysterium Coniunctionis*, in *Collected Works, Vol. 14*, Princeton: University Press.
- Jung, C.G., and Pauli, W. (1952): *Naturerklärung und Psyche*, Zürich: Rascher.
- Kalckar, J. (1985): *Niels Bohr Collected Works. Volume 6. Foundations of Quantum Physics I (1926–1932)*, Amsterdam: North-Holland.
- Kalckar, J. (1996): *Niels Bohr. Collected Works. Volume 7. Foundations of Quantum Physics II (1933–1958)*, Amsterdam: Elsevier.
- Kapur, S. (2003): Psychosis as a state of aberrant salience: A framework linking biology, phenomenology, and pharmacology in schizophrenia. *American Journal of Psychiatry* **160**, 13–23.
- Kelly, E.W. (2007): Psychophysiological influence, in Kelly, E.F., Kelly, E.W. et al. (eds.) *Irreducible Mind*, pp. 117–239, Lanham: Rowman and Littlefield.
- Meier, C.A. (1975): *Psychosomatik in Jungscher Sicht*, in Meier, C.A. (ed.) *Experiment und Symbol*, pp. 138–156, Olten: Walter.
- Meier, C.A., ed. (1992): *Wolfgang Pauli und C.G. Jung. Ein Briefwechsel 1932–1958*, Berlin: Springer.
- Meyenn, K. von (ed.) (1985): *Wolfgang Pauli. Wissenschaftlicher Briefwechsel, Band II: 1930–1939*, Berlin: Springer.
- Meyenn, K. von (ed.) (1993): *Wolfgang Pauli. Wissenschaftlicher Briefwechsel, Band III: 1940–1949*, Berlin: Springer.
- Meyenn, K. von (ed.) (1996): *Wolfgang Pauli. Wissenschaftlicher Briefwechsel, Band IV, Teil I: 1950–1952*, Berlin: Springer.
- Meyenn, K. von (ed.) (1999): *Wolfgang Pauli. Wissenschaftlicher Briefwechsel, Band IV, Teil II: 1953–1954*, Berlin: Springer.
- Meyenn, K. von, (ed.) (2001): *Wolfgang Pauli. Wissenschaftlicher Briefwechsel, Band IV, Teil III: 1955–1956*, Berlin: Springer.

- Pauli, W. (1948): Moderne Beispiele zur Hintergrundphysik, in Meier, C.A. (ed.) *Wolfgang Pauli und C.G. Jung. Ein Briefwechsel*, pp. 176–192, Berlin: Springer.
- Pauli, W. (1950): Die philosophische Bedeutung der Idee der Komplementarität. *Experientia* **6**, 72–81. English translation in Enz, C.P., von Meyenn, K. (eds.) *Wolfgang Pauli. Writings on Physics and Philosophy*, pp. 35–42, Berlin: Springer, 1994.
- Pauli, W. (1952): *Der Einfluss archetypischer Vorstellungen auf die Bildung naturwissenschaftlicher Theorien bei Kepler*, in Jung, C.G., Pauli, W. (eds.) *Naturerklärung und Psyche*, pp. 109–194, Zürich: Rascher.
- Pauli, W. (1957): Phänomen und physikalische Realität. *Dialectica* **11**, 36–48. English translation in Enz, C.P., von Meyenn, K. (eds.) *Wolfgang Pauli. Writings on Physics and Philosophy*, pp. 127–135, Berlin: Springer, 1994.
- Primas, H. (2003): Time-entanglement between mind and matter. *Mind and Matter* **1**, 81–119.
- Primas, H. (2007): Non-Boolean descriptions of mind-matter systems. *Mind and Matter* **5**, 7–44.
- Primas, H. (2009): Complementarity of mind and matter, in Atmanspacher, H., Primas, H. (eds.) *Recasting Reality*, pp. 171–209, Berlin: Springer.
- Putnam, H. (1987): *The Many Faces of Realism*, LaSalle: Open Court.
- Pylkkänen, P. (2007): *Mind, Matter, and the Implicate Order*, Sec. 3, Berlin: Springer.
- Quine, W.V.O. (1969): Ontological relativity, in *Ontological Relativity and Other Essays*, pp. 26–68. New York: Columbia University Press.
- Roesler, C. (2010): *Analytische Psychologie heute*, Freiburg: Karger.
- Russell, B. (1921): *The Analysis of Mind*, London: George Allen & Unwin.
- Russell, B. (1948): *Human Knowledge: Its Scope and Limits*, London: George Allen & Unwin.
- Scheibe, E. (1973): *The Logical Analysis of Quantum Mechanics*, pp. 82–88, Oxford: Pergamon.
- Seager, W. (2009): A new idea of reality: Pauli on the unity of mind and matter, in Atmanspacher, H., Primas, H. (eds.) *Recasting Reality*, pp. 83–97, Berlin: Springer.
- Silberstein, M. (2009): Why neutral monism is superior to panpsychism. *Mind and Matter* **7**, 239–248.
- Stubenbergh, L. (2010): Neutral monism, in Zalta, E.N. (ed.) *Stanford Encyclopedia of Philosophy*, <http://plato.stanford.edu/entries/neutral-monism/>.
- van Gelder T. (1998): The dynamical hypothesis in cognitive science. *Behavioral and Brain Sciences* **21**, 615–661.
- van Os, J. (2009): A salience dysregulation syndrome. *British Journal of Psychiatry* **194**, 101–103.
- Velmans, M. (1991): Consciousness from a first person perspective. *Behavioral and Brain Sciences* **14**, 702–726.
- Velmans, M. (2009a): *Understanding Consciousness*, second edition, London: Routledge/Psychology Press.

- Velmans, M. (2009b): Psychophysical nature, in Atmanspacher, H., Primas, H. (eds.) *Recasting Reality*, pp. 115–134, Berlin: Springer.
- Velmans, M. (2012): Reflexive monism: Psychophysical relations between mind, matter and consciousness, this issue.
- Zwirn, H. (2000): *Les Limits de la Connaissance*, Paris: Odile Jacob.