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Integrity as identity

Sylvie Pouteau

The theme of identity through the double, the 'sosie', has been a recurring one since antiquity. There have been many versions of the myth of Amphytron and Sosie since Plautus,[1] which bears out the fascination it has not ceased to exert from that time. During the course of the last few decades, the question of identity has assumed growing importance in public life, to be seen not only in the rise of social movements but also in developments in science. We can think for example of the debate about cloning which gives a new twist to the Sosie myth. But beyond its primary use for describing the human being, the notion of identity has acquired an important place in the science which aims to study the living, that is to say, biology. Here it is not only a question of man as a person, individual, or group of human beings, but of all living beings, all biological units, of limbs, organs, tissues, cells, subcellular compartments and as far as molecular building blocks. We could ask ourselves about the anthropomorphic content given to the notion of identity in its use in biology and in return, due to the authority accorded to science for vouching for the real, about the biological projection which is thus exercised on the perception that man has of himself and of others, associated with a materialisation of identity. These questions – and the discussions which they give rise to in matters of ethics concerning the technological applications of science – rest in part on the equivocalness of the notion of identity. This ambivalence of the self oscillating between the same and the other has been depicted in great depth by Paul Ricoeur,[2] on whom I will lean to approach the question of the own identity of the living.

I *The self between the other and the same*

The term identity comes from the Latin *identitas*, *idem*, which means the same. It is thus logical that its first sense describes the 'sameness' (in Greek *homos*/similar and *isos*/equal) that is to say the relationship of a perfect likeness or equality between two entities. A second sense characterises the permanence of an entity over time. Finally, a third sense is relative to the self and that which individualises an entity in an absolutely specific, particular and unique way.[3] Whereas in the first sense, we seek to bring together entities as sames, the third sense aims to distinguish, to mark out an entity for itself. The double is thus commingled right into the semantics, and it is on this quality that the confusion about the notion of identity is perpetuated. Philosophers have termed individual identity 'ipseity' from the Latin 'ipse' (self). In layman's language, this corresponds to the notion of selfhood (*Selbstheit* in German). Surprisingly, there is no such common word to describe the identity of the self in the French language. There are of course many words derived from the corresponding Greek root (*autos*/self, in itself and to a lesser extent

[1] Plautus, *Amphitryon* (Flammarion, Paris, 1998).
[2] Ricoeur, P. *Soi-même comme un autre* (Seuil, Paris, 1990).
[3] The hierarchy of the three senses of identity is taken from the Larousse dictionary.

idios/own specific) – one example is autonome (autonomous), i.e. that which is governed by its own rules, a term directly taken from the Greek. One can think of more recent constructs such as auto-organisation. But the word 'soi-ité' derived from *soi* (self) is missing in French. So Ricoeur is led to distinguish individual identity by using the neologism, ipseity.[4] In the philosophical tradition, ipseity is linked to reflexivity and narrative identity, hence to human identity. Implicitly, selfhood is also usually considered to be a human attribute. My objective will be to examine how selfhood can be thought of beyond human beings, in the living world at large. I will try to address individual identity as a property of beings that are endowed with autonomous life processes, i.e. an identity that is self-determined and centred in itself rather than in the same as a fellow creature or in conformation to a model.

We would not be able to talk of identity without reference to the other. The other as antonym of the same and of the self (in Greek *heteros* and *allos* respectively) appears as a mirror in which identity is seen as a counter-image, in the negative. The *alter-ego* is another which is a same, hence it deserves all our sympathy. But such a situation is exceptional, more often the other inspires various degrees of aversion. An aversion which expresses itself towards what is unknown (to a category of sames), the heterogeneous, the composite, the chimera and the mixed – one thinks in particular of the hybrid, from the Latin *hybriditas* (of mixed blood) and derived from the Greek *hubris* (excessive pride) and finally, the abnormal, the mutant, the monster. Alteration is a degradation, not a potentially positive transformation. The *alter*, the other is only valued from the moment where it applies to oneself: according to Ricoeur, oneself can only be conceived as an other.[5] So otherness finds its full expression as taken up in the notion of alter-globalisation which, over and above the rejection of worldwide uniformity, asserts itself as an identity-ipseity. It is the 'otherisation', the differentiation which allows qualification of the 'self-hood'. Depending on whether it is a question of sameness or ipseity, the other's position is thus radically different; logically then, worldly permanence, which is the foundation of the notion of identity, cannot be conceived in the same terms in the two cases.

II *The same: of general categories and genes*

The debate about general, or universal categories, between supporters of a self or essential reality (Realism) and those in favour of a denomination endowed by the intellect (Nominalism) in the Middle Ages, initiated the confrontation between sameness and ipseity as a foreshadowing of the question of identity.[6] For example, has the idea of dog as general category a reality in itself or are there only particular entities whose similarities allow them to be grouped together under a single name, a 'same' concept? Does the dog

[4] Ricoeur, P. (1990) *op. cit.*

[5] Ricoeur, P. (1990) *op. cit.*

[6] Pouteau, S. 'Food democracy: the other legitimate factors and the cultural power' in *EurSafe 2003*: *Ethics as a dimension of agrifood policy – Proceedings of the 4th Congress of the European Society for Agricultural Food Ethics* (ed. Rainelli, P.) 43–46 (INRA, Toulouse, 2003).

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identity exist as ipseity or only as sameness? Taken up again in another way by Constructivism (general categories are intellectual constructs) the nominalist thesis does seem to have prevailed, opening the way to biological nomenclature – a discipline which names, arranges and constructs connections of causal significance.

Generations of naturalists will devote themselves to collecting, itemising living beings and finding criteria and rules for classifying them in kingdoms, orders, families, classes, types, species, etc. It is a question of a descriptive effort which in no way prejudges the reality of the categories thus established. It is more a matter of map-making, of cutting up and marking out a landscape and its objects, than a real penetration to the interior of possible underlying principles. The other and the same are the springs of this undertaking. The same being here simply a fellow creature, counterpart, that is to say another resembling and assimilable according to a hierarchy of criteria. With the appearance of transformism and the idea of evolution, classification clears a new hurdle: it is not only a work of cartography, but of genealogy, of relation in which each phylum has a similar status to that of an individual descendant of a parental line.

Since then, the representation of a world at once created and fixed has become untenable: the creation of the world takes place under our eyes, evermore acquiring its identity in differentiation and complexification. This being so, the idea of evolution should have encouraged an interest in what is changeable, malleable. But not at all, the stereotypical, the immutability of the categories of descent, has continued to exercise a dominant power of attraction. In fact, from the myth of a created world has been removed only the idea of a reality in itself of categories of the living. Once we admit the postulate of the machine animal,[7] the enterprise of dissecting the real then continues at lower and lower scale levels in the search for constituents which confirm the fixedness and permanence of the same, the genetic substrate of heredity. After the era of morphology, of histology, and of cytology, the molecular species become new objects of an inventory in the 20th century. The revolution in molecular genetics ascribes with ever increasing authority – currently represented by the huge development of genomics and of other methods of 'omic'[8] profiling – the role of identity carriers to the DNA and to the genes. Within a genetic world view the whole biological organisation is forcibly endowed with an identity: a cellular, tissue, etc. identity. With DNA, a quasi-mineral substance and capable of surviving for several millennia, we could not expect a better support for what is the same and to assure its permanence in descent.

Not only does identity find itself thus materialised and reduced to a segment of the living, but it presents us with a new reading of the real. It is no longer a direct reading, perceptible, but an abstract reading, conceptual, in which the frontiers between the cat-

[7] Descartes, R. *Discours de la Méthode* (Nathan, Paris, 1998).
[8] The 'omic' profiling methods comprise in particular genomics, transcriptomics, proteomics and metabolomics: they aim at a systematic list of all the chemical components – genes and other DNA sequences, the products of gene transcription, proteins, and other metabolic substances called 'secondary' respectively – as well as the interpretation of their activities and multiple interactions.

egories blur in a continuum deprived of landmarks intelligible to our senses. From qualitative and based on analogy – cornerstone of the morphology thought up by Goethe[9] – the gradation between biological categories has become quantitative, anchored in the sequence analysis of DNA. This paradoxical situation is not however without interest. The questioning that such a continuum gives rise to would ultimately be able to assign all its magnitude to the idea of evolution: that of a world crossed by a vast flux of transformation, swept along by the unceasing dynamic of variations and metamorphoses, of 'otherisation' and of individualisation. On reaching the limits of the identity-sameness, one is led to the threshold of own identity – ipseity for the human being, 'selfhood' for other living beings. But passing through will only be possible provided that we finally take the full measure of the implications of evolution for our representation of the world, calling for a renewal of biology.

III *The narrator and the mediatory body*

From the point of view of the narrator, the particulars of one's own identity are stated as an 'I am myself (an 'I' on its own)' of which the *cogito* is one version. This expression covers the same – the narrator is equal to himself in naming himself 'I', the temporal continuity – 'am' is a permanent present, and the self –'myself' indicates a unique and absolute reflexiveness. This myself thinks, feels and acts. It thinks of course, without which there would be neither narrative awareness nor moral responsibility. It feels, and it is there that it has the most intimate experience of itself. Finally, it acts, that is to say it expresses itself in the world and in this way, goes out from the private, subjective domain of thinking and feeling to enter the public, objective/ising, sphere of interaction with the other. This external manifestation passes through a materiality, a substrate of the 'I', that is to say a body. The first manifestation is to stand in the world, in other words to be born with a body.[10] Then, with growing degrees of intentionality and responsibility, appearing becomes to move (attitudes, behaviour, etc.) to speak (emit sounds, articulate ideas, etc.) and finally to act deliberately (direct its thought and its actions).

If one leaves the narrator's point of view – where one is necessarily at the human level – in order to enter into that of witness of the identity of others – which can thus be that of all living beings, animals and plants, or even cells – one can then only confront the self from outside as a phenomenon. The question we are faced with is to know whether it is possible to also have the inner experience of the self of the other, that is to say to recognise and respect it, without the witness projecting itself into the space left empty by the 'I', ending up in an anthropomorphisation of the living. Through a mental inclination for only perceiving contingencies and not essences, modernity responds clearly in the negative to this question, not without paradox however. The narration is in fact objectivised by a reduction to the visible, tangible and material part of an entity: the body and its

[9] Bortoft, H. *La démarche scientifique de Goethe* (Triades, Paris, 2001); Steiner, R. *Goethe, le Galilée de la science du vivant* (Novalis, Montesson, 2002).

[10] The register of births, with the attribution of proper names, is a primary form of the identification of persons.

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attributes, traits and distinctive features. But in spite of its contingency – all biological organisation would be the result of chance, the living remains metaphorically endowed with intentionality: the organisms, the cells have 'strategies' (of adaptation, of survival, etc.), the genes themselves have their plans.[11] The body-identity, whether one wishes it or not, cannot confound our intuition that the existence of an intelligible world – condition for the development of a cognitive endeavour – cannot be deprived of intelligence, that is to say, of essence, of an own self not reducible to the 'I' of our human narration, as scientific as it may be.

IV Public order and moral confusion

Common sense is also that which must have juridical value, at the service of public order – the function of law. The body-identity thus responds to a juridical necessity: the identification of people and living organisms. For a long time social proximity served as an identifier of the human person, it is only in most recent times that biometric markers have been put to use, the fingerprint, the map of the iris, and finally, molecular markers with DNA tests, with the aim of recognising a criminal as easily as a tie of filiation.[12] For other living beings, the unit of identification is not generally the individual (except for the sires of animal races) but the species, the ecotype, the animal breed, the plant variety or cultivar, and the microbial line. In the medical, foodstuffs and agronomic domains, authentication, accreditation and certification are all prerequisites for the guarantee of a quality, of an innovation, of a property right or of a restriction on use (patent). For modernity, the world – including the living – is at the same time a materiality and a commodity, in other words no less eloquent with regard to biodiversity: a 'heritage' of humanity constituted of 'genetic resources'. Thus identification serves market objectives before anything else, science acting as the authority for establishing political decisions.[13] Economic-political-juridical and scientific questions thus find themselves intermingled, strengthening a mechanistic 'biologisation' of the social domain and a politicisation of biology.

The example of the concept of substantial equivalence illustrates how legal identification contributes to reducing identity to a material constituted of physico-chemical substances of which the composition is the analytic criterion of description.[14] This concept

[11] 'Individuals are devices invented by genes in order that they may reproduce themselves' in Gouyon, P.H., *Les Harmonies de la Nature à l'épreuve de la biologie* p. 38 (INRA, Paris, 2001).

[12] See the display at the Cité des Sciences et de l'Industrie de Paris: *Biométrie: le corps identité* (Biometrics: the body-identity), 29 November 2005 – 5 November 2006

[13] Callon, M., Lascoumes, P. & Barthe, Y. *Agir dans un monde incertain: essai sur la démocratie technique* (Seuil, Paris, 2001).

[14] Pouteau, S. 'Beyond substantial equivalence: Ethical equivalence' *Journal of Agricultural and Environmental Ethics* **13**, 273-291 (2000); Pouteau, S. 'Substantial equivalence and ethical equivalence: contrasting approaches' in *Genetic engineering and the intrinsic value and integrity of animals and plants* (eds. Heaf, D. & Wirz, J.) 107-112 (Ifgene, Llanystumdwy, 2002).

created for the new foodstuffs derived from GMO's – of plants (GMP) to date – is based on the comparison with foods traditionally consumed.[15] Equivalence, concerning identity-sameness, is in fact a semantic contortion between the distinct – prerequisite for claiming that an innovation can be the object of a patent – and the same, or at least the similar, the familiar – a necessary factor for gaining the acceptance of global consumers resistant to GMP's. If studies on substantial equivalence strive above all to define the conditions of comparison – in particular the molecular profiling permitting the inventory of diverse chemical species, the means of detection and the acceptable levels of contamination for the regulations, it says nothing about the establishment of norms which authorise stating that a GMP is at the same time distinct and similar.

Paradoxically, the materialisation of own identity and its reduction to molecular determinants, aiming at a more precise identification, obliterates in reality the frontiers between categories of the living, and between matter and living. It results finally in a dissolution of the selfhood in the physico-chemical multiplicity, thus clashing with our sense of the indivisibility and the unchangeableness of the self. The acknowledged or promised possibilities of the biotechnologies give rise to as many hopes of improvement as fears of violation, feeding more and more ethical questioning. From the confrontation between an inalterable essence and a transformable material, the technological intervention gives shape to an improbable monster, a hybrid half-living being, half-object which completely modifies our psycho-spiritual landscape and our representation of ourselves. GMOs, xenotransplants, clones are the new horizons of the mutating social space.

The body is malleable, but can the own identity be remodelled from the outside, by others? Identity being a priori that which belongs to the self and the self alone, can one call 'me' someone other than oneself, like Sosie in Plautus' and Moliere's *Amphytron.*[16] The possibility of a copy of the self by another would invalidate the human person, who from then on, would no longer be a self but an 'us'. The question is far from being anecdotal: we know of the reciprocal problems which twin-ness presents for around 1% of the true (homozygous) twins existing throughout the world. In the case of animals and plants, the clone is only a consequence of the standardisation of domesticated varieties and races, promulgated in particular by the green revolution. Reproductive cloning is certainly natural for lots of plants but its large-scale application – by micro-propagation *in vitro* for example – just as the constraints imposed by the regulations – in particular the DHS system[17] have accelerated the erosion of biodiversity of cultivated species, equally inevitable with the production of GMP. With animals, recourse to artificial insemination has expanded considerably to the point where the quasi-totality of the European bovine livestock population descends from a handful of male stock. Put back on the identity scale of plants and animals, the clone in its diverse expressions threatens the very exist-

[15] OECD report: *Safety Evaluation of Foods Derived by Modern Biotechnology – Concepts and Principles* (OECD, Paris, 1993); *GM food crops and application of substantial equivalence in the European Union,* A Report to the Dutch Foundation 'Consument and Biotechnologie' (Schenkelaars Biotechnology Consultancy, The Netherlands, 2001)

[16] Plautus (1998) *op. cit.*; Molière *Amphitryon* (Larousse, Paris, 1999).

- The solutions of the Dirac-Hestenes equation for nucleons are constructs of sums of dual numbers and 'I'-numbers, polarities and a universal force in projective velocity space; with this there is a connection with the plane at infinity.
- With both the cognitive theory of realistic idealism and the 'I'-numbers and their scope, the quantitative facts about the hydrogen atom reinterpreted in velocity space, like the theories of both spectral lines and nucleons, give rise to a new reality for the 'atom' and for the problem of matter: *in the inner make-up of matter we can recognise the signature of the Representative of Man.*

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Gschwind, P. (2005) Zum Begriff der Ich-Zahlen. *Elemente der Naturwissenschaft* **82**, 5–27, and *Mathematisch-Physikalische Korrespondenz* **221**, 3–23.

Gschwind, P. (2006a) Die innere Struktur der Materie I, *Mathematisch-Physikalische Korrespondenz* **224**, 3–32.

Gschwind, P. (2006b) Die innere Struktur der Materie II, *Mathematisch-Physikalische Korrespondenz* **225**, 3–27.

the subject has to be taken into consideration.

- The role of the subject in cognition is moulded by the relationship of the 'I' to will and mental picture in the form of a polarity. Via will and mental picture, the 'I' is in communication with the things of the world through at least two polarities; mental picture with forms and will with warmth.
- Twelve senses permit, through the 'I', the perception of states of non-'I'. In contrast to the Lockean separation of sense qualities into objective primary and subjective secondary, the twelve senses are of equal validity. They differ in how easily they can be used. The lower senses produce percepts from our own bodies, the higher from the rest of the world.
- The axiomatic foundations of projective geometry represent the abstract quintessence of the artistic-mathematical qualities of the position of the 'I' between will and mental picture and the artistic portrayal of the corresponding forces in the statue of Christ by Rudolf Steiner.
- The position of the 'I' between will and mental picture corresponds to the position of line space as a connection between point space and plane space. The space of linear complexes is the completion of line space.
- Linear complexes are described by hypercomplex numbers, so-called Clifford algebra. They show a structure of seven entities that are significant for the central region of the *Group*. Six of them are reflected in the seventh, namely line space.
- Taking into consideration the role of the subject in the process of cognition produces the result, in contrast to the usual conception, that of the three concepts space, time and velocity, with a given reference of the object to the subject, velocity is the primal phenomenon, i.e. it is not just a quantity derived from calculation. Space and time are deduced quantities.
- Therefore, the mathematical structures, hitherto used for spatial-temporal atoms and particles, serve for the projective definition of velocity structures.
- The spatial Lorentz group is isomorphic to the projective group with an invariant quadric. The interpretation based on realistic idealism makes use of this isomorphism.
- In the realm of microphysics, the mathematical structure, beside the line spectra, plays an important part in the realm of phenomena when it is set free from received materialistic and quasi-classical conceptions.
- With these preconditions, the solutions of the Dirac-Hestenes equation for the hydrogen atom are presented in velocity space as a four-parametric family of sums of dual numbers and linear complexes, also called 'I'-numbers, i.e. as a general velocity state like in the mechanics of rigid bodies. They are connected oriented to a centre.
- The known energy eigenvalues of electrons in the so-called electron shells of an atom, whose differences express themselves in the line spectra, are guaranteed.
- Instead of quantum jumps of an electron from one path to another during emission or absorption of radiation, a discrete partial single-parametric family of 'I'-numbers passes through.

ence of some species which are the masterpieces of the inter-community developed between man and other living beings since Neolithic times. At a time when what will be probably the sixth great extinction of species in the history of the living world is taking place, it is becoming urgent to understand that the mechanistic constraint of uniformity in vigour in no way conforms to the nature of the living and to the needs of a sustainable agriculture.

V *The other: of mosaics and acquired characters*

The emphasis placed on identity-sameness – of which we have seen that it still relies on a vision of a one-time-created, fixed world – has contributed to favouring deterministic theoretical frames of explanation of the living according to the metaphor of a genetic programme or architect's plan (blueprint in English, *Bauplan* in German). These sketches, comparable to the construction plans of scaled down models, have the advantage of giving an account of permanence, of a stereotype of forms and species. But they are incapable of describing a living world in gestation, in creation, in becoming, that is to say a variable, changing, plastic and innovating world. Each living entity is unique, this singularity not necessarily giving rise to the bases of an individuality in the sense in which we understand the expression for man, but giving substance to the idea of an auto-determination, an auto-organisation, of an autonomy of the living.[18]

Wherever one looks, the living presents itself like a patchwork, a mosaic of changeable forms, hybrids, fluctuating, asymmetric. The plant is above all the domain of fluid forms, half-leaf/half-stem or half-petal/half-stamen. It abounds in progressive transitions, in particular in the sequence of successive leaves and floral organs, the observation of which led Goethe to formulate the thesis of the metamorphosis of plants.[19] In this multiplicity, this diversity, an identity stands out in permanence, that of the leaf as primordial form or archetype (in German *Urpflanze*) of the plant. In the tradition of Goethe, the plant 'fuzziness' has been widely documented,[20] inspiring in particular the continuum mor-

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[17] The DHS system (Distinction, Homogeneity, Stability) serves as a reference for every registration of a plant variety in the official catalogue, an indispensable procedure for the commercialisation of seeds and plants: the distinction, comparable to an identity-'selfhood' always occurs as the first criterion for qualifying an innovation; homogeneity and stability are opposed to the variable and come under identity-sameness and its worldly permanence for guaranteeing a specific and fixed uniformity. See Groupement National Interprofessionnel des Semences et Plantes (GNIS). http://www.gnis.fr/pages/frame3_0.htm.

[18] Amzallag, G. N. *L'homme végétal, pour une autonomie du vivant* (Albin Michel, Paris, 2002).

[19] Goethe, J. W. 'The Metamorphosis of Plants' in *Goethe: Scientific Studies* (ed. Miller, D.) (Surkamp, N.Y., 1988).

[20] Claßen-Bockhoff, R. Plant morphology: the historic concepts of Wilhelm Troll, Walter Zimmermann and Agnes Arber *Annals of Botany* **88,** 1153-1172 (2001); Rutishauser, R. & Isler, B. Developmental genetics and morphological evolution of flowering plants, especially bladderworts (Utricularia): fuzzy arberian morphology complements classical morphology *Annals of Botany* **88**, 1173-1202 (2001).

phology of Rolf Sattler,[21] described as dynamic in opposition to classical morphology, congealed in structures once established. With animals whose growth is not sequential and additive as with plants, the variations are in general more subtle, for example the fluctuating asymmetries corresponding to disparities in bilateral development.[22] Similarly, at a lower scale level, we find a very great flexibility of molecular structures, which generally form themselves by auto-assembly and are able to exist under different alternative states.[23] The different proteinic functions harbour a certain degree of indetermination, being able to a certain extent to act as a substitute one for another, a phenomenon known as degenerescence.[24] Even at the genetic level, uniformity is not the rule, living organisms reveal themselves to be genetic chimeras as much at the level of their DNA sequences as in the stochastic expression of their genes.[25]

Besides this abundance of forms and states, biological systems are also continuously modelled by the environment in which they are evolving.[26] There again, plants are the favoured observatories for noticing the environmental contingency and plasticity of biological development.[27] Unlike the animal, mobile and self-centred, the plant is fixed, completely open to the environment. Its plasticity to the geoclimatic, eco-regional conditions are sometimes extreme to the point where expert taxonomists can be mistaken on the identity of a specimen. Finally, the evidence abounds to show that modifications induced by the met environment can sometimes be transmitted over several generations.[28] Lamarck's transformist theory – supposing a capacity of living organisms to spontaneously induce changes in order to adapt to the environment encountered – finds a certain echo in these phenomena. Perhaps Lamarck's theory was carrying in embryo the promise of a truly dynamic vision of evolution. Perhaps also it was threatening to overturn too

[21] Sattler, R. Classical morphology and continuum morphology: opposition and continuum *Annals of Botany* **78**, 577-581 (1996).

[22] Malashichev, Y. B. & Wasserung, R. J. Left and right in the amphibian world: which way to develop and where to turn? *BioEssays* **26**, 512-522 (2004).

[23] Laurent, M. & Kellerershohn, N. Multistability: a major means of differentiation and evolution in biological systems *TIBS* **24**, 418-422 (1999); Greenspan, R. J. The flexible genome *Nature Reviews Genetics* **2**, 383-387 (2001); Dennis, C. Altered states *Nature* **421**, 686-688 (2003).

[24] Edelman, G. M.; Gally, J. A. Degeneracy and complexity in biological systems *PNAS* **98**, 13763-13768 (2001).

[25] Paldi, A. Stochastic gene expression during cell differentiation: order from disorder? *Cell. Mol. Life Sci*. **60**, 1775-1778 (2003); Pearson, H. Dual identities *Nature* **417**, 10-11 (2002); Check, E. Patchwork people *Nature* **437**, 1084-1086 (2005).

[26] Bateson, P. et al. Developmental plasticity and human health *Nature* **430**, 419-421 (2004).

[27] Sultan, S. E. Phenotypic plasticity in plants: a case study in ecological development *Evol. Dev.* **5**, 25-33 (2004).

[28] Amzallag, G. N. 'Plant evolution: towards an adaptive theory' in *Plant response to stresses: from hormone to genome reorganisation* (ed. Lerner, H. R.) 171-245 (Marcel Dekker, N.Y., 1999).

the single-parametric family of 'I'-numbers in discrete steps corresponds to the energy differences of the line spectrum.

Likewise the mathematical structure for the solution for a nucleon is, besides dual numbers, a structure of 'I'-numbers in which the influence of a simple, dual vector quantity, a universal force plays a part. Physics uses mathematical structures for nucleons that have the character of a polarity without being aware of this concept. Thus the character of materiality of the objects described becomes blurred, and a nucleon becomes an entity that is conceived as being in constant transformation. It is now no longer possible in the conventional relativistic conception to speak of fixed *material* centres that are supposed to form the basis of matter.

The interpretation of the solutions in velocity space can be extended to the field of quantum chemistry, i.e. the field of molecular structure. Besides ionic bonding, additive and subtractive combinations of wave functions produce quantum mechanically the bonds between the atoms. This approach can be adopted without further ado for the projective conception.

Even if people regard various aspects of our knowledge about the human being as being irrelevant to physics, or if they do not want to or cannot understand the epistemological discussion, in particular that regarding the three concepts of space, time and velocity, at least the other interpretation of the Dirac-Hestenes lets us view the usual conceptions in relative terms. Therefore, the particle and atom conception that is in all physics textbooks is in no way forced to follow from the equation considered. At most that conception follows when a series of additional preconditions or assumptions are made that correspond to the epistemological position declared by empiricism and its Lockean restrictions for the objectivity of the senses.

What is presented here shows only the ostensible conclusions from the geometric facts of the projective view. But it also creates a new reality of the 'atom' by taking the human 'I' into consideration, because, a concept of 'I'-numbers, when grasped as regards its content, inherently leads further. The conceptual scope of the 'I'-numbers stretches from an epistemology that takes into consideration a self-conscious 'I' and a real world and that works with metamorphoses and polarities of various forces in the human being, to a concept of the three velocity spaces that are derived from the artistic qualities of the *Group*. For their part, the I-numbers show a structure that can be described as a kind of signature of the Representative of Man (Gschwind 1977, 2005). When all the points of their construction are condensed into an overall picture, the main result is as follows: the quantitative facts of the hydrogen atom, and the various elements of matter, in the theory of line spectra as well as the nucleons, can, with the cognitive theory of realistic idealism, lead to the statement, totally different from the materialistic conception, that the signature of the Representative of Man, can be recognised in the inner constitution of matter (Steiner 1911, lecture 3, para. 7 and 1924/25, commentary to leading thoughts 137, 138 & 139.)

Summary

- A separation of subject and object is not feasible if the significance of thinking in the process of cognition is taken seriously. Therefore in analysing an object, the role of

planar velocity or universal force plays a part. There is an orientation to the plane at infinity in velocity space and not towards a centre. How far the concepts of the shell and the nucleus of an atom are still in some way justified is left open.

It would be understandable if the reader, with years of practice in quasi-classical concepts of particle and atom or with education in materialistic thinking, does not find it easy to imagine the pictures of line geometry as belonging to the world of atoms. However, in the course of time, even the conventional conceptions of quantum mechanics have gradually changed. Furthermore, authoritative physicists such as Schrödinger (1952) emphasise that a particle has no 'sameness', i.e. that it is in no way possible to observe a particle at two positions sequentially because it has no actual identity.

The reality of the atom

If we do not use Minkowski's space-time, but instead the concept of three kinds of space constructed on the basis of our understanding of the human being – with a projective velocity space with corresponding dual space and complex space – we can interpret certain equations of atomic physics in the space of line complexes. The underlying epistemological position (Steiner 1894) leads to completely new pictures for the solutions of the Dirac-Hestenes equation for the hydrogen atom and for nucleons. With the conclusion (Gschwind 2004) that, in a certain given system of reference, velocity and not space or time is the primal phenomenon, it urges us correspondingly to regard the projective view as the epistemological standpoint and not that of space-time. The pictures obtained this way are totally different from the quasi-classical concepts of particle and atom supported hitherto.[12] Accordingly, in the projective interpretation, the mathematical structure of atomic physics does not describe point-like centres of force with a material basis, but general states of velocity that permeate the whole of projective velocity space familiar in the mechanics of rigid bodies. What has hitherto been called the electron shell is conceived, besides dual numbers, as a four-parametric family of linear complexes or 'I'-numbers connected with a centre. Likewise, all quantum numbers and energy eigenvalues remain available. The solutions for the shells are valid as close approximations for the heavier elements and for ionised atoms,[13] whereby the quantitative relationships for many line spectra of elements are guaranteed and thus the appearances are saved. The concept electron shell or quantum jump of Bohr's model of the atom loses its meaning. The difference of two energy eigenvalues corresponds to the transition from one linear complex to another in a single-parametric family of linear complexes or 'I'-numbers. The course of

[12] If we stay with the space-time interpretation and carry out a particular kind of quantum mechanical experiment in the laboratory with a particular kind of matter, we obtain the familiar results of quantum physics. It is not asserted that quantum physics is wrong, but that it is an expression of interpretations in the realm of space-time and the result of an empiricist world view. If we take the subject into consideration and do not separate subject and object, the circumstances in velocity space present themselves as valid.

[13] The word 'atom' is in the projective interpretation a shorthand for the totality of the relationships described as atomistic phenomena in the sense of realistic idealism.

rapidly our vision of an ordained and fixed world. It is perhaps one of the reasons for which Darwin's theory – postulating that species evolved through chance variation then selection by the environment – has maintained its hold right up to the present time, because it allows at least provisionally for reconciling the idea of evolution with the ancient view of the world.

VI *The self: from the kept promise to integrity*

The 'otherisation', the differentiation whereby ones own identity builds up, rests on negations, successive crises, which can be described as sectarian in the original meaning of the term. Like the little child who starts saying no before being able to name him/herself, or the adolescent who rejects his or her education, the living proceeds from breaks in discontinuity in the course of its development. In becoming another, the living centres itself in itself and conquers its identity. It is a work of assimilation made of unceasing interactions and exchanges and not only of opposition. This construction of identity is inseparable from a socialisation of interactions between cellular entities, between organisms, with the environment. Identity does not define itself only by contrast with others: at each stage it is another *vis-à-vis* the self which appears in a unceasing dynamic of emergences. That is another nuance to look for in Ricoeur's formula 'one's self as another'.[29]

Worldly permanence is at the crossroads of the confrontation between the same and the self. While identity is defined by a substrate, permanence remains bound to the constancy of characters, to the sameness and to the shape of a world essentially congealed. This does not signify that selfhood is of a strictly immaterial nature. But its permanence being assured, not by constancy but by a maintenance of self in the change, it cannot be found in an exhaustive inventory of the parts of a whole. For Ricoeur, this uninterrupted continuity of ipseity in the change defines itself as 'to keep one's word' (in French *tenir parole*) or ' to keep a promise' (in French *tenir promesse*).[30] Whatever the lasting changes of the characters involved, the disagreements and the separations, the kept word is that which in a story, just as in a literary plot, makes identity correlative to this story – an identity fundamentally dynamic and not set in stone. The other, who unceasingly mixes with the same is an assumed otherness, interiorised. The acquired character is thus to the *ipse* what the innate character is to the *idem*.

To keep one's word is to be accountable for one's acts. This definition of own identity returns us to its ethical character. Identity is an ethic, that which underpins the dignity of the individual, his/her intrinsic value – inherent value - in itself, that is to say, his/her integrity. Where Kant had reserved the notion of dignity (in German *Würde*) for the human person, the expression '*Würde der Kreatur*' – in French '*valeur intrinsèque des organismes vivants*', in English 'dignity of creation' – has more recently appeared as a moral preoccupation *vis-à-vis* animals and plants in the text of the Swiss Constitution.[31] The integrity of living beings is not an integrality, a term which refers back to permanence as a constancy of character, that is to say to the same. It cannot be reduced to

[29] Ricoeur, P. (1990) *op.cit.*

[30] Ricoeur, P. (1990) *op.cit.*

criteria, determined by parts, being by nature indivisible. It conflicts with the hypothesis of the living machine or object which has only a use, a market value, but bases itself in an autonomy, a constitutive principle of auto-formation, of an indetermination of the subject. It is only accessible in a perception of the flux of transformation which runs through the living; it is this permanence which emerges from the variable, the diverse, the plastic, this form not visible and yet inscribed in each facet of a continuous metamorphosis, that of the *Urpflanze* of Goethe. The 'otherisation' of the living is not simply an essential notion for the renewal of biology, it is also the necessary condition at the basis of an ethic of living beings. In order to think the integrity of the animal, or of the plant, we are guests at a process such as that which Goethe initiated.[32] This calls for an integrative vision, not in the sense of an additivity as that is generally understood, but of a dynamic correlativity.

VII *Conclusion*

The world at present – perhaps the West is the most affected – is going through a double identity crisis, which is at the same time biological and social. In effect we are witnessing an explosion of illnesses of a biological kind: cancers, immunodeficiencies, degeneracies, etc. In parallel, in reaction to the rise of mass consumerism, standardising and alienating, fundamentalist community movements, sources of violence, are multiplying, while trying to assert itself is an alter-global movement, demanding another identity.[33] The breakdown of the fabric of necessary social interactions for the construction of an identity, has made the traditional markers of identity explode. We can ask ourselves if the parallel between medical and social pathologies is fortuitous or if illnesses are reflections of today's society, indeed contributing to its transformation. In this mutation towards a new culture, each individual must add to his/her reflective awareness in order to maintain his/her integrity: we are obliged to individualise ourselves on threat of global alienation and death.[34] This transformation comes through an individualisation, not as a factor of division – even though it may seem such to begin with – but as a catalyser of a new global cohesion working itself out by auto-organisation. Identity as integrity comes through a growing individualisation, a maintenance of the self in permanence where the promise to keep one's word is not only *vis-à-vis* the others, but the self. This individual ethic bases itself in an abandoning of permanence and fixity, formerly guarantor of a world – a cosmos – ordered and beautiful. It calls for an integration of the idea of evolution in all its depth, not as an abstract idea, but as a reality. It is a question, as much for man as for the

[31] Schmidt, H. 'Dignity of man and intrinsic value of the creature (Würde der Kreatur) – Conflicting or interdependent legal concepts in legal reality?' in *Intrinsic value and integrity of plants in the context of genetic engineering* (eds. Heaf, D. & Wirz, J.) 19–23 (Ifgene, Llanystumdwy, 2001).

[32] Bortoft, H. *op. cit.* (2001); Steiner, R. *op. cit.*(2002).

[33] Perlas, N. *La société civile: le troisième pouvoir – Changer la face de la mondialisation* (Yves Michel, Barret-sur-Méouge, 2003).

[34] Steigler, B. 'Le désir asphyxié, ou comment l'industrie culturelle détruit l'individu' in *Le Monde Diplomatique* (June 2004).

given, then space and time intervals, as we can immediately see, are only defined as a multiple of ρ. Thus velocity space is a projective space, in which the considerations above can be executed with the concept of the three kinds of space in velocity space.[9]

With the tools we have developed we now turn to the mathematical structure of quantum mechanics. Together with line spectra it belongs to the phenomena in this field. Historically, Schrödinger's equation and Heisenberg's matrix mechanics form the key relationships from which a large part of the conceptual content of quantum physics was developed. Dirac's relativistic invariant equation for the electron and his antiparticles was a further step.[10] Even today, despite the classical concepts accompanying it, its real meaning remains a riddle. But it produces so many meaningful quantitative results that nobody doubts it. Generalisations facilitate the calculation of energy levels that form the quantitative basis for the line spectra of the elements. With the revival of Clifford algebra after the fifties of the last century, further forms of these equations were discovered.[11]

An example is the Dirac-Hestenes equation for the hydrogen atom. Various forms of this equation are known, depending on the mathematical structure used to formulate it. Using the concept of 'I'-numbers for its solutions, it is possible to construct new concepts of structures in velocity space additional to what are otherwise referred to as electron shells of the hydrogen atom (Gschwind 2006a). The same quantitative results are produced, but a totally different interpretation, precisely because the linear complexes permeate the whole of line space. It is no longer possible to speak of particles and atoms in space and time.

The same applies to Yukawa's theory. Even if this theory of the strong interaction is no longer to the fore we can analyse its mathematical structure as we can that of the atomic shell. A nucleon or nuclear particle is regarded for simplicity as a particle that, from the point of view of charge, shows as a proton a charge of unity or, as a neutron, a charge of zero. It is subject to, on the one hand, the outer electromagnetic field and, on the other hand, a pion field which, through the exchange of virtual pions, produces the variation in charge and the masses of almost equal size, i.e. the transformation of proton into neutron and vice versa. Proton and neutron are not regarded as independent particles, but as a kind of polarity with variable weight to one side or the other. Nucleons are described by an extended Dirac-Hestenes equation (Casanova 1992, Gschwind 2006b) whose solutions are, together with dual numbers, also 'I'-numbers, i.e. linear complexes. If the equations are interpreted in velocity space with the pions, in contrast to the electron shell, a

[9] Just as point space has a dual space or plane space, so too there is a dual space for velocity space; it is also called reciprocal velocity space. Point space and plane space are connected by line space and from a higher viewpoint by line complex space. Likewise we can identify a connecting centre for velocity space and its dual space that contains all velocity states that are known as screws in the mechanics of rigid bodies (Gschwind 2004).

[10] cf., for example, Landau & Lifschitz 1986, Chapters 3 & 4.

[11] cf., for example, Hestenes 1966, p. 40ff, and Casanova 1976, p. 96ff. They have somewhat similar forms of the equations that Steiner (1920) gave for the various ethers.

world of Clifford algebra. According to the significance of the central region in our understanding of the human being and in mathematics, we can call the numbers that can be developed from the six entities 'I'-numbers (Gschwind 2005).

Archetypes of material structures

It may not seem surprising that with a different epistemological standpoint a different view of the micro-world arises. Modern particles resulted from the consistent pursuit of an empiricist agenda where only primary sense qualities are regarded as objective. A result of this is that the particles and atoms are pictured as objects in space and time, or more precisely through apparatuses of all sorts that construct them as such. With these come fundamental epistemological assumptions. In contrast to the common physical conception where only the object counts, realistic idealism, that also takes into account the subject, regards, out of the three fundamental concepts, space, time and velocity, only the latter as a primal phenomenon. Through a given reference system of the subject a moving object has, as an essential property, a certain velocity. Space and time arise, as secondary phenomena from the velocity, only in a subjective process of splitting.[7] Thus it makes sense to give a direct description of velocities. Interestingly, this step is taken unwittingly in physics with the concept of Minkowski space-time. In doing so it is not realised that when the calculus is conceived projectively it is velocity that is described. With relativistic four-velocity, which itself has a projective character, the step is completed. Nevertheless, the space-time world is dragged along with it as something seemingly indispensable. Consequently, the interpretation in velocity space is only a final logical step. All that is missing is just another paradigm change for the interpretation of the special theory of relativity and everything that is connected with it.

As a result, for considerations on the basis of realistic idealism, it makes sense to establish a new concept of structure for matter: *velocity constructs as archetypes of material structures*. Only with the splitting of velocity into time and space was it possible to derive a space-time concept of the atom from intensity distributions for lattices of solid bodies (Gschwind 1977, 2003b, 2004).

The necessary change in the meaning of mathematical formalism for the new interpretation means conceiving the space-time co-ordinates t, x, y, z as projective co-ordinates x_0, x_1, x_2, x_3 thus translating them from space-time connotations directly into relationships with velocities, to velocity space.[8] If then a constant velocity $\upsilon = x/t = (\rho x)/(\rho t)$, $\rho \neq 0$ is

[7] The most important thing in this context is that velocity is conceived as an immanent property of a body and not as the result of a calculation. Velocity can be analysed with a spatial metric or a temporal metric into the quotients of distance and time interval, in the way usually applied in the usual definition of velocity. This is why primary and secondary quantities are referred to (Gschwind 2004).

[8] Velocities can be defined mathematically with the same procedure as position in space, for example with vectors. Instead of real space or point space we then speak of a velocity space. Of course we then need to take into account what we are defining with these methods (Gschwind 2004).

living in general, in particular cultivated or domesticated species, no longer to remain the same – in protected environments or in a field - but to teem in the flux of transformation which pours out across the world in a permanent reorganisation, an unceasing metamorphosis, so working to bring about an expression, an ever increasing manifestation of the self emanating from all living forms.

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Goetheanism – its methods and significance in the science of living organisms

Ernst-Michael Kranich

Und es ist das ewig Eine,
Das sich vielfach offenbart;
Klein das Große, groß das Kleine,
Alles nach der eignen Art. (Goethe)

And it is the eternal One,
That reveals itself manifoldly;
Small as great, great as small
All after their own kind.

Abstract

Starting from Goethe's approach to understanding the living world, this paper characterises as an important methodological tool the inner reproduction of processes of transformation on which the outer appearances of the plant are based. From this results a distinction regarding, on the one hand, the concept of the type as *Bauplan*, also attributable to Goethe, and, on the other hand, pure phenomenology.
Goethe's exhortation to derive the visible plant forms from a mobile inner picture of the type (*Urpflanze*, archetypal or primal plant), is illustrated with examples in relation to three plant families (crucifers, onion family and umbellifers). The phases of the ontogenetic development of herbaceous plants serves as a relational framework.
In conclusion, a sketch is presented of how recognition of the laws of form of organisms, as an independent reality supplementing the physical phenomena in the context of modern biology, opens up a new field for research.

Introduction

When Goethe republished his morphological essay *The metamorphosis of plants* in journal form in 1817, he placed before it two short sections. The second 'Our objective is stated' contains an important indication of Goethe's epistemological method:

> For this reason, the man of science has always evinced a tendency to recognize living forms as such, to understand their outwardly visible and tangible parts in relation to one another, to lay hold of them as indicia of the inner parts, and thus, in contemplation, to acquire a degree of mastery over the whole. How closely this scientific aspiration is bound up with the creative and imitative urges need not be dealt with in detail. (Goethe, 1807/17 p. 55; trans. p. 23.)

This paragraph, particularly, the last sentence, shows the difference between Goethe's scientific method and that of the modern biological sciences. The latter describe and analyse the phenomena and then try to find among the material facts the principle for their explanation. In contrast, Goethe did not stop at phenomena. The artist, to whom Goethe is referring, does not just observe phenomena. He recreates a tree, for example, and takes care to work its characteristics into his picture. In imitating we repeat in our own activity that of the other and thus unite ourselves with it.

What Goethe's research shows is the fact that it does not stop at perusing phenomena at

line space, whereby the four dimensionality of line space expresses the exalted nature of the middle (Schuberth 1976, Gschwind 1977).

The threefold composition of the *Group* forms an important basis for a mathematical approach to understanding the human being. It can be rediscovered so to speak in the axioms of projective geometry which characterise in a certain way the geometrical aspects of the *Group*. We obtain in mathematics what is also valid in the study of the human being who, in many respects, comprises polarities held in balance from the centre.

The subject aspect in the process of cognition cannot only be treated as a receiver of information. We are dealing with realistic idealism and its equal status of subject and object only if we take into consideration the complex system of reciprocal relationships and balancing processes in the form of polarities between 'I' and outer world, and between the inner activities of forces and the 'I'. If we do not separate subject from object, because the role of the 'I' is considered real and the process of cognition is not treated as a process of representation, then viewpoints for the subject aspect can be applied to the object aspect and vice versa. In contrast to custom, abandoning rigidity of categorisation is recommended; living polarities are not rigid (Gschwind 2000, 2003a, 2003b, 2004).

The centre of the three geometric realms to be found in the *Group*, namely line space, when studied at a higher level, exhibits a signature that corresponds surprisingly with the real relationship of the human 'I' to the world. Line space is not a disordered set of lines, but has its inner principles. Through these we discover that the considerations of line geometry can acquire their polished form only if they are performed at a higher level in the projective space of line complexes (Adams 1956, Gschwind 1977, Stoß 1995, 1999, Ziegler 1981, 1985). These are formed from a set of lines which show the screw form characteristic of the central region of forms in the *Group*. By further contemplation of the inner gestures of this line structure we ultimately obtain an extended view of linear complexes that discloses new aspects for characterising the central region of the *Group* through both mathematics and our understanding of the human being. The linear complex can be understood as an entity that reflects itself at line space (Gschwind 1977, 2005). It is not just made up of sets of lines. Much more it is an entity that is understandable via a kind of trail in line space. This is the only approach that does justice to the entity of the linear complex.

As geometric aspects represent another kind of cognition algebraically, it is justified to take into consideration, besides the geometric facts, algebraic or structural viewpoints. The structure exhibits six essential entities. Thus a higher view allows formulation of a conclusive characterisation of the central region. There are gestures that are known from other, non-mathematical fields (Steiner 1908, 3rd lecture, 20 May 1908 and 1910b, lectures 4-6): *The world of linear complexes is structured through a signature of seven entities, line space and six entities that are reflected at line space.*

Clifford algebra, that is closely associated with projective geometry, allows us appropriately to formulate the algebraic aspect of the concept of three geometric realms and their inner relationships (Gschwind 1977, Conradt 2000a, 2000b). With this, we now have a route in thinking from the process of cognition via the study of the senses, with the 'I' between mental picture and will, and projective geometry, extending to the numerical

of point space, ray or line space and plane space has manifold components. Points contain bundles of planes, i.e. the set of planes that pass through this point, and straight lines contain sheaves or axial pencils of planes, the set of planes that pass through the straight line. Planes can be seen as 'planes of points' and lines 'ranges of points'. The components are defined by axioms, the fundamental laws, of projective geometry. Point and plane can be regarded as opposite extremes of line space. When lines crystallise into a bundle of lines we have the quality of point space and into a plane of lines the quality of plane space. In between can be found the typical structures of line geometry such as a regulus, congruence etc. The lines of a bundle can also be displaced such that they nearly go through a point, i.e. almost form a bundle or lie approximately in a plane. The rigid trinity point space, line space and plane space can be dissolved and connected in a process such that a mobile centre, line space, can be pictured between the extremes. Four dimensional line space is like a movable bridge that connects point with plane space and qualitatively embrace both three dimensional spaces at the same time (Gschwind 1977).

This gives us a first step in the direction of formulating a mathematical approach appropriate for the aforementioned polarity of the 'I' between will and mental picture. The mobile relationship of the three kinds of space together in their qualities, especially the polarity of point space to plane space, with line space in between as a balancing centre, forms a kind of archetype of polarities which can be recognised at various places in the human realm. In particular, the position of the 'I' between will and mental picture corresponds to the position of line space as a connection between point space and plane space.

A development of this fundamental polarity having comprehensive relationships to our knowledge about the human being can be found depicted in the statue of the Representative of Man, the *Group*, by Rudolf Steiner. This sculpture shows how the human being himself, considered at a higher spiritual level, is under the influence of two active principles that form a polarity. Two principles of force, and in between an impulse to balance, play such a decisive part in the real relationship of the human 'I' to the world that, without our taking them into consideration, we cannot expect to understand the world. This work of art enables us to bring into mathematics views of a fundamental kind regarding our understanding of the human being.

If we have intensively involved ourselves with projective geometry, especially qualitatively, we will be able to recognise in looking at the work of art with artistic-mathematical eyes three characteristic formative principles. In the Lucifer section there is the principle of spherical-ensheathing forms. Lucifer forms a kind of sheath. He sheathes himself in his own being. He himself has a somewhat spherical, in-flowing shape. Lucifer portrays in a certain way the sheath-moulding, planar principle in geometry. Ahriman's form has something of a central point, of delimited spatial components going outwards. He represents the forces of the central point, that radiate out. Geometrically we would say he represents the principle of the point that manifests in distinct parts of space. In the form of Christ in the middle, above all in the way executed in the model in plaster of Paris, a third principle manifests: screwing, even swirling surface forms, that in the context of geometry would be classified as the realm of lines that embrace the whole of space. The trinity nucleus, sheath and winding line forms can be seen in the statue, i.e. point space, plane space and

a distance, but, through inwardly recreating and actively thinking through them (*Mitvollziehen*), opens up a dimension of reality that is closed to the process of observing and recording, the point of departure of modern biology. Conventional observation of a plant, for example, considers the shape that in each case has already come into existence. But by recreating it we enter into the realm of the formative processes that brought it into existence, i.e. from which the finished forms emerged and on which they are based.

In an essay published in 1900, Rudolf Steiner pointed to this specific characteristic of Goethe's researches: 'In this recreating there is a key to understanding Goethe's world view. If we want to ascend to the endlessly changing principles, we should not look at what has already happened but we must eavesdrop on nature's creative process'. (Steiner 1884-1901, p. 211)

We will properly understand *The metamorphosis of plants* when we take it as an introduction to actively retracing in inner contemplation the process of transformation that a plant goes through as it develops from one stage to the next. Of course, we are supported in doing that by the outer facts. But thereafter comes the inner recreation of the process of transformation. That is the transition from outer perception to intuiting (*innere Anschauung*) the idea. This teaches us how to recognise the plant as a being developing through transformations. And this does not mean any particular plant, but the general essence of the plant, its type.[1]

As several people have remarked (Gädke 2000, Jahn 2005, p. 27f.) the type is something different from the *Bauplan*. The *Bauplan* of higher plants is a generalised scheme that arises from the intellect, whereas the type (archetypal plant) is the living being of the plant that we become aware of through the recreation of it in intuiting the idea. The *Bauplan* is a construct of the intellect, but the type is the reality of the plant grasped only in intuition. In an essay in 1894, Steiner put it thus: 'The type is realised nowhere in the outer world, but arises only as an idea within us when we observe all that the processes of transformation in living beings have in common' (Steiner 1884-1901, p. 75), including all that the transformation processes of plants have in common. What modern botany recognises as the sense-perceptible plant is not the full reality of the plant, but merely its appearance. Thus, in contrast to Goethe, modern botany bases its scientific framework on an incomplete experience of reality, i.e. on an inadequate foundation. That has significant consequences as we shall see.

What is now designated as 'type' in modern botany is something different from Goethe's vivid intuition (*lebendige Anschauung*) of a developing general plant being. According to Jahn the concept of the type 'became increasingly abstract ... from the middle of the 19th century' (Jahn 2005, p. 25). Thus, Claßen-Bockhoff defined the type as a 'Group of elements that are not separated from the elements of another group (another type), i.e. indicate transitions to it' (Claßen-Bockhoff 2005, p. 33). Forms that belong to such a type have the distribution of a Gaussian curve. We arrive at this kind of type 'through comparison and generalisation' (Claßen-Bockhoff 2005, p. 41). This formulation shows how very different it is from Goethe's conception of the type. For one thing, this type corresponds

[1] Explanatory commentaries on the method of Goethe sketched here can be found in *Anschauende Urteilskraft* by Schieren (1989), especially chapter V/3.

to what we have characterised as the *Bauplan*. Thus Hagemann expressed it very directly: 'When we are referring to the type of a group of plants we mean a common *Bauplan* in which we can distinguish a number of structural elements that are definable by their mutual positional relationships' (Hagemann 2005, p. 81). Here he is referring to several types which at most can be regarded as sub-types of Goethe's much more comprehensive type.

In the following discussion, when we refer to type we always mean the type discovered by Goethe, the archetypal plant.

The twofold law of plant formation and its operation

In his essay *Preliminary notes for a physiology of plants* Goethe formulated the twofold law. He writes:

> The metamorphosis of plants is the basis of the physiology of plants. It shows us the laws by which the plants are formed. It draws our attention to a twofold law:
> 1. the law of inner nature, whereby the plant has been constituted;
> 2. the law of environment, whereby the plant has been modified. (cited in Steiner 1884–1901, p. 279; trans. p. 85)

Goethe presented the law of inner nature in *The metamorphosis of plants* as the general being or essence of the plant, the type (archetype). Through the law of environment (or external conditions) the type shapes itself into the various forms of the plant kingdom, for example the families, genera and species of the flowering plants. In the introduction to the first volume of his edition of Goethe's scientific writings Steiner wrote:

> The type, resting upon itself, possesses the potentiality of taking on endlessly manifold forms as it enters the phenomenal realm, and these forms are the objects of our sense-observation; they are the genera and species of the type existing in space and time. As our mind comprehends that universal Idea, the Type, it has comprehended the whole realm of organisms in its unity. When the mind now looks at the Type as it has taken shape in each particular phenomenal form, the latter becomes intelligible; this form appears to the mind as one of the stages, the metamorphosis in which the Type comes to realization. And the pointing out of these various stages was to be the essence of the systematics which Goethe was to establish. (Goethe 1883, p. LXX; this translation from Steiner, R. *Goethe the scientist*, Anthroposophic Press, N.Y., 1950, p. 74, Trans. Olin D. Wannamaker.)

In the 18th and 19th centuries, the classification of the plant kingdom, the natural system of plants, was developed by a series of famous, primarily French, scientists. For example, they recognised the divisions of the flowering plants into Rosacae, Papilionaceae, Cruciferae, Umbelliferae etc., and the more comprehensive groupings into classes and phyla. They remained completely in the dark as to how these families, and only these, came about. Taxonomy shows us the classification of the plant kingdom, but it does not understand it. Something else eludes understanding. When we study an umbellifer, for example, we see a particular shape of stem, leaves, inflorescence, flower, etc. But what is the nature of the connection between the hollow stem and the usually manifold pinnate leaves, the double umbels and the small, usually white flowers with their inferior ovaries?

This is a simplified description of the complex interrelations of how, on the basis of realistic idealism, we can regard the human being and his cognitive relationships with nature. It is extended by taking into consideration on the one hand the further stages of nature or aggregate states and on the other hand fields such as light, chemical forces etc.[6]

The picture of the 'I' in mathematics

The role of the 'I' in the process of cognition and the polarity between will and mental picture is used in what follows as a kind of archetype, i.e. quite the opposite to the procedure in mathematical physics. The latter looks for mathematical methods for a given problem that lead to the best quantitative results. What kind of mathematical objects are used, whether vectors, matrices, etc., is not important. Custom, tradition and even the level of knowledge of the researcher strongly influence the choice. What has to be achieved is that the inner structure of the objects and their relationships are represented in the mathematics used. Otherwise, it will hardly be possible to obtain good quantitative results, and certainly not figures to several decimal places. That in this procedure fundamental, unnoticed assumptions influenced by world outlook have already been made, cannot easily be recognised in the empirical approach to knowledge, as it focuses only on the object. In contrast, realistic idealism must argue that the mathematics used belongs to the process of forming concepts that is adopted for fitting a particular object into the body of knowledge, and therefore has to be pursued with exactness in accordance with the equality of treatment of subject and object. The mathematics that comes to be applied should be chosen with the same care as the necessary non-mathematical concepts. Mathematical concepts arise as a result of unconscious activity of the three lower senses (Lauer 1977), i.e. as a result of the activity of these senses in our own bodies. Even though the body is constructed according to the same laws as the rest of the world – this is why there is often surprising agreement between the results of mathematical thinking and other findings – the mathematical procedure still has the problem of taking hold of reality. Mathematical ideas lead easily into the abstract, but whatever this is it remains to be clarified. Therefore, in mathematical physics further viewpoints were and are applied to the mathematical structures, for example, conceptual residues from the materialistic epoch of physics, and empiricist approaches such as the primary sense qualities being the only objective ones. Atom and particle physics is a typical example.

Taking the subject into account, i.e. the 'I', requires us to use mathematics in such a way that it does not just direct us in this way to tradition, but takes up the part of the 'I' in the way shown. A kind of mathematics is called for that corresponds to the polar nature of the situation of the 'I' between will and mental picture. Again, this requires Schiller's method (Schiller 1793/4). Polarities, transformations and metamorphoses in the realm of mathematics should be formulated and all should be conceived within a coherent overall context. We can find this overall context if we think more deeply about the content of the polarity between will and mental picture.

For this, we consider a few fundamentals of synthetic projective geometry. The trinity

[6] cf. Steiner's (1920) *Warmth Course*, especially the lectures of 13th & 14th March 1920.

both mental picturing and will have their continuations. With which aspects of the outer world is mental picturing connected, and which with will? In cognising the world, on the one hand the mental pictures that are connected with the things in the so-called outer world play a particular part and the forms are tightly connected with them. On the other hand, the will is, amongst other things, closely linked with warmth.

With the concept 'forms' we are referring to the forces that constitute the formation of solid bodies, minerals, plants, animals and the human form. The activities of formative forces can be seen in the development of the body from baby to adult. If the mental picturing life of a child is compared with that of an older person, it can be observed that the life of mental picturing continues to develop and does so approximately according to the diminution in the course of time of the up-building formative forces. With strong formative forces in childhood, the life of mental pictures is still somewhat modest. As the formative forces weaken in adulthood, the world of mental pictures can be further enlivened. Obviously there is some kind of relationship between formative forces and mental picturing. However, formative forces do not appear in consciousness as formative *forces* in the same way as they occur in the building of form in the world, but are transformed into the content of the mental picture of an object. Formation and mental picturing are no doubt connected, but mental picturing is transformed formative force. In normal cognition, the formative forces cannot be grasped as forces, only their transformed equivalent, namely mental picturing.

The relationship between *warmth* and the human will is similar. We can again speak of a close relationship between two things that differ in their manifestation. If you really want something, you have a strong need to bring to reality something that is not real, i.e. to realise something. A strong drive, which is generally associated with a strong will, causes a strong manifestation of warmth qualities, not only in the subject but also in his area of activity.

The transformation of neither outer form into mental picturing nor warmth into will involves a transition in space. The formative forces take effect spatially and warmth appears in space. But mental picturing and willing lack a spatial connection. The outer forces so to speak go out of space. The cognising subject transfers warmth element into its negative in order to make it into will element, and forms into their negative in order to grasp them in a mental picture.

The activity of the 'I' in the process of cognition can be summarised as follows: the two polarities presented, mental picture versus form and will versus warmth, are direct connections of the consciousness to the world, not after-images in the optical sense. They enable the cognising subject to understand the world with soul forces that arise from outer forces through metamorphosis. These two polarities come into the consciousness of the cognising subject as mental picture and will as if from different directions. With these two components, the 'I' is again in a polarity which it has to bring into balance. If the 'I' inwardly experiences the two poles, mental picture and will, it experiences at the same time the outer forming and outer warmth elements in nature. The human 'I', in its already polar structure, is in communication with the world by at least two further polar relationships.

People always grasp only a sum of various forms, and describe them as an accidental mosaic, because they are still in the dark about the inner connections. The challenge of a 'systematics which Goethe was to establish' is to point out these inner connections and the reasons for the various forms in the plant kingdom.

It was originally Goethe's intention to do this, but in his *Later studies and collections* of 1820 he wrote that 'the goal ... must remain unattainable'. He continued:

> What I had undertaken to do was nothing less than to present to the physical eye, step by step, a graphic, orderly version of what I had previously presented [in the *Metamorphosis of plants*] to the inner eye conceptually and in words alone, and to demonstrate to the exterior senses that the seed of this idea [the *Metamorphosis of plants*] or archetype might easily and happily develop into a botanical tree of knowledge whose branches might shade the entire world. (Goethe 1820, p. 119; trans. p. 85.)

Thus Goethe wanted to show how, from the archetypal plant, all the plants on the earth emerge in the same way as a tree with wide branches emerges from a seed.

This required a particular method that Steiner presented in his book *Theory of knowledge implicit in Goethe's world conception* republished in 1923. In the chapter 'Organic nature', to distinguish it from knowledge of the inorganic, he writes: 'In the case of the type we must evolve out of the primal form each specialised instance that meets us. We must not confront the single form[2] with the type in order to see how the latter governs the former ... the type flows into the single living entity, identifies itself with this' (Steiner 1889, p. 106; trans. p. 91).

The way it is to be done is described in what follows: '... if we are to have a rational science, we must presuppose hypothetically determined forms in which the type takes shape. One must then show how these hypothetical forms can always be reduced to a definite form lying before our eyes' (Steiner 1889, p. 106; trans. p. 92).

And further on he writes: 'We can allow the type to follow its course through the series of possibilities and then fix (hypothetically) in each case this or that form. In this way we arrive at a series of forms deduced by thought from the type, as the content of a *rational organics*' (Steiner 1889, p. 107; trans. p. 93).

Goethe was thoroughly familiar with the principle of this. In the aforementioned *Preliminary notes for a physiology of plants*, he distinguished four different stages of scientific knowledge. The highest is that of the researchers he described as 'comprehenders':

> 'The comprehenders – in a deeper sense they might be called creators – are original in the highest sense of the term. By proceeding from ideas, they simultaneously express the unity of the whole, and it is almost the obligation of Nature to conform to the ideas' (cited in Steiner 1884–1901, p. 271; trans. p. 92).

In the essay *Considerable assistance from one ingeniously chosen word*, Goethe indicated with different words that this proceeding from ideas was his inner endeavour. He writes: 'I...discovered that my whole procedure rests upon deduction. Because I am cautious and faithful in my work – both in what I accept from others and in what I achieve myself – I do not rest until I find a pregnant idea from which much can be deduced, or rather a point which voluntarily yields and brings many things to me' (Goethe 1817b, p.

[2] For example, a particular plant genus or species.

40; trans. p. 237) What Goethe here describes as a 'pregnant idea' is the type in botany.

If we want to understand plants in the way described, we need to develop to a high degree a creative thinking that in the process of intuition traces how the type realises itself under the given conditions as a particular plant form. We have to construct the living forms of nature through an inner activity that is guided by principles, just as Steiner urged in other places with Goethe in mind (cf. Steiner 1908/09, p. 191).

Phenomenological and Goethean botany

At this point we must distinguish between strict methodological application of Goetheanism in the fields of botany or zoology and the phenomenological approach. The phenomenological botanist would carefully describe the forms of the plant kingdom, for example. He would discover a multitude of relationships and also show that there is a sequence of stages from less differentiated to increasingly differentiated forms. Throughout he would remain faithful to the realm of appearances, the phenomena.[3] The Goethean botanist is aware of this, but feels himself driven to regard everything from a higher vantage point, that of the type, and thus shed light upon what must still remain hidden from the phenomenologist, namely the reasons why the various plant forms came into existence and the reasons why increasingly differentiated forms in the plant kingdom came into existence etc.

But it should also be admitted that the use of the term 'Goetheanism' is very diffuse. If one is being precise, much of what is done under the heading of Goetheanism belongs in the field of phenomenology. In the strict sense there is not much Goethean scientific work in the field of biology. Because of their scientific training, it is often difficult for scientists to lift themselves out of the realm of visible objects into the sphere where, through creative, formative, level-headed thinking, they can inwardly participate in the coming into being of all those forms that we see in the natural world. They lose the security with which have been familiar hitherto and sometimes end up rejecting Goetheanism or pass off phenomenology as Goetheanism.

The different ways in which plant forms are produced out of the type

Some people will be aware to varying degrees of what I have discussed so far. But, in concrete terms, how do we move from the universal being of the plant to its various forms that manifest to us in the natural world? According to Goethe's twofold law, it is the outer conditions that cause the type to shape itself into the various plant forms. Thus we need to take into consideration the different climatic regions of the earth; the changing seasons; the conditions in the coastal or mountainous regions; and the exposure in each case etc. In contrast to animals, plants integrate themselves fully openly into the forces of their environment and are therefore influenced by it in their formative processes. We are dealing

[3] In the volume *Phänomenologie der Natur* published by G. Böhme and G. Schiemann, phenomenology is described as the 'Cognitive method.... that acquires a knowledge of nature through unfolding and adhering to what is given to the senses' (Böhme/Schiemann 1997, p. 8).

mentation play a subordinate part. In quantum physics it is the reverse of how it is in other fields of physics. The entities investigated reveal themselves most reliably in the mathematical structures. Most other accumulated 'phenomena' already have the characteristics of a world view and are thus loaded with preconceptions.

The outcome of these considerations is therefore the conclusion that we must recognise the higher mathematical structure as being an essential part of the phenomenal component of quantum physics. Quasi-classical auxiliary approaches contribute nothing to this. How do we then arrive at a concept of reality for the entities of quantum physics and all that is connected with them? To arrive at conscious reality, we need conceptually to enter the field of phenomena presented in mathematical form using the appropriate methods of realistic idealism. These methods have to be developed before they can be applied. A first step in this direction is to take into consideration, in both content and methodology, the aspect of the subject.

On the trail of the 'I'

Taking the subject seriously in the process of cognition means concretely taking into consideration the human 'I'. What this involves will be sketched out in the following. We proceed phenomenologically and describe, according to Schiller's (1793/4) method, how the human 'I' is in communication with the world (Steiner 1920). From the standpoint of realistic idealism this is just as important as the usual analysis of the objective aspect. For it, we must use concepts justified by phenomena and not metaphors from technology, because the latter are inadequate for an understanding of the complex interplay of subject and object.

The 'I' has before it, as a result of various acts of cognition, *mental pictures* of all kinds occasioned by the most varied percepts. In further steps in cognition these mental pictures are used as foundations with which new cognitions are connected. With new steps in cognition, and with their incorporation into the entire system of concepts and mental pictures, we can observe a soul force that is generally referred to as *will*. It holds, so to speak, a complementary significance in relation to mental picturing. These two soul faculties play an important part in the relationship of the human 'I' to the world. With a healthy human cognitive capacity, especially involving a healthy everyday life, the 'I' is able to let mental picture and will interplay meaningfully such that they do not fall into contradictions or mutually hinder each other in an uncontrolled manner. The faculty of the 'I' to harmonise *will* and *mental picturing* is a fundamental characteristic of the subject for understanding the world and dealing sensibly with it.

Will and mental picturing rarely occur in isolation from one another. Mental picturing requires will and the will, for its part, is more or less saturated with mental picturing. For example, high quality meditative mental pictures call for a strong will, whereas rows of associative pictures so to speak wander through consciousness on their own, requiring practically no will at all. The relationship between will and mental picturing is one of equals, but the two forces vary in weight. It is a kind of polarity with all possible intermediary stages from will that bears mental pictures to mental picturing laden with will.

On the way from the actual subject, the 'I', to the outer world, the non-'I', we find that

tations, present no genuine cognition through which spatial-temporal objects, full of various secondary sensorial characteristics, can be processed.

The 'substitute percept' delivered by the apparatus and with it the apparently confirmed conventional interpretations of the theories, cannot therefore serve as a basis for contemplation. They mutually support each other and thus do not provide a secure foundation. For the theories, for their part, are largely connected with a series of assumptions and with historical, especially materialistic, encumbrances. As a result they are altogether out of the question for an unprejudiced analysis. From the point of view of realistic idealism, most so-called phenomena in the field of quantum mechanics are not real phenomena but blends of them with quasi-classical interpretations (Gschwind 2000, 2003a, 2003b, 2004).

What then remains as a basis? Besides the line spectra it is essentially the mathematical structure of the aforementioned theories that describes the abstract inner aspects of the problem and which in particular can reproduce the line spectra numerically. In addition, we have to consistently free it of traditional materialistic concepts and interpretations. In the field of microphysics it takes on the role of a phenomenon which is grasped by thinking and can be processed (Unger 1959-1967). The higher mathematical structures of quantum mechanics – this expressly does not refer to the elementary and provisional formulae – have a status in the field of quantum physics that is very different from mathematical structures in classical physics where penetration with non-mathematical concepts includes almost the entire field. And this is not changed by the mathematical formulations, for example theoretical mechanics inclusive of Hamilton and Lagrange formalism. On the contrary they abstractly summarise the conceptual relationships. In contrast to this, in quantum physics the mathematical structures in various places are a direct substitute for the lack of adequate conceptual penetration of the phenomenon, such that ultimately formal mathematical procedures, for example in applying certain rules, help to jump over the gaps in thinking. Examples include the de Broglie relationships between wave and particle and the translation key between partial derivation of a space co-ordinate and the corresponding impulse component produced by the basic approach of a plane wave. The mathematical structure was important in the development of quantum physics – one thinks for instance of Dirac's equation, which resulted in the possibility of postulating anti-particles – in the way that at least it influenced the course of experimental research as strongly as did the ordinary phenomena in other fields. The situation is comparable with the circumstances in modern art since the beginning of the 20th century. Here the conceptual component plays an increasingly larger role compared with the outer form. The conceptual, not pure mathematical, penetration of quantum physics has until today, and for whatever reasons, not achieved the significance that it has in other areas of physics. It never really got beyond classical conceptualising even if it tried, for instance with the rigorous interpretation in the sense of Copenhagen. An important foundation stone of quantum physics, and this is typical throughout this field and perhaps also a crucial problem, still comprises the various generally accepted equations verified by experiment of Schrödinger, Dirac and others, and their solutions. It can be observed purely externally how, in the specialist literature on quantum physics, it seems almost a 'law' that a book is more professional the more mathematical it is. Conceptualising and experi-

with a process called adaptation.

How is adaptation to be thought of in the Goethean sense? The type, the archetypal plant, is inherently a living organism. Its organs arise through transformation from one another, of course. In doing so they are placed in a living inner context; the type is inherently totally mobile. When, under particular outer conditions one of the formative processes becomes stronger, it expresses itself in all the rest of the plant being. The plant acquires its particular character through this formative process. Adaptation is the tendency of the type to realise or manifest itself in a specific plant form.[4] Steiner wrote in an essay in 1891: 'These [outer] conditions provide the causal opportunity for the organic realm to manifest in a particular way; knowledge of the inner law provides the explanation of *how* this particular form of reality could arise' (Steiner 1884–1901, p 284).

Thus, in the sense of what is already presented, we can explain the forms that the plant being (the type) adopts when various formative processes achieve predominance, and why the basis for this process is also referred to as adaptation.

But it is also fully justified, in the sense of the formulations cited from *Theory of knowledge implicit in Goethe's world conception*, to make it clear, without immediately going into adaptation, how various plant forms emerge from the type. First of all, we can very generally distinguish two opposite processes here. One is that early processes in the development of the plant (under the influence of outer conditions) become stronger than normal and modify the resulting formative processes. In this sense, root formation and the formation of overwintering buds can leave their mark on the early stages of shoot formation and an intensified sprouting in the entire rest of the plant. The other is that later stages of metamorphosis reach into preceding development, for example flower, fruit and seed formation. Other modifications are also possible. In his last botanical study, the essay *The spiral tendency*, Goethe distinguished two fundamental formative tendencies: the vertical tendency by which, in root and stem, the plant attains its sturdiness, and the spiral tendency, for example all those organs that are arranged in a spiral around the stem. As Goethe emphasised 'the two vitalising systems' can never 'be imagined apart from one another, for the vitality of one is maintained only through the operation of the other' (Goethe 1883, p. 226; trans. p. 129). But one system can predominate over the other. According to Goethe, the spiral tendency is dominant in Convolvulaceae. It is clear how it rules the formation of the plant. The otherwise vertical stem grows in spiral movements, likewise the flowers unfold their crowns spirally.[5] By contrast, in other plants the vertical tendency determines the whole plant.[6] Of all the possible plant formations arising from the type, we can only present a few here. But this may suffice to demonstrate the method and its significance.

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[4] It probably does not need to be particularly emphasised that this concept of adaptation differs in an essential feature from the one currently used. The latter does not recognise the inner principle residing in the type and therefore regards the changes leading to adaptation as chance mutations.

[5] cf. the chapter 'Die Windengewächse' in my book *Pflanze und Kosmos* (Kranich 1997).

[6] For example, *Dianthus* (see Kranich 2000, p. 53.ff)

Two examples for the influence of earlier formative processes in later ones

In herbaceous plants, what characterises the development of the green shoot is the repeated formation of new stem divisions and leaves until this process ceases through the transition to flowering and, in the metamorphosis to flower, is dammed up, so to speak: a successive structure becomes a simultaneous one. Before that, the side shoots of the inflorescence emerge that likewise are concluded with terminal flowers (so-called open inflorescence). Through this sprouting in the region of flowering, the flower-formation process is weakened because the flowers, as already mentioned, arise through a damming-up of sprouting. Therefore, the numerous flowers that arise remain small, and it is to be expected that the damming up is weakened in the emergence of the flowers. Then, however, flowers appear with fewer than the typical five sepals and petals, and there is not a wholly simultaneous formation of the various organs in the flower. Finally the sprouting process will take hold of the formation of fruit and modify the typically rounded form of it.

All this occurs with inner necessity. We follow with formative thinking how the type transforms itself into a particular plant form – and notice that the archetypal plant becomes a crucifer. We then understand how it comes about that in the Cruciferae the inflorescence is open and more and more flowers are produced on it; that they are small and only have four sepals and petals; that two sepals appear a little before the others, likewise the two shorter anthers before the four others; and that the fruit are largely long pods. For we have followed in intuition how all these forms owe their origin to the same process.

In his *Metamorphosis of plants*, Goethe describes as irregular or retrogressive metamorphosis the process by which the plant does not achieve the transformation to the next stage in its development and comes to a standstill, so to speak, at the earlier (section 7). When an earlier formative process modifies further development and, as with the Cruciferae, development does not reach its full extent, retrogressive metamorphosis of the archetypal plant is the case.

A second example for this form of retrogressive metamorphosis is provided by many of the perennial herbaceous plants in our region [Germany] that go through winter as overwintering buds. On a strongly dammed-up stem, simple scale-like leaves, with veins aligned parallel, close themselves together to form bud casings. Inside the bud is the shoot primordium, now and then with the flower primordium that in the following year develops into a new plant. Furthermore, this overwintering bud can grow far beyond the normal extent. It then becomes a bulb and acquires an influence over the delicate plant form taking shape within, and thus over the plant into which this eventually grows. Its leaves are then marked with the principle that rules in the bud. Through the character of the bud that is centred in itself, they unfold only a little into its surroundings and do not form a petiole, which otherwise would hold the leaf blades that encircle the plant. The character of the bud stamps itself on their simple, undifferentiated form and on the parallel course of the leaf veins. If the closing-up tendency in the leaves is very strong relative to the environment, the leaf blades close up to form a tube. In that the centripetal forces of bud formation work into the region of flower formation, the inflorescence is restricted in its development of side shoots. In the extreme case these are totally suppressed and only

of a size from one seventh to one ninth of the mass of the proton.

About ten years after this suggestion by Yukawa, the so called π-mesons, abbreviated as pions, were identified in experiments as having the required properties. With them it was possible to construct one of the quantum electrodynamics analogue theories for the strong interactions. But the difficulty is that the strong interaction is associated with a coupling constant $g \approx 10$ that is far bigger than the fine-structure constant α. In quantum electrodynamics, α is definitely a lot smaller than 1. The analogy with electrodynamics and adopting it for the strong interaction was therefore not possible. Thus, after 1970 another theory was sought for the strong interaction and it is believed to have been found in quantum chromodynamics.

Even if the boundaries of individual particles are blurred in modern theories, it was assumed with good reasons in the sense of a postulate that matter is built of atoms. Thus, for example, successful molecules with the desired chemical and physical properties for particular applications are designed on computer screens according to the laws of the spatial arrangements of atoms in molecules, and then realised in synthetic processes. Nowadays the electron microscope and scanning tunnelling microscope offer opportunities to 'observe' the world of atoms and molecules.

One can ask to what extent these modern 'facts' are empirical evidence for a world of atoms, of microscopic *material* particles, built up of innermost centres. This world is certainly not constructed in the sense of classical materialism from material particles. Indeed, there is enough evidence that particles are strange things because, of all their great variety of properties, they do not possess the slightest bit of matter perceptible to the senses. They lack colour, temperature or even smell. The atom itself lacks most features that one usually associates with a piece of matter in everyday life. Here we have the consequence of the aforementioned postulate of Locke on the splitting up of sense qualities into so-called objective primary and subjective secondary. Atoms and particles have only position, form, movement, mass, charge and, if need be, spin etc., but no real sense qualities.

In observing atoms and molecules in the scanning tunnelling microscope, we should take into consideration how such pictures arise in the apparatus, how such pictures are constructed out of the measured *intensity distributions*. These apparatuses construct 'images' or 'photos', often with artificial coloration, according to the generally accepted conception of the physical effects applied from the electrical measurements. These constructs are in no way optical in origin. A 'picture' in an apparatus cannot prove the existence of something in a particular *sensorial* form, because the apparatus is constructed according to the accepted scientific view. It gives only the intensity distributions. Thus it is difficult to distinguish what is sense percept and what is a thing that is already processed by thinking and is only produced by a preconceived theory in an apparatus. As it is hardly the case with ordinary optical equipment based on lenses and mirrors, we disregard the special cases of the astronomical telescope and the microscope. But if electrical and quantum mechanical effects are used, it is without doubt no longer a matter of sense percepts. If we judge from the standpoint of realistic idealism, where genuine percepts and concepts are combined in cognition, apparatuses in the latter case, based on interpre-

19th century arose out of the explanation of the compressibility of gases due to the spaces between their atoms, and from the need to produce impressive pictures from the simple numerical relationships of chemical compounds. The kinetic theory of gases was very successful. From the Van der Waals law it was possible, with the assumption of a spherical shape, to arrive at an admittedly not wholly accurate estimate for the size of the atom. The postulated electrical composition of matter was a further step towards the concept of the atom. In the determination of the electrical elementary charge, the assumption of a spherical form of the droplets used also played a part. Loschmidt's constant and the mass of the electron are further factors. Although the trails in the Wilson cloud chamber are very convincing images for the concept of particles, it is conceivable that such trails could arise in other ways.

The Rutherford scattering experiments in 1911 showed that the building blocks in an atom have radii far smaller than the gaps in between them. This established the nucleus-shell atom. But the energy emission of electrons encircling the nucleus like a planetary system led to a fundamental instability of such an atom. New laws had to be postulated. Photo effects and quantum effects were further steps towards Bohr's single electron atom. The equations of motion were declared invalid because arbitrary starting conditions gave arbitrary parameters for electron paths. Bohr fixed the paths in the atom such that the sum of the angular momentums came to a multiple of the unit $\hbar$. Movement along such paths takes place without radiation; emission and absorption of light quanta happen only by spontaneous change from one path to another. Bohr's concept of complementarity, Heisenberg's matrix mechanics, Schrödinger's differential equation and Dirac's relativist version of a differential equation for the hydrogen atom are the elements from which ultimately the present day conception of the atom was constructed. Together they form the central core of the theory.

The development of ideas on the structure of the atomic nucleus was as much entangled as that of the atomic shell. The arrangement of protons and neutrons in such a small space in the nucleus of the atom was a riddle. For example, in the nucleus of the uranium atom, according to the validity of the laws of electrodynamics, there must be 92 protons concentrated in a tiny volume. The electrical repulsion of the protons would be such that a violent explosion would immediately take place. It was this that led to the discovery of the strong interaction that is supposed to stabilise the nucleus. It would have to be at least a hundred times stronger than the electrical force described by the fine-structure constant α, and be strong only at distances on the scale of one hundred-thousandth of the diameter of an atom. If, for example, two protons are brought closer together than this distance, the strong interaction between the two protons draws them together – the true basis of the atomic nucleus. At macroscopic distances the strong interaction is not detectable.

The interaction between two electrically charged objects, attraction or repulsion, is explained by postulating the exchange of virtual photons. Because of this, a new particle was sought for the strong interaction that, by exchange between the nucleons, could produce the strong force. As quantum theory recognises a connection between the mass of the exchanged object and the reach of the corresponding interaction – photons are massless, hence the unlimited reach of electromagnetic interaction – the particles sought had to be

one terminal flower results. The flower formation is itself very characteristically modified. It becomes bud-like in character. In the type, the green calyx forms a bud casing out of which unfolds a colourful corolla. Under the influence of intensified bud formation a green flower bud is formed, but in the middle of it no corolla arises. Flowering stays at a bud-like stage. Blossoming can then only manifest by the bud-like calyx becoming coloured.

Once again, in the process of intuition, we go through the way in which the archetypal plant metamorphoses into a particular plant form according to strict laws. In this case it is the plant form of the bulbous perennials of the lily family. Once again we grasp the inner circumstances, i.e. those between increased bud formation and the simple parallel-veined leaves (for example, the tube-shaped leaves of the genus *Allium*), the inflorescence, often shaped like a bunch of grapes, and the simple perianth.

Likewise, a whole range of plant forms arises through the early stages of development modifying in one way or another the formative processes that follow, for example, besides the bulbous perennials of the lily family, all the rest of the monocotyledonous plants[7] and amongst the dicotyledonous plants, for example the goosefoots, the knotgrasses and nettles.

An example of the dominance of a later developmental process

The third example is intended to show how the further continuance of a stage in metamorphosis can, through its predominance, modify the rest of the plant. We have already been reminded that, in the emergence of the flower, the shooting process is dammed-up and a transformed leaf structure appears as sepals and petals simultaneously and at the same level as members of a higher whole, namely the flower. This damming-up can have an effect lower down the plant in such a way that the sprouting stops at an earlier stage of development. This intensified flower formation process can affect the entire inflorescence. In which case the shoots of the inflorescence no longer appear sequentially from the axes of the highest leaves on the stem but instead simultaneously from a centre, the base of the inflorescence. In consequence this damming up also affects the individual shoots of the inflorescence. This results in a double umbel with a number of so called umbellules or secondary umbels as a higher flower, so to speak; an inflorescence transformed into a pseudanthium. The individual flowers are now members of a higher whole, relative to which they recede, i.e. do not become very large. How does the rest of the plant shape itself when it is modified by the formative gesture of this double umbel? This formative gesture (in the rays of the umbel) is a reaching out to the periphery and then an opening in the periphery (in the umbellules). When it affects the plant, it will make the whole of it grow vigorously towards the periphery, i.e. very tall. The stem will be extended. And the leaves will reach out into the surroundings and open out there in that they strongly subdivide and thus incorporate themselves into the periphery. But the flowers too are modified. In the umbellules, they orientate themselves wholly to the periphery and incorporate themselves into it by opening completely and by giving up all centring.

Again we follow the way in which the archetypal plant turns into a special plant form

[7] See the corresponding chapter in my book *Pflanze und Kosmos* (Kranich 1997).

that in all its organs is an expression of intensified flower formation. We can recognise this plant form in the Umbelliferae. They now become understandable to us because we grasp how the law formation rules the whole plant in the following ways: the emergence of the double umbel; the production of an extended hollow stem with its multiply pinnate leaves; the wide-open small flowers; the fact that the ovaries appear under the flowers and the latter are not centred in themselves by the ovaries; and the fruit, like the inflorescence and the leaves, dissolves into the surroundings in that at ripening they split into two halves.

The necessary distinction between causa formalis *and* causa materialis

It would be totally feasible to show how further plant forms arise from the archetypal plant, and, indeed, not only various families of flowering plants[8] but also simpler, less complete forms of the plant such as ferns or algae. But this short treatment is concerned not with completeness but rather with presenting the scientific significance of the Goethean approach.

Through Goetheanism we penetrate that region of reality in which the laws of form of the various plant forms come into being. This region lies on the other side of what we recognise with the senses. In formative thinking we grasp these laws of form by intuitively participating in the production of them from the archetypal plant. As Goethe expressed it, 'Through contemplation of ever-creative Nature...', we arrive at 'participating spiritually in her productions'.[9] This solves many riddles. When people get to know plants in the usual way today they appear as a particular sum of individual features. And as there is no inner connection visible when viewed from without, they arrive at the view that they are dealing with a purely chance combination.

But we discover the formative laws and with them the inner connecting principles of these features. It becomes clear that thinking in terms of chance combinations of features is a wholly superficial and provisional conception. Darwin was aware of this. At the beginning of the fifth chapter of his book *The origin of the species by means of natural selection* he wrote with regard to the origin of characters: 'I have hitherto sometimes spoken as if the variations ... were due to chance. This, of course, is a wholly incorrect expression, but it serves to acknowledge plainly our ignorance of the cause of each particular variation' (Darwin 1899, p. 153f.).

In an earlier part of this discussion we indicated that any approach which takes into consideration only the outer appearance of plants is operating with an inadequate con-

[8] Further examples, in a somewhat different context however, can be found in my book *Pflanze und Kosmos* (Kranich 1997).

[9] In the essay *Anschauende Urteilskraft* (Goethe 1817a, p. 30; trans. p. 232.
Translator's note: *Anschauende Urteilskraft* has been translated in various ways by different translators; for example: perceptive power of thinking; deductive intuition; judgement through intuitive perception etc. As '*Anschauende*' refers to the capacity of direct inner perception, i.e. intuition, and '*Urteilskraft*' to the capacity to bring it to a conclusion, this translator adopts Bertha Müller's version, 'intuitive judgement'.

tive secondary, is connected with the division into lower and upper senses and can in certain circumstances be justified. But to universalise this division for the investigation of questions of cognition is a judgement that is a hindrance to unprejudiced knowledge, because it predetermines what is supposed to be subjective and what objective.[5]

Phenomena and evidence of atomism

It is now necessary to clarify what can be described as atomistic phenomena. In this field, it is not at all easy to maintain even a rough overview of the various phenomena, for at practically all levels of complexity of the manifold presentations on this theme there is no clear separation between phenomenon and thought. Textbooks present a world of atoms which is still somewhat quasi-classical. Bohr's atomic model continues to be ubiquitous. Besides this, we mention the uncertainty principle, which cancels out again many of the ideas conveyed. Textbooks at a higher level avoid excessively thorough portrayals of the micro-world and concentrate more on the purely mathematical content of theories. In general, what is presented very much depends on the author. The great founders of quantum mechanics are largely radical in their utterances, leaving the quasi-classical world behind them. In order to save materialism, the later generations make recourse to a generally statistical world outlook. Innumerable practical experiments in a great variety of fields are supposed to support the ideas of the atomic composition of matter. The inescapable question arises as to how far they achieve this and how far they confirm Einstein's remark that theory determines what is measured. Critical analysis finds in the scientific literature no coherent overview of real phenomena of the atomic world in the sense of realistic idealism.

Atomic phenomena in the form of quantum events occur in some physical experiments: cathode rays as bearers of negative charge; permeability of matter to cathode rays; line spectra; Zeeman effect; radioactivity; law of radiant heat; Rutherford scattering; Wilson cloud-chamber; deflection of x-rays etc. Quantum phenomena can be indicated through the appearance of discrete values in measurements. Electrical charges or energies turn out to be multiples of fundamental values or follow from mathematical formulae for discrete values that are isolated. Discrete values for physical measurements do not necessarily have to be connected with ideas of atoms or particles. They are also exhibited by vibrating strings or the discrete values of the buckling loads of a thin, axially loaded bar. At best such a connection is permissible for experiments with a collector screen for light quanta at low intensity of the light source. The general conception of atoms or particles requires the idea that the world is made up of material particles. The generally prevalent atomistic materialism is more an uninformed and unconscious way of thinking than a scientific result founded on confirmation by experiment.

Thinking about atomism started in antiquity when there was a kind of atomistic conception of the natural world. The broad development towards mechanistic atomism of the

[5] How the senses, regarded as subjective, are rehabilitated, so that all twelve senses are given their justifiably equal place in relation to cognitive potential, is found in Schuberth's (1980) research results, which follow on from Steiner's. See also Gschwind (2000).

ment – in recent times above all from information technological processes – as bases for how we arrive at presenting ourselves with a sensorial percept. Even today, because at the neurological level the contents of perception are split into incomprehensible parts that are not immediately experiencable, the transition to the contents of consciousness is still obscure, even though people have been able to go into outer processes with increasingly detailed measurements. But they never arrive at an inner process through an outer one. With Berkeley's spiritual world view, cognition is a reflection of the activities of divine beings. His process of cognition already has the character of a sensorial percept and this is a kind of divine inspiration.

A conception of the process of sense perception that can be represented by the middle epistemological position briefly looks as follows (Stein 1921): for example, in the perception of a colour four stages can be distinguished. The first stage of colour perception is a process in the outer world that continues through the sense organs into the body. The second stage comprises the experience of the colour phenomenon as something that is not caused by the body. The third stage is a recreation process in the body to restore it to the condition before the perception of colour. Only the recreation process is consciously experienced, not the second stage. The fourth stage comprises experiencing the process of the outer world in the recreation process. This is nothing other than a process of the outer world with a negative sign, because the process of the outer world is active there not as an objective process but as an experience of a percept.

Steiner's realistic idealism, which serves as a basis in what follows, distinguishes twelve senses (Steiner 1917, 1910a). They convey the sole basis for the mental pictures which the human being makes for himself from the world that is described as the physical world, to which belongs the body of the cognising subject. A human sense is what enables us to recognise the existence of an object, being or process in such a way that we can place this existence in the physical world. Furthermore, a sense is more than just a sense organ.

By certain changes in the sense organs there are obviously variations in sensorial percepts. These can be corrected by thinking in the process of making a judgement if other senses provide supplementation. Errors arise through use of inadequate concepts or through disregard for logic, but they do not originate from deceptive perception.

The senses of life, of movement, of oneself and of balance together result from the direct sensations about the state of one's own body and indirect impressions of how this body is situated in its environment. With the following senses we can relate to the outer world, not to our own bodies: sense of touch, sense of smell, sense of taste, sense of sight or vision, sense of warmth, sense of sound or speech, sense of concepts and sense of 'I'.[4]

Senses which permit perception in the immediate outer world, i.e. in one's own body, are called *lower* senses and senses that grasp the outer world that does not belong to one's own body are called *higher* senses. Each sense is unique insofar as it delivers typical qualities that *cannot* also be provided by *other* senses. Therefore Locke is being arbitrary when he describes particular sense qualities as subjective. Only the lower senses – senses of life, of movement of oneself and balance – would be the senses useable for objective cognition. Lock's division of sense qualities into two, with objective primary and subjec-

[4] However, the senses of touch and 'I' are in a certain way exceptions (Steiner 1910a).

ception of reality. An inevitable consequence of this is, for example, the view of chance combinations of characters which among other things underpins the current view of evolution and the essential interpretations of genetics.

Therefore Goetheanism calls for a revision of theories that today are taken for granted. We shall sketch such a revision for only one of the theories.[10] According to Aristotle, there are several causes to be distinguished when considering objects, for example the formal cause (*causa formalis*) and the material cause (*causa materialis*). In modern biology the view is largely prevalent that the reason for the origin of living forms is to be found in the cells, in the genes in fact. The production of form results from the material realm in a complicated way. A differentiation is necessary with regard to the multitude of established gene effects. When a particular formative process takes place as the result of a gene, the gene can be the condition or the cause of it. We can be certain that it is the cause if no other reason for the formative process can be found. Yet we have seen how the formative principles of plants emerge from the archetypal plant. It realises itself in the development of plants. For Goethean scientists it is therefore unthinkable that the development of a plant with its various organs is an effect of genes, because he has grasped through complete evidence that the formative laws, for example, those of the families, genera and species, are an independent reality. What he recognises in formative thinking is just as much a reality as cells and tissues with the genes they contain. Goetheanism can thus distinguish, with all clarity and certainty between *causa formalis*, the formative laws of the plant, and the *causa materialis*, the still undifferentiated cells with their genes. This results in a new area for research. We now have to clarify how the undifferentiated cells are the condition for the various formative processes in the development of a plant, i.e. how the formative principles gradually reach into the as yet undifferentiated tissue and thereby realise themselves in it.

Goetheanism and modern genetics – a short overview of a further theme

In the foregoing discussion, we have exclusively adopted the position of Goetheanism. The previous remarks could be interpreted to contain the assertion that there is an irreconcilable difference between Goetheanism and modern genetics. That there is no such thing has been thoroughly demonstrated by Wirz in his essay *Typusidee und Genetik* (Wirz 2000). Our remarks are merely directed against the view that genes are all powerful in the origin of living organisms. The fact that the particular gene expression, i.e. the way a particular gene takes effect, is dependent on the position of the cell in the emerging organism, shows that the latter guides gene expression. As Müller put it: 'Because of the context dependence of gene expression as well as the fact that with the completion of each new stage of complexity in the process of development, newly emerging features determine the further development, the development of the embryo is described as "epigenetic"' (Müller 1994, p. 163). The particular influence of the organisms undergoing development on the emerging organs became particularly clear through a discovery of

[10] In *Thinking beyond Darwin* I have shown how evolution should be rethought (Kranich 1999).

Gehring. Together with his colleagues, he was able to demonstrate that through almost identical master genes emerged in the mouse the lens eye typical of mammals, in the squid the lens eye with the very different development of cuttlefish, and yet in fruit fly the complex eyes (see Gehring 2001, p. 225ff.). Thus, there are 'no species specific genes, just a species-specific differential usage of them' (Wirz 2000, p. 324). This is also shown by another important discovery of molecular biology. In fruit fly, a system of homoeotic genes were discovered, i.e. genes that are essentially involved in the segmental division of the embryo and the positional relationship of the emerging divisions to each other. In the segmentation of the mouse embryo the same system was found as in animals that had no segmental division, namely sea urchins, nematodes, leeches, corals and hydra. This basic genetic pattern has been described as the 'zootype' and the following conclusion drawn: 'The concept of zootype enables the revival of Geoffroy Saint-Hilaire's idea of an archetype of animals' (Maynard-Smith & Szathmáry 1996, p. 257). But Geoffroy Saint-Hilaire's idea is Goethe's conception of the type. However, in their statement there is a confusion of levels, because the type is the general idea of the plant or animal organism and not a genetic structure that ranges through the animal kingdom. The latter is the condition for the appearance of type in its various manifest forms, i.e. in the various forms of the animal kingdom. In this respect this structure is connected with the type and is no doubt its correlate in genetic information. Something similar is of course also conceivable in the plant kingdom.

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Goethe, J. W. von (1817b) 'Bedeutende Fördernis durch ein einziges geistreiches Wort'

consciousness into his cognitive theory. The object aspect is over-emphasised. Material objects seemingly separated from mind play a part and he puts forward the theory of *primary* and *secondary* sensorial characteristics. Sensorial qualities are only objective if they are connected with position, form and movement. Colours, smells and the like, because they are subjective, belong not to the world of objective existence, but to the realm of psychology or aesthetics. Locke's objects are colourless, odourless and silent. They possess only position, form and movement. From this empiricist standpoint, thinking does have its place, but is conceived as merely a subjective faculty that has no objective significance whatsoever. For Locke, the 'I' disappears into an extreme that is object.

In another conception of cognition the object can be lost too if the subject is over emphasised, as is the case with Berkeley (1710). Berkeley's epistemology is a rebuttal of Locke's. He takes a one-sided spiritual standpoint: *esse est percipi*, i.e. *being* is *perceiving* or to be is to be perceived. This standpoint leads to an immaterial, purely spiritual view. All the objects that occur in everyday life are, according to Berkeley, the result of divine action with no material basis. According to this view, if we cannot perceive an object it cannot exist, and this applies to inner perceptions too. The human being is in interchange only with divine beings, not with material objects. The aspect of the real object, a real outer world, disappears in the 'I'. Cognition becomes a reflection. Thinking plays no part. No conscious reality arises, i.e. no mental picturing.

With either a strongly empiricist approach that gives too much weight to the object aspect, or a one-sided spiritual standpoint, it is impossible to take into consideration both a conscious 'I' *and* a real world. With this tension of cognitive polarities, Steiner's epistemology solves the problem of connecting a self-conscious 'I' with a real, objective outer-world. Thus Steiner's epistemology takes a middle position between the empiricist and subjectivist positions. Steiner's conscious reality is based on the cognising subject as well as the object that is to be cognised. Therefore there is *no absolute separation of subject and object*. And there are no *a priori* laws that predetermine the direction of cognition.[2] This epistemological stance can be called *realistic idealism*.[3]

The three epistemological positions lead to different conceptions of sense perception. Empiricist cognitive theory uses metaphors of a particular stage of technical develop-

[2] For example, in the sense of Kant's *a priori* (1787).

[3] The term *realistic idealism* requires explanation. In 'realistic' we discern that this idealism reckons not only with ideas but also with a world that exists independently of them. The difficulty in this designation of course resides in the fact that, in the history of ideas, realism and idealism are opposites. One term stands for a world independent of the 'I' thereby allowing no contribution of the subjective human being to valid knowledge. And the other term challenges this independence and thus loses the pure objectivity of the world. Without further clarification of what the middle position, Steiner's epistemology, contains, realistic idealism seems contradictory. Other terms that have been used are *empirical idealism* or *objective idealism*. The first term is easily confused with empiricism, which is here described as an extreme epistemological stance. The second term is used by, for example, D. Wandschneider: www.phil-inst.rwth-aachen.de/lehrenden/wandschneider.html.

occasioned by phenomena, the epistemological standpoints can be characterised by positions at the extremes. One-sided positions can then be avoided. If we consider subject and object together, there are various possibilities for weighting them in different conceptions of cognition. Three typical positions are represented by John Locke, George Berkeley and Rudolf Steiner. Locke and Berkeley represent opposite extremes and Steiner takes a position in the middle.

According to Steiner's conception of the process of cognition (Steiner 1894), the human being tries, through thinking, to connect with a concept the percepts given by his senses. *Conscious reality* of an object is given only by the combining of percept and concept in the cognitive judgement, which also includes becoming aware of the cognition. A mental picture arises, which subsequently replaces reality, as a subjective representative in the mind of the person engaged in the cognitive act. Therefore three things are connected with the process of cognition: the percept, the concept and, as a result, the mental picture together with the becoming aware of cognition.

Thus, knowledge comprises not only recording empirical facts supposedly given independently of the subject, but also appropriate formation of concepts. For this reason, the processes of forming concepts and judgements must be pursued with precision. In content and form, only thinking belongs to the continuance of experience of the world. According to this view, the so-called empirical facts are in no way given independently of the subject as finished contents of knowledge, but their character can only be deciphered by a process of cognition of the subject, through applying thinking to percepts. For new cognition the percepts are in a state of pure chaos where one thing cannot be distinguished from another, i.e. where everything is still of equal value. But as soon as only the slightest distinction is made, thinking is at work and the cognitive process has begun (Steiner 1892, Gschwind 2003a, 2004). However, for repeated cognition there is a certain automatic attunement between percept and concept.

At this point we need to negotiate the obstacle of Humean scepticism (Hume 1742). The sceptic would object that with this approach the problem of cognition is merely postponed, but not solved, and would enquire whence comes the certainty that the concept grasped really 'belongs' to the percepts and that freely combining percept and concept does not make cognition impossible in principle. Granted Steiner's approach also makes a certain cut in the process of cognition. However, it is not between subject and object but between percept and concept. Even so, it is not a true cut, only seemingly one. Steiner shows that the concept is an integral part of the object which has to be perceived by means other than those used for other percepts, namely with the help of thinking, through consciousness. This shows that the apparent cut does not exist. A festival firework is perceived by two routes, namely by the ears and the eyes, without our concluding that two different objects are involved. We too easily forget thinking, together with its concepts, occurs like a percept in consciousness.

Locke (1689) regards cognition as a rational individual process and not as a religious edification or revelation, i.e. there should be no influence from church dogma or religious traditions. Only what he can establish for himself is permitted. This is an expression of the strengthening 'I'-consciousness. But it is impossible for him to integrate this 'I'-

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The 'I' and the reality of the atom

Peter Gschwind

Abstract

Given the solutions of the well known Dirac-Hestenes equation, the position of realistic idealism, combined with the idea of I-numbers in projective velocity space, can lead to an entirely new concept of the atom and a new view of the problem of the material constitution of the world.

Realistic idealism

Science frequently raises the issue of the relationship between subject and object. Despite this, the subject is rarely mentioned in modern physics. It is generally accepted that it is possible to concentrate solely on the object because it is supposed to be considered independently from the subject. Only quantum mechanics provides a certain exception to this.

At least two matters show that the problem of the boundary between subject and object is not as simple as that. Firstly, an experience can be interpreted in different ways. Paradigm changes can be detected at various times in the history of most branches of science. The interpretation of particular experiments or facts, with their mathematically formulated theories, is suddenly changed, and this frequently leads to scientific progress.[1] Secondly, for most abstract mathematical structures, there are various visual geometric interpretations. This shows that something else is needed besides the facts of the object so as to be able to interpret them. This additional thing, namely thinking, that goes beyond pure mathematical modelling is generally overlooked in physics. But it plays an important part in all science. There is no science without thinking, because every scientific experiment involves applying thinking to facts, to observations.

If we accept thinking as a constitutive part of knowledge, then its significance in the production of an item of knowledge should be taken into consideration. That thinking is neither subjective nor objective follows from the fact that subject and object are concepts that are brought to consciousness by thinking. Thinking is on a level above that of concepts. As thinking only manifests through the subject, it follows that a separation of subject and object is not really feasible.

A precise grasp of the significance of thinking in scientific knowledge is particularly crucial because, for all investigations in the field of atomism, a clear distinction between concept and phenomenon is fundamental to atomism's concept of reality. With many of the 'objects' discussed in this field it is not clear what is concept and what is phenomenon.

Towards an understanding of the role of thinking during the contemplation of concepts

[1] We cite as an example the interpretation of Schrödinger's wave function which was reinterpreted as probability waves by Born.