

## Editorial

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Let me start this editorial with good news for the future. After negotiations with several professional publishing houses, regarding the publication and distribution of *Mind and Matter* for the time after 2004, a contract with Imprint Academic at Exeter (Great Britain) has been finalized. Imprint Academic is well known to most of our readers as the publisher of the widely circulated *Journal of Consciousness Studies*, and their website at [www.imprint.co.uk](http://www.imprint.co.uk) contains information about their other activities. All editorial work for *Mind and Matter* will remain in our own hands at Freiburg. The journal homepage at [www.mindmatter.de](http://www.mindmatter.de) will be further maintained by the editorial office. In the future, access to the full texts of all articles will be provided by Ingenta. Full texts will be available charge-free for subscribers and can be purchased by everybody else.

Collaborating with a devoted and successful publisher like Imprint Academic has numerous advantages. Cooperation with other journals, in particular with the *Journal of Consciousness Studies* and its managing editor Anthony Freeman, will become even stronger than they already are. Since Imprint Academic is not an oversize company, interactions with them can be flexible, direct, and efficient. Both their marketing organization and strategies are perfectly adapted to serve the interests of subscribers. Moreover, administrative overheads and related charges are minimal. For our individual subscribers this means that the introductory rate of 2004 will continue to apply for the year 2005 as well. (Please fill and return the subscription renewal form included in this issue!) There are very good reasons to looking forward to a pleasurable and successful collaboration.

The core topic of the present issue is “parts and partitions”. Partitions are schemes that generate parts from a whole. The idea behind this approach is almost universal and can be found in all civilizations since ancient times. For instance, Plato expressed the relation between a whole and its parts in terms of the relation between pure ideas or forms ( $\epsilon\iota\delta\omicron\varsigma$ ) and their manifold appearances or manifestations. While the ideas themselves are not directly accessible, their turbid appearances are, and they allow us to develop guided intuitions about the ideas behind them. Similar thoughts can be found in Chinese and Indian philosophy and religion.

The construction of a partition requires to distinguish, to divide, to differentiate, to separate, or to decompose something that is not yet partitioned. All these notions are key terms in many contemporary disciplines of science and the humanities. Two millenia of philosophy are filled with

antinomies, dichotomies, opposites, dualities, *différence*, and so on: inside and outside, subject and object, becoming and being, being and nothingness, and, of course, mind and matter are only a few most familiar ones among them.

Various kinds of dualities can be found in numerous branches of mathematics. The notion of inverse elements plays a basic role in algebra, and negations are at the basis of logical calculus. Spencer-Brown starts his *Laws of Form* of 1969 with the statement that “we take as given the idea of distinction and the idea of indication, and that we cannot make an indication without drawing a distinction.” It is tempting to read this almost as an epistemological axiom. Modern science makes use of it in many instances, most obviously in cognitive science. Another example is the distinction of self and other, on which the principles of biological autonomy are grounded.

Where a partition is imposed on a whole, there is usually more than one partition possible; often one has to choose among infinitely many of them. For this reason, partitioning a system requires a selection criterion for suitable or appropriate partitions versus unsuitable or inappropriate ones. Such a criterion is typically not easy to obtain – it is not prescribed by universal laws but requires a context with respect to which the suitability of a partition can be evaluated. A general idea regarding this problem is that proper parts should be as independent as possible from each other.

More formally this means that a proper partition should minimize correlations between the parts that it generates. In some cases in which this idea can be carried out rigorously it is intimately related to stability properties: minimal correlations between parts correspond to maximally stable parts. As simple as this sounds, non-trivial techniques are often required to implement this criterion soundly. In this context, a sophisticated concept, of crucial significance in the theory of dynamical systems, has been introduced and developed by Kolmogorov, Sinai and others in the 1950s and 1960s: the concept of a so-called generating partition. Since the article by Peter beim Graben in this issue strongly relies on this concept, some brief words of explanation are appropriate. Several properties of a dynamical system as a whole, such as its entropy, can only be specified with respect to a partition of the system into subsystems. (In general, not the system itself but the representation of its dynamics in a so-called phase space is partitioned.) Since different partitions generally yield different entropies, the question arises as to how a proper partition can be determined.

One can indeed show that there is a distinguished partition which is invariant under the dynamics of the system and, thus, gives rise to an entropy which is equally invariant. This is due to the fact that the boundaries between the cells of the distinguished partition are mapped onto one another, so that the partition is generated by the dynamics of

the system and does not change. Such a generating partition is stable under the dynamics in the sense that no correlations between cells are created.

It should be emphasized that this approach is not restricted to physics only, but is truly interdisciplinary in its applications. It requires only the specification of the state of a system, its observables (or properties), and their dynamics. For instance, it is in principle possible to represent brain states, say, in terms of electromagnetic activity, as a function of time in a suitably constructed phase space. Then partitions of this space can be used to define symbolic cognitive states that are physically implemented by brain activity.

A general introduction to contemporary approaches to modeling representations in cognitive science is given by Peter Gärdenfors. He distinguishes between the two classes of symbolic and connectionist approaches and argues in favor of a third way of modeling representations in terms of “concepts”. For this purpose, he suggests to use “conceptual spaces” (the title of one of his recent books) as a geometrical way to represent information.

In particular, Gärdenfors elaborates on the construction of conceptual spaces for specific situations and proposes to represent individual concepts, or categorizations, by partitions of such spaces into convex regions. This idea is backed up by examples which demonstrate its viability. In Gärdenfors’ opinion, conceptual-space representations may be a useful theoretical tool to fill the gap between neural connectionism and classical symbolic approaches.

Referring to connectionist approaches in cognitive neuroscience, Peter beim Graben argues that a specific kind of modeling by dynamical systems offers new and promising points of view: the field of symbolic dynamics. He shows how the terms “implementation” and “incompatibility”, which are crucial for the debate, must be revised in the framework of symbolic dynamics modeling. It is hard to overlook the similarity of the notion of a “symbol” in this framework with Gärdenfors’ notion of a “concept”.

Beim Graben presents three examples of implementations of symbol processors that are generically incompatible with respect to different partitions (topologies). This is due to the fact that, in these examples, the partitions are not generating. As an important consequence of this result, it is to be expected that descriptions at a cognitive level (as opposed to the neural level) are necessarily incompatible in general. This shows any discomfort about the lack of a coherent unified framework for cognitive science to be misplaced. Incompatible descriptions are unavoidable and not an obstacle that one may hope to overcome some day.

In addition to these aspects of partitions, the generation of parts from a whole is of paramount significance in quantum theory. With its fundamentally holistic features, quantum theory makes it mandatory to know

how to decompose systems as a whole into parts if one wants to discuss the properties and behavior of those parts. The illustrative notion of a so-called “Heisenberg cut” has been coined to address this problem. In a letter to Heisenberg of June 15, 1935, Pauli suggested that a systematic foundation of quantum mechanics should start with a discussion of the way in which systems are composed and decomposed.

In his article in this issue, Rudolf Haag addresses precisely this idea. Using the example of the Pauli principle, which implies that all electrons in the entire universe are entangled, he asks for an approach allowing us to talk about events caused by individual electrons. The notion of events, rather than objects, is a cornerstone in Haag’s programmatic paper. Understanding the irreversible emergence of events (or, in another terminology, facts) is a key *desideratum* for him, ultimately requiring a fundamental solution of the quantum measurement problem. His ideas in this regard are similar to aspects of Whitehead’s actual events (or actual occasions). In contrast to Haag’s deliberate restriction to a purely physical notion of events, however, Whitehead’s events comprise a “mental pole” as well.

In addition to the epistemically interpreted statistical formulation of quantum physics, Haag emphasizes the importance of including individual systems with an ontological interpretation. He argues that the emergence of individual events requires a decomposition of an originally holistic process in which they are tied together. A precise definition of events, Haag suggests, might be related to the problem of their localization in space-time. If statements about space-time are to be conceived as relations between events, the quantum theoretical “division of the world” into individual events needs to be discussed together with the concept of locality in space and time. It might be interesting to contrast this with Penrose’s speculations about quantum space-time, which contain explicit extrapolations beyond physics into the domain of consciousness.

The paper by Günter Mahler continues the discussion about quantum ideas regarding partitions. Mahler’s emphasis is the emergence of information and functionality by decomposing systems into subsystems. Although he refers mainly to examples in the physical world, he does also address the relevance of quantum-type partitions and the resulting limitations for issues of brain research and consciousness. In particular, he warns us that modes of operation that are inherently unstable cannot be exploited in a controlled way.

For the same reason, Mahler’s article offers an informative, though pessimistic view of future breakthroughs in the field of quantum computation. Rather than continuing the trend toward ever harder control on ever smaller length scales, which may eventually become impossible, he calls for a change of perspective and proposes the study of macroscopically emergent functions as a promising alternative. He discusses a number of

interesting examples, in regard to which some unconventional and inspiring ideas concerning the role of partitions in the process of perception deserve particular attention.

Klaus Michael Meyer-Abich's contribution addresses the case in which partitions are complementary. Although the notion of complementarity is usually referred to quantum theory, Meyer-Abich stresses the historical fact that Bohr derived the notion of complementarity from the philosophical idea of a holistic entanglement of knowledge and action. Any separation of the two leaves them in a relationship of mutually excluding each other and nevertheless completing each other at the same time. Meyer-Abich relates his notion of complementarity to pragmatist thinking such as that of William James.

Meyer-Abich develops some striking parallels between Bohr's ideas and psychopathological impairments described by Kurt Goldstein in the 1930s. Goldstein observed that patients with particular brain injuries were unable to both act and reflect on their action in the same context. He argues that such examples illustrate most clearly Bohr's original intentions about the philosophical impact of complementarity. From the perspective of an entangled wholeness of existence, complementary phenomena become much less perplexing. Partitioning entangled systems provides complementary parts.

A generalized complementarity of consciousness and physical systems is the key feature of Hartmann Römer's contribution. He addresses the distinct notions of experienced time and physical time as a consequence of an "epistemic split" that is necessary in order to distinguish the domains of consciousness and physics. In Römer's dual-aspect approach, the common origin of these two domains is inspired by C.G. Jung's concept of an *unus mundus*, an undivided holistic reality that is empirically inaccessible in itself. Only by its division into parts can empirical access be achieved.

Using the framework of a generalization of ordinary quantum theory (called weak quantum theory) to conceive abstractly such a primordial holistic reality, Römer shows that entanglement correlations lead to the synchronization of mind and matter without any direct causal relation between the two. Similarly to Primas' approach published in this journal a year ago, this provides an innovative alternative to other variants of dual-aspect thinking. Further work will be needed to tell how such an at present abstract approach can become applicable to empirical research problems.

