# Ernst Cassirer: open constitution by functional a priori and symbolical structuring

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This article aims at presenting
1. the innovations of Ernst Cassirer's open epistemological model, transforming the concept of 'constituting objectivity' by founding it on the dynamical 'constitution of meaning'
2. the entailed conception of physics' objectivation as a process of 'symbolic formation', studying its transcendental functions and their roles for the major tasks of creative constitution and pragmatic justification of knowledge
3. the clarifying and convincing solutions this view offers for the interpretation of relativity theory and quantum mechanics.[1]

## 1.

Ernst Cassirer's oeuvre can be seen as a unique, radical and most fertile continuation of the original ideas of transcendentalism. It overcomes the historical forms of the Kantian as well as the Neokantian schemes, even if it is greatly indebted to them and remains entirely truthful to their founding philosophical orientation. The comprehension of physics, especially of relativity theory and quantum mechanics - the challenging contemporary theories of his time -, has played a decisive role in the development of his conception. Cassirer has discussed his epistemological views directly with Einstein and Bohr, and it is astounding to see that in the midst of the intellectual uproar caused by their innovations, he was one of the rare thinkers able to receive and to appreciate their revolutionary changes with open arms as a clear confirmation of his own analysis of science and its evolution. He even claimed "that his fundamental outlook could be formulated more precisely and corroborated more successfully than before thanks to the development in modern physics"[2]: a tendency and claim which can be still further substantiated by the latest developments.[3] This remarkable fact deserves attention and confers great credibility to Cassirer's philosophical position and its explanatory power.
In Cassirer's view relativity theory and quantum mechanics had touched upon the defining limits of physics as a specific form of objectivation and it was precisely this discovery of their own epistemic preconditions that caused much incomprehension if not refusal - which to some extent lasts until today. It could be held that modern physics had thus reached the stage of 'transcendental reflection' by itself, and - as history shows - this crucial change in its auto-appreciation provoked a profound crisis, for it shattered the convictions inherent in the still dominant, representational view of knowledge. Some of its protagonists - like Bohr, Schrödinger or Pauli - fully grasped this epistemological dimension and it is revealing to see how Bohr succeeded in countering all of Einstein's obstinate efforts to refute quantum mechanics only by elucidating the hidden, highly questionable, often ontological assumptions behind his arguments. “I therefore tried […] to explain [to Einstein] that the only question was an endeavour to *clarify the conditions*, in each field of knowledge, for the analysis

1For a detailled discussion of Cassirer's philosophy and the interpretation of modern physics see C. Schmitz-Rigal, Die Kunst offenen Wissens.
2 E. Cassirer, ZMP, 131: “meine Grundanschauung […] auf Grund der Entwicklung der modernen Physik schärfer formulieren und besser begründen zu können als es früher der Fall war” Cp. a. ZMP, 277.
3 See H.G. Dosch: Renormalized Quantum Field Theory and Cassirer's Epistemological System.

and synthesis of experience"[4]. In Cassirer's analysis it was to be expected that physics would have to face the task of acknowledging the role played by the conditions of its own possibility as a science and that it had to integrate them explicitly into its reasoning and research.

Already his early work on the foundations of science - "Concept of substance and concept of function"[5] - studies science's inherent tendency to rediscover the open transcendental *function* - as stability, definiteness or unity - lying behind each of the *fixed historical forms* - i.e. particular notions of basic 'entities', categories or principles - that temporarily succeed in fulfilling them. As long as their use remains unproblematic these forms naturally assume a 'substantial', realistic appearance and obscure the open tasks to which they are the momentaneous answer. This is not prejudicial in itself and can help to motivate the research efforts, but it becomes a powerful obstacle, if their transitory status as a 'working hypothesis' is entirely forgotten. For the blind belief in them then creates strong resistance to the very change, in which progress inevitably consist and which is necessary to adapt and to assure the fulfilment of these fundamental functions in the constantly evolving context of new evidence. For Cassirer this was exactly what happened regarding relativity theory and quantum mechanics: both theories caused considerable confusion, because they put into question central concepts of classical physics, which seemed to be beyond doubt, as 'time and space', and worse even, 'object', 'causality' and 'predetermination'. Thus they dared to abandon the classical invariants, which had long served as firm reference points for the system of physics. The resulting destabilisation and disorientation was aggravated by the fact that the new foundations they introduced did not fulfil the needs of immediate perception and diverged from the intuitive world view, safely inscribed into our languages, both of which - according to Cassirer - habitually play the role of the reassuring "mother soil"[6] from which our common understanding grows. In Cassirer's position these difficulties are a direct consequence of questionable representational and foundationalist expectations, and they can be solved by differentiating and disentangling the conflicting claims between perception, language and physics through a deeper epistemological analysis of their origin.

Cassirer's main epistemological motivation is to grasp, how such a historic process and progress of knowledge is *possible*, that is, how our knowledge can be *inherently* changing and contingent *on all levels*, without loosing its claim of veracity. It seems as insufficient to him to simply separate 'temporal' and 'atemporal' elements - as the idealist-rationalist version attempts - as it is to merge the two poles of 'transitoriness and truth' - so the empiricist-realist tendency - thus dissolving their fruitful tension. He tries to construe a third, intermediate position in which he can fully meet this major epistemological challenge by maintaining their opposition yet explaining, why 'temporality' and 'truth' are not only compatible, but why *they even mutually demand and depend on each other*.

He finds the key to a solution in a consequent continuation of Kant's critical effort, reapplying the transcendental search for preconditions onto those elements in the work of their *own* proponents which still keep a 'given', isolated character and carry the traces of the very epistemological dualism and metaphysics they tried to overcome. Fully acknowledging the inexhaustible dimension of temporally open, contingent experience, Cassirer does no longer try to find 'final' answers to the perpetually open "*problem* of knowledge"[7], but centers on the concrete question how the 'order' arises in which our knowledge actually consists. Therein pursuing reflexions from Kant's 'Critique of Judgement' and integrating numerous other philosophical influences - especially Leibnizean, Pragmatist and 'Gestaltist' -[8] Cassirer arrives at a thoroughly *dynamised* view of knowledge which eliminates pretendedly atemporal and absolute components by understanding all formerly fixed conceptual elements - as the form-matter scheme, the categories, judgements and principles of the Kantian a priori - as results of an open process of structuring and organisation. Cassirer strives to reveal its functions and presuppositions, its *open tasks*, thus presenting knowledge almost like an 'operator', able to yield different solutions depending on the initial conditions. Thanks to this performative, purely *functional* and *operational* perspective he is not only capable to trace back every claim of 'objectivity' to its concrete process of objectivation, but he completes the Kantian analysis by revealing the constitutive conditions of the *means of constitution themselves*. He thus performs a kind of 'second Copernican

4 N. Bohr: Discussion with Einstein, p. 63, italics C.S.
5 E. Cassirer: Substanzbegriff und Funktionsbegriff.
6 E. Cassirer, PSF III, 398: "Mutterboden der Anschauung", "Mutterboden der Sprache".
7 E. Cassirer: Das Erkenntnisproblem in der Philosophie und Wissenschaft der neueren Zeit.
8 Cassirer refers to J. Dewey, but particularly to W. James (see f. ex. SFB 319, 382, 388, 424, 441).

turn' and brings into sight a fundamental aspect of constituting objectivity which has not been discussed by his predecessors: the *constitution of meaning*. Cassirer claims that "we must conceive the problem of knowledge and the problem of truth as particular cases of the more general problem of meaning"[9]. This crucial turn leads to an innovative, open, inherently plural and holistic model of knowledge which offers maximal adaptability of *all* of its components - the fundament included - as well as sound safeguards against arbitrariness. And it proposes nothing less than a reconciliation of the traditional dichotomy between idealistic-rationalistic and realist or empirical paradigms.

It is essential to grasp that it is *not* the recognition of the semiotic dimension *in itself* that leads to a solution for the epistemological problems of dualism. For as long as symbols are still looked upon as 'representations of pre-existing predetermined things' the problematic dualist pattern is simply *reproduced* on this level, offering no intellectual progress whatsoever. What Cassirer proposes is not a semiotic, but a Copernican turn, because it implies an *inversion* of the seeming epistemological priorities. His rigorous analysis reveals that it is impossible to justify a 'symbol' by referring to the designated, allegedly independent pre-existing 'entity' and a bijective relation of 'cause' and 'effect'. But *inversely* it is in fact the elementary *possibility of 'symbolic reference'* without which we would not be able to refer to 'some-thing' as 'this definite object' at all. In the same way as Kant solved the inconsistencies of the dogmatic approaches by renouncing direct ontological hopes and founding knowledge humbly on what is truly ours, Cassirer reiterates and completes this critical movement for the means of constitution themselves. We cannot explain 'symbolic reference' with reference to other phenomena, we cannot go beyond or behind it, because it is the necessary condition which enables us in the first place to *address something as a phenomenon at all*. It is what we have to start with. That is why for Cassirer this transcendental condition is a "primary phenomenon" or "primary function"[10], equivalent to our primary experience of consciousness and phenomenality itself. All 'consciousness' is as such 'symbolic', in the fundamental sense that it is 'consciousness *of*', 'of someone' and 'of something'; indeed it only *is consciousness*, *insofar as* it is this *relation*, a unity of inseparable, yet clearly distinct poles, the bipolar *relation of reference* which the symbol *is*. It is precisely because of this rare and unique structural quality to be *as such* a unity of unity and difference, an *inherently plural*, yet *inseparable unity*, that Cassirer uses his key-term 'symbol' as an incorruptible alternative to the omnipresent, Aristotelian 'form-matter'-scheme and its intrinsic dualism. Even if Bohr, Schrödinger and other ingenious interpreters of quantum mechanics already discovered the level of constitution and meaning and thereby discussed the limits of the predominant ontology and language, they are still standing on its ground and remain its prisoners, because they were lacking a working epistemological alternative to representationalism, able to reveal the liberating dimension of the constitution *of* meaning. 'Meaning' is not simply 'given' by a 'pre-existing thing'; 'meaning' is what enables us to focus and fix reference and to relate to 'something' as a 'thing'. When a full comprehension of this *constitutive* role of our symbols is reached, the object-intention appears as an *integral part of the bipolar structure of reference itself*, enabling us to construe productive anticipations of order, which can then be tested and confirmed - or rejected - pragmatically.

## 2.

What then - according to Cassirer who proposes such an alternative to representationalism - are the open tasks and constitutive functions that need to be fulfilled in order to make the objectivation of physics possible?

1. Differing from classical epistemologies, Cassirer asserts that an objectivation-process cannot even begin before a particular aim has been delimited, which defines its direction, provides its driving force and serves as a criterion for its success. So the first open task consists in some sort of symmetry-breaking, in which one aspect, one determinate respect has to be singled out, which is already a

9 E. Cassirer: Erkenntnistheorie nebst den Grenzfragen der Logik und Denkpsychologie, p. 34: "müssen wir […] das Erkenntnisproblem und das Wahrheitsproblem *als Sonderfälle des allgemeinen Bedeutungsproblems* begreifen". See also E. Cassirer, PSF III, 229. J.M. Krois also stresses this underestimated fact. Cp: Symbolic Forms and History, p. 44ff.

10 See E. Cassirer, PSF III, 102 ("Urphänomen"), PSF I, 34 ("Urfunktion"), PSF III, 61 ("Urfaktum"), cp. also PSF III, 117, 229, 462, 458f, 524.

product of a first particular constitution of meaning. For Cassirer it is self-contradictory to strive for 'unconditioned', 'absolute' knowledge, for partiality and interrelatedness describe the very nature of determinateness. In his analysis knowledge is on the contrary on all of its levels a matter of concrete interest, precise determination and engaged choice. It therefore appears as a lack of depth and understanding to imagine physics as 'a true image of the world in itself' as the traditional model of correspondence suggests. Instead Cassirer refers to a physicist himself, Henri Poincaré, to specify physics' particular aim of objectivation: "'Jean sans terre' has passed through here: there you have something which is admirable, something for which I would give all theories of the world. That is the way the historian speaks. The physicist would rather say: 'Jean sans terre' has passed through here, well, what do I care, for he will not pass again."[11] Poincaré thus clearly expresses that the physicist is not interested in the unique, individual and unrepeatable aspect of events - even if it is perfectly, even enviably, objectifiable too. On the contrary it restricts its investigation to the repeatability, the regularity and lawfulness of observable physical events – a view of the epistemic range of physics equally shared by Pauli.[12]

Since this initial choice of an aim allows for various diverging directions, it follows that objectivation can take place in a *diversity* of ways and has actually done so historically. This introduces another significant difference to the representational conception of knowledge. With every different orientation is born what Cassirer calls a 'Symbolic form' which is in fact an open ongoing objectifying organisation. Science - along with language, history, art, religion, myth, technique, custom etc. - is one of them. In this productive as well as pragmatic view, each of these "different modalities of 'sense-giving"[13], of 'making sense', contribute in an irreplaceable manner to our understanding and none of them can pretend to exhaust the notion of 'reality'. Taking into account this fundamental "multidimensionality of knowledge"[14] Cassirer concretises and widens the one-sided 'critique of pure reason' to a plural 'critique of culture' which he attempts to accomplish in his main work: 'The Philosophy of Symbolic forms'.[15]

2. The second open, constitutive task of objectivation concerns its means. Cassirer holds that a Symbolic form cannot simply rely on any 'given, predetermined' framework of logical, psychological or ontological orders - this impression only occurs, because our main orientation system, the Symbolic form 'language', occupies a predominant place in our understanding and seems to furnish unquestionable orders which we can draw from. But even if a Symbolic form can borrow and integrate notions from other forms – as physics has done with language – in the end the physicists have to actively choose, conceive and create all conceptual tools adequate to achieve their specific goal themselves - from the basic notions, the appropriate images and laws to the principles and experimental testing methods. That is in fact what a 'Symbolic formation' *is* and does and it presents another aspect of the permanent 'constitution of meaning'. Since this applies to any of the different directions of objectivation, it follows that – strictly speaking - each Symbolic form has its own symbolic system and creates its own, particular, irreducible 'universe of sense'.

Investigating concretely how the symbolic articulation of experience takes place that constitutes physics and its objectivity, Cassirer draws our attention to an initial paradox: the very physicality of the phenomena it wants to study actually has to *disappear* before it can begin its work. For the lawlike, regular relations it is interested in only become visible, once the multitude of dissimilar sensitive observations have been made comparable by finding a common denominator: that is why physics *measures* and this demonstrates, how the driving aim shapes the symbolic form to be adopted. Cassirer has coined the telling term of "trans-substantiation"[16] to characterise this first necessary step of physics' objectivation: the seeming sensory 'substance' of its observations is completely 'transfused' into abstract mathematical concepts, the plural phenomenality of perception is abandoned in favour of the sameness of mere numbers, keeping as only trace of their origin the accompanying dimension-sign. This constitutive step of quantification also implies that *from the very beginning* - far from our

11 H. Poincaré: La science et l'hypothèse, p. 158: "Jean sans terre a passé par ici: voilà ce qui est admirable, voilà une réalité pour laquelle je donnerais toutes les théories du monde. C'est là le langage de l'historien. Le physicien dirait plutôt: Jean sans terre a passé par ici; cela m'est bien égal, puisqu'il n'y repassera plus."

12 W. Pauli: Phänomen und physikalische Realität, p. 94.

13 E. Cassirer, PSF III, 234: "verschiedener Modalitäten der Sinngebung".

14 Cp. E. Cassirer: Zur Logik der Kulturwissenschaften, p. 101: "Mehrdimensionalität der Erkenntnis".

15 E. Cassirer, PSF I, 11: "Die Kritik der Vernunft wird damit zur Kritik der Kultur."

16 E. Cassirer, PSF III, 510. Cp. a. 503ff, especially 513.

common sense beliefs - the actual 'objects' of physics are *no longer* those of our everyday perception and spatio-temporal intuition which we tend to generalize spontaneously as a model for all objectivity. But analysed thoroughly each of them is nothing more and nothing less than a complex and abstract "notion integrating determinations of number and measure"[17], a unique focus of attention and intention, inseparable from an entire system of interrelated meanings, known as 'physics'. The illusion of 'the same objects' persists mainly because our habitual structuring of perception and language – unjustly - claims uniqueness and priority, but also because the originally borrowed terms from language – the great majority of physical terms in fact – have preserved the same name, although in their new context and use they no longer have the same *meaning* at all. Bohr already wondered about this disturbing discrepancy when noticing that "Our basic tool is, of course, plain language, which serves the needs of practical life and social intercourse."[18] As physics progresses the gap to ordinary experience and its convenient order patterns inevitably widens, for 'language' and 'physics' do not pursue the same aim. It is hence perfectly natural that finally the physicists have to create their own original notions and orders, being more apt to obey the requirements of their specific quest - like 'isospin', 'CP-violation', 'strangeness' or 'boson' - and it is natural too, that they no longer resemble our cherished 'everyday objects', for in fact they have never been the same. Nonetheless they are perfectly objective - in a certain sense even more so than 'sense-objects' - since they successfully occupy their place within physics' extremely rigorous, well-experimented and working knowledge system.

This 'trans-' or 'de-substantiation' distinguishes physics from other Symbolic formations and confers a particular potential to it, since it entails that physics expresses itself almost exclusively in mathematical terms. Its major symbolical tools are basically two: 1. 'number' - resp. vector, matrix, tensor – to unambiguously fix the measuring results and 2. 'function' to clearly express their lawful relations. These mathematical terms, free of any material connotations, belong to a specific type of symbol Cassirer calls "signs of pure relation and order"[19]. They introduce a particularly strict, unequivocal type of reference, which does not permit shifting polyvalence and ambiguous suggestiveness and thus differs considerably from 'image-signs' or 'word-signs', typical of perception and language. Therefore physics is exposed to precise and powerful inner constraint that act as a motor for its perpetual transformation, because they are able to contradict and counter the pressure of our habitual, linguistically laden beliefs - as modern physics has demonstrated so impressively.

But he who wants to quantify, first needs a measure. Besides these mathematical tools, physics employs 'word-signs' – as 'mass', 'charge' or 'temperature' - which specify the needed respects of measuring. These notions define the actual, presumedly recurrent and stable 'entities', the 'objects' and 'qualities' of physics. They establish the first of three main levels of inner articulation of the knowledge system of physics which Cassirer characterizes as "notions of measure", "notions of law" and "proposition of principles".[20] These notions correspond to different epistemological functions that indicate conditions for structuring determination and the constitution of physics' specific objectivity:

1. the 'notions of measure' determine the fundamental reference units, providing the needed stability and basic articulation of the symbolic system,
2. the 'notions of law' serve to integrate the measurement results into notions of higher order and thus determine the actually sought relations between the elementary notions
3. the 'principles' anticipate regulatory ideals of coherent unity for a sub-group of these notions or – as the highest heuristic principle - for all of them. Should there be different, competing options how to reach such a unity for the entire symbolic system, then the principles of univocity and simplicity - i.e. explaining a maximum of phenomena with a minimum of principles, "plurima ex paucissimis" as Cassirer formulates with Kepler - specify the notion of unity itself by indicating an extremum. Principles thus serve as criteria for overall orientation and evaluation.

In order to arrive at any of these organising notions we have to make a "leap into the void"[21], a constructive guess and effort, which anticipates an order that might or might not be confirmed by later experience. Neither can the laws be simply inferred from the measuring results, nor can the principles be deduced from the postulated laws. It requires active 'Einbildungs*kraft*' and 'Urteils*kraft*' - which

17 E. Cassirer, PSF III, 510: "Inbegriff von *Zahl*- und *Maßbestimmungen*", Cassirer's italics.
18 N. Bohr: Unity of Knowledge, p. 67.
19 E. Cassirer, PSF III, 389, cp. also 396, 400, 408.
20 E. Cassirer, ZMP, 161-194: "Maßbegriffe", "Gesetzesbegriffe" und "Prinzipienaussagen".
21 E. Cassirer, ZMP, 194: "Sprung ins Leere".

already in Kant's fine analysis name the same 'force', the same capacity of anticipative structuring, of creating 'sense-units' - to fill the conceptual gap between these different degrees of order and to generate these orders themselves. In Cassirer's framework all three types of notions are principally equal: they are 'symbols', 'foci imaginarii'[22] - to use the famous expression that Kant invented for the 'ideas' – i.e. imagined centers for our orientation, fixed intentions, organising anticipations of order, tentatively fulfilling a specific function, yet remaining entirely questionable and transformable. And it makes no difference, what particular function they happen to assume: be it providing the elementary stability of basic units or the integration into highest unity. In either case our use of reason cannot claim to be more than hypothetical. Even if we are ready to admit, that this hypothetical status is applicable for the overall principles - since they 'only' extrapolate concrete experience to a horizon of its possible completeness - we are not used to consider 'laws' and especially not the basic 'notions of measure' in this way. The commonsense belief is that there have to be 'anchoring', 'corresponding' elements, which connect our symbolic system directly to 'reality' and thus guarantee its 'truthfulness'. It is indubitable that we need operational criteria which guarantee the objectivity of our knowledge. The decisive question is however, how we can *really* attain them. The tempting idea of 'direct correspondence', seeing knowledge as a 'one-to-one mapping of pregiven 'elements of reality' to 'elements of our symbolic representation" turns out to be untenable, because it yields no viable criteria. It is natural to charge the notion of 'reality' with the most important epistemic function to warrant 'truth' and serve as ultimate security against arbitrariness and empty speculation. But it does not help to invoke it with much emphasis and engagement, because it only designates the aim of our investigation, the *unknown*, and not a given means we could readily employ, and it is not able to assume the crucial role we would like it to play. For Cassirer the classical 'foundational effort' - be it through 'deduction' or 'direct correspondence to reality' - is an integral part of the dualist model of knowledge and its validity stand and falls with it. For as long as we conceive of knowledge as a hierarchical structure, reposing on an untouchable fundament, the linear dependence of its epistemic layers inevitably leads back all claims of 'truth' to the foundational basis, which then needs to be justified as 'true' in order to assure the legitimacy of the whole structure built on it. Already the habitual metaphors employed - 'structure', 'fundament', 'underlying', 'build up' etc - betray the allpervasiveness of this static epistemological pattern. In this view the entire system and its epistemic value 'breaks down' when its fundament changes - which could very well describe the impression of crisis called forth by modern physics.

In Cassirer's analysis these 'foundational' problems are artificially created by an inadequate model of knowledge, which confuses the separate tasks of 'constitution' and 'justification', because it violates the symmetry between all elements of any symbolic system, forcing it into a linear order. If we study the concrete symbolic system of physics and e.g. its 'notions of measure', we find that they define their 'basic entities' by providing a precise definition of how to measure them. So a' second', as a unit of 'time', is defined to be 9 192 631 770 times T($^{133}$ Cs), i.e. the period of a Caesium-maser oscillation. The significance of this basic definition already presupposes nothing less than an understanding of the complex theory of atoms, which itself remains incomprehensible outside the entire system of physics. In fact the three 'levels' of articulation - notions of measure, law and principle – cannot be understood as a linear structure, resting on a 'solid basis'. Instead they turn out to be inseparable, for they *mutually* define each other and form *one*, completely interconnected whole, structured internally by different functions of order, none of which can claim to be more important than the other. This reveals the internal symmetry, the principally relational and holistic character of any symbolic system and of 'meaning' itself. The *determinateness* in which individual sense *consists* can only be constituted as a relational 'limit', a 'relative internal difference' arising within a network of mutual de-limit-ations and differentiations *from which it cannot be abstracted*. It is of prime importance to grasp that 'meaning' therefore has no independent 'substantial' character, based on a mysterious transcendent 'one-to-one correspondence' to 'given entities', but an interdependent or co-dependent character, based on concrete, rational mutual constitution.[23] To acknowledge this irreducibly holistic character of a symbolic system

22 I. Kant, KrV, A 644.

23 Even more profoundly it can be shown that it is in fact this holistic structure of *mutual constitution*, which makes the phenomenon of *mutual reference*, of symbolic reference *possible*. For if every element is a function of all the others, it can also *stand for another one or for the whole* and thus act as the 'sign of'.

implies that it does not make sense to formulate the question of 'truth' for a single element*, but only for the system as a whole*.

3. Thanks to this entire internal structuring the physicists can anticipate and calculate theoretically a particular measurement result and invent practical procedures on how to test it as a third open task of objectivation. Now, if the actual result does not coincide with the anticipated one, a tension is introduced into the symbolic system of physics. Since it aims at coherent unity - which is not the case for all Symbolic forms - this disagreement is evaluated as a 'contradiction' that needs to be removed. However, the result in itself does not indicate, how to undo the tension, and the system's holism allows for a multitude of possible changes to dissolve it: so again the physicist's creativity is challenged to make a clever 'leap into the void'. Yet the structuring transcendental conditions of his Symbolic form serve him as indispensable guide-lines: so the driving principles of coherence and unity are to be satisfied in such a way, that they allow for a maximally simple integration of the respective basic notions and laws best satisfying the evidence and all disturbing contradictions. But *vice versa* - diametrically opposed to the Kantian categorical conception - in Cassirer's holistic view the basic notions and laws can *equally* be re-conceived and changed in such a way, that they allow for an optimal fulfilment of the principles: it is in fact the productive *interaction* between the different actual *equally important transcendental demands* - determinateness, univocity, stability, simplicity, unity - which generates a fertile *dynamics* and leads to the inner transformations that create new insights. Surprisingly close to recent theories of self-organization Cassirer's model thus envisages a nonlinear feed-back-loop between all interacting elements of the symbolic system. It gives rise to a movement of self-correction by constantly searching a dynamic *equilibrium* between these constitutive functional demands in the permanently changing context of new evidence. Relativity theory and quantum mechanics give a striking example for the great catalytic power of these abstract exigencies: intrepidly following the principles of coherence and unification the physicists were driven - even against their personal convictions - to opt for a thoroughly different configuration to find a new equilibrium, which asked to abandon the ancient fix-points of the system, the classical 'entities' that had so long been able to play the stabilising role, but, given the new situation, could do so no longer.

In Cassirer's model it appears as just another inevitable open constitutive *task* of each specific objectivation-project to decide and define which should be its most adequate 'fix-points', serving as 'putatively invariant entities'. And the answers depend 1. on the particular objectivation-goal in question, but also 2. on the entire evolving structure of the respective symbolic system - as the history of physics corroborates. The physicist has to advance skilful anticipations, which local choice of 'stable reference units' will lead to an optimal transformation of the entire system in direction of the global aim of unification. But he needs to have the humility to leave the judgement about their epistemic value to time, contingency and experience rather than to his personal ontological predilections. For if these notions will be able or not *to fulfil this function of 'invariants*' does not depend on him, but only and entirely on their pragmatic success. It is not the rigid, atemporal fixity of 'substantial elements' that will grant us the stability knowledge necessarily requires, but the adaptability and strength of mutually supporting interrelatedness we attain in a concrete symbolic system.

Cassirer finds this functional view of stability and invariance confirmed in the work of the German mathematician Felix Klein. Working on comparative geometry at the end of the 19$^{th}$ century, he outlined that the so-called 'in-variants' clearly depend on the type of 'variation' one studies: so the invariants of rotation are not the same as those of lateral translation or of a mirroring bijection etc.. It seems evident, but is often neglected or ignored that the notion of invariance itself is *relational* - as all notions are - and that it only makes sense with reference to a specific framework. In the same way, the invariants of our knowledge systems cannot be considered to be absolutes, but they *depend on the framework of the specific Symbolic form they are an integral part of*. Hence for Cassirer it is not shocking, but even to be expected, that the invariants of our worldly kinaesthetic perceptual orientation and the invariants of the search for the fundamental laws between quantifiable observables are most probably not going to be the same.

4. Thus we reach the fourth open task of knowledge: its justification. Even if the choices and infinite options of organising constitution are our task, their actual epistemic value and usefulness, given the chosen aim, then no longer depend on us. It is up to us to formulate the questions, but then we do not decide upon the answers. "The first step: we are free to choose - but on the second and all following

steps we are servants."[24] Thus Cassirer dares to surrender *all* elements of our symbolic systems without exception - from the anticipations of 'basic entities' to the highest formal principles - to the judgement of their pragmatic success, for knowledge cannot pretend to 'justify itself' *concerning its actual epistemic efficiency*. Cassirer's dynamic view of knowledge liberates the multiple tasks of 'constitution' from the unfulfilable constraint of 'direct correspondence', but with the same theoretical movement 'justification' becomes entirely a matter of pragmatism. An element is justified in its epistemic function, *because* it is able to fulfil it and *as long* as it is able to fulfil it: and that is all we have - and all we need. Those who dream about 'final justification' by correspondence or deduction adhere to an 'absolutist', static vision of knowledge that takes the risk of paralysing itself by clinging to limiting prejudices. For Cassirer the only form of legitimation able to meet future, uncontrollable contingency without restriction is the temporal justification 'by function and efficiency'. This type of 'open' justification is not Cassirer's own invention, but other than in the pragmatist tradition it can already be found in the 'Critique of pure reason', following Kant's arguments to justify the 'ideas'. For the critical analysis of the Transcendental Dialectics explores the insoluble incoherencies that arise if one wants to affirm - as the metaphysical tradition before Kant did - that ideas are 'true', because they 'correspond' to pre-existing entities. Nonetheless it in no way undermines their epistemic value and utility, if one admits that ideas *do not possess a categorical, but only a hypothetical and heuristic status*. They are still perfectly justified, because they are "an indispensable condition for the practical use of reason"[25], that is, because they fulfil a transcendental function. One could draw the parallel that the antimetaphysical critique Kant undertook for the 'ideas', Cassirer has completed for the categorical 'basic entities' and 'invariants', showing that both are fundamentally the same: symbols, 'foci imaginarii'. They are fully objective and justifiable, not because they 'correspond' to a given, enigmatic entity, but because they likewise fulfil an indispensable epistemic function which this time is the function of providing adequate stabilising fix-points.
The great achievement of this functional approach is that it gives us *perfectly concrete criteria* to judge. So, if the physicist wants to decide about the epistemic value, about the 'truth' of a symbolic element, he can test, whether *within his constituted symbolic system* 1. it fulfils its own, local function and 2. whether this allows the whole of the system to fulfil its global goal and 3. whether this development shows an overall direction towards greater unification: together these three criteria clearly inform him about the pragmatic success of the knowledge system. "We call a proposition 'true' not because it corresponds to a fixed reality beyond all thought and all thinkability, but because it proves a success during the process of thinking itself and because it leads to new fertile consequences. Its actual justification is the effectiveness it unfolds in direction of the progressive unification."[26] It is this functional and pragmatic conception of 'truth' that succeeds in including transitoriness and temporality as its own essential elements.

## 3.

One of the finest examples of the transformative power of transcendental reasoning is special relativity. One can hold that Einstein's ingeniosity resides precisely in the fact that he dared to give absolute priority to the *conditions of the possibility of physics*, even if this implied apparently 'unacceptable' consequences. He did not hesitate to sacrifice the conventional concepts of time and space, although they seemed to be untouchable, in favour of these abstract principles, because he deeply understood that these requirements are the true core value of physics, for without them there would be no physics at all. Hence consciously integrating them and using the transcendental presuppositions as his guide-lines Einstein *postulated,* or as he himself formulated "elevated the

24 E. Cassirer, PSF III, 492 f: "Das Erste: die Wahl […] steht uns frei - aber beim Zweiten und bei allem Folgenden sind wir Knechte."
25 I. Kant, KrV, A 328; see also KrV, A 671.
26 E. Cassirer, SFB, 423: "'Wahr' heißt uns ein Satz, nicht weil er mit einer festen Realität jenseits alles Denkens und aller Denkbarkeit übereinstimmt, sondern weil er sich im Prozeß des Denkens selbst bewährt und zu neuen fruchtbaren Folgerungen hinleitet. Seine eigentliche Rechtfertigung ist die Wirksamkeit, die er in Richtung auf die fortschreitende Vereinheitlichung entfaltet."

supposition to a presupposition"[27], that the velocity of light *should be* a constant, independently of the observational status, and that the 'principle of relativity', the claim that all inertial systems are equivalent, *should* hold. For without this demand of equality and symmetry of all observational situations, the laws of physics would no longer be the same in all domains, and thus the conditions of *unity* and *coherence* of physics could no longer be fulfilled. And Einstein reapplied the same method to arrive at general relativity. The consequence of this apparently simple demand was a revolutionary change in our world-view, able to overthrow venerable convictions about the 'nature' of time and space. Using this approach he reached a viewpoint in which formerly unconnected, independent 'substantial' theoretical items reappear as interdependent observables, as quantifiable aspects of one and the same process of determination of movement: be it time, space, energy or mass. But the fact that they thus lost the 'last rest of their status of independent objects', as Einstein himself affirmed,[28] does not in the least threaten their status of 'objectivity'. The very opposite is the case: for the newly discovered dynamic relations between them concretise, enrich and strengthen the meaning, importance and position of each of them for the whole of physical knowledge and they constitute the specific *knowledge-gain,* the new objectivation that relativity theory actually consists in. In fact, the claim of 'time', 'space', 'energy' and 'mass' to be 'rational' or 'real' can only be formulated, affirmed and justified *thanks to this 'relational', 'relative' status.*

Provokingly one can even assert that all progress in physics is nothing other than that: relativising seemingly given 'absolutes' by integrating them into a larger context and thus *'understanding'* them; for that is precisely what 'com-prehension' *is*. The 'invariants' of the old theory then appear as dependant and variable with respect to other, more fundamental conditions, now taking on their role of 'invariants'. Progress thus appears as a "deepening of the foundations"[29] as Hilbert put it, which takes place when we succeed in replacing former fix-points in favour of new, more performing, more *encompassing* ones, thus expanding the scope of explicable phenomena while concentrating at the same time the theoretical core. In reality the much dreaded or denigrated 'relativisation' is only the visible sign of a deeper level of understanding, equivalent to the discovery of further preconditions, leading to a fruitful 'relationalisation', *which expresses the very essence of 'rationalisation'*, of our fundamental endeavour to 'com-prehend'. This comprehensive progression describes precisely what the transcendental method *actually amounts to* and thus we can understand, why it is so apt to analyse the parallel abstract quest of physics.

In Cassirer's analysis relativity theory as well as quantum mechanics did not cause a crisis of physics, but rather a crisis of our habitual worldview, inscribed in most of the world's languages, and a crisis of intuition, for their results could no longer be apprehended within the unity of a unique spatio-temporal picture. But why should it? "It may be remarked that the main object of physical science is not the provision of pictures, but is the formulation of laws governing phenomena and the application of these laws to the discovery of new phenomena"[30] In accordance with Cassirer Dirac here insists, that above all we have to be aware of the *particular* objectivation-aim of physics and clearly distinguish it from external, heterogeneous demands. The impression of a crisis disappears when we clarify the epistemological situation thanks to Cassirer's antimetaphysical 'Occam's razor' par excellence: by searching the actual transcendental functions hidden behind the apparently failing forms. Thus we are able to realize that it is not intuition and imagery, which are put into question, since relativity theory as well as quantum mechanics still successfully use a multitude of images. But it is the *function of 'unity' and 'continuity'* which can no longer be fulfilled in a spatio-temporal form. Yet nothing in these abstract demands themselves obliges us to understand them in this way: that is only the form in which they appear *under the conditions of our perception*. Cassirer teaches us to observe, that 'continuity' has not been *lost* in these theories, but that it only had to be *transferred* to another, more *appropriate* theoretical location *which allows for its satisfying fulfilment in the new context.* Concerning relativity theory the 'unity' and 'uniqueness' lost on the level of the classical, individual space-time-parameters is restored through the equations of the Lorentz-Transformations, which permit a complete re-integration and transformability, taking into account the new dynamic parameter, their relative velocity. In terms

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27 A. Einstein: Zur Elektrodynamik bewegter Körper, p. 276f: "Wir wollen diese Vermutung (deren Inhalt im folgenden 'Prinzip der Relativität' genannt werden wird) zur Voraussetzung erheben."

28 Cp. E. Cassirer, ZMP, 71: "letzten Rest physikalischer Gegenständlichkeit".

29 Cp. E. Cassirer, ZMP, 179.

30 P.A.M. Dirac: Principles of Quantum Mechanics, p.10. W. Pauli defends the same point of view, see 'Raum, Zeit und Kausalität in der modernen Physik', p. 68f, 74.

of physics' symbolical tools the 'unity' has thus been *elevated* from the level of 'number' to that of 'function', of 'relation'. In terms of our understanding it has thus been elevated from the level of sense-perception to the level of thought - which is not surprising if we remember its initial goal. In the same way one can analyse the 'failure' of strictly determined individual laws, the 'failure' of continuous causal relations, the 'failure' of continuous space-time paths for particles in quantum mechanics as the expression of a new, successful adaptation and progress, now satisfying the necessary demand for 'continuity' by elevating it from the level of mere numbers describing the individual outcomes of single experiments to a higher, more abstract, more *encompassing* theoretical level: that of the Schrödinger-equation and the evolution of the probabilities for the *entire space of possible outcomes*. *Therein consists* in fact the undeniable *progress in understanding* these theories offer us, demonstrating a degree of coherence, unity, explanatory power and pragmatic success never equalled before.

A parallel analysis holds for the so-called 'Uncertainty-relations'. In spite of their name - betraying above all our 'classical' expectations and prejudices - they do not leave us in a deplorable state of uncertainty or indeterminateness, announcing the end of our search for unambiguous scientific determination. On the contrary they constitute a remarkable progress, likewise reached by revealing further conditions of objectivation. For these equations quantify with precision the very limits of possible quantification and thus of *objectifiability itself*. In this way they succeed in determining the physical core-activity of determination itself: hence they furnish us *more*, and not *less* information than classical mechanics.

In Cassirer's view even the frightening 'failure' of the key-notion of 'localised object' - which appears though as the very 'incarnation' of the scientific project and subject itself, as the guarantor of 'objectivity' as such - can be accepted and understood as a liberating achievement. Using again his transcendental 'Occam's razor' we have to determine, what is the constitutive function this notion actually fulfils? Being the prototype of all 'notions of measure' it provides the elementary reference units that fix and structure our knowledge. It thus fulfils the basic functions of stability and differentiation and serves the needs of 'identification' and 're-identification'. Moreover the 'foci' it offers can be used as support for further determinations: we ascribe 'variable qualities' to 'invariant objects'. It thus presents a specific pattern of order, conceived to grasp change conceptually, that corresponds to - and most probably stems from - the linguistic schema of 'subject and predicate'.

Now the question is, can this specific pattern of order, can this notion of 'localised object endowed with intrinsic qualities' still assure its stabilising role as an 'invariant' in the light of the quantum mechanical evidence? If we analyse whereupon exactly its use is founded, we find the basic fact, that consecutive measurements can repeat certain localised results. This has led to the assumption, that an invariant, individual 'carrier' supports these observable 'qualities'. But do we really need that particular assumption to account for the evidence? Let us investigate inhowfar the fundamental physical objects, i.e. 'elementary particles', still fulfil these epistemic requirements to be stable, differentiable, identifiable and re-identifiable. Most of them show an extremely short life-time, so the claim of 'stability' has become a matter of our own arbitrary definition of an 'appropriate time-span'. We can still differentiate one type of elementary particle from another one, e.g. a K-meson from an electron. But within a certain 'type' all particles have *identical* qualities and can no longer be differentiated from one another and a fortiori cannot be identified or re-identified by internal attributes. We can try to avoid this problem and save our 'object-idea' by applying an external differentiation-process using the space-time-coordinates of our particles and following their continuous path and history. But even if this is still working in classical mechanics, it is no longer possible in quantum mechanics, since for consecutive measurements of the conjugate variables the previous results can *not* be reproduced. That is where and why the - already weakened - concept of the 'localised, invariant object' looses its usefulness and plausibility as a stabilising invariant within this domain of experience - which does not mean that it cannot continue to fulfil other helpful functions. Would not the state-vector in Hilbert-Space be a more adequate candidate for its vacant vital post in this realm, assuring the needed stability, differentiatedness and unambiguous identifiability? As in the cases we discussed before, for Cassirer it is to be *expected* that mathematical, relational concepts will take over the role we have assigned to directly perceivable items as a 'first guess and approximation', guided by our daily habits and the elementary need to 'see' in order to 'grasp'. But just consider that - following either Bohr or Bohm, Everett or Schrödinger etc. - one can adopt very different ontological 'colourings' to understand quantum mechanics. Yet these choices do not alter the equations, nor the physical constants, nor the

symmetry-principles and conservation laws. This clearly shows that the 'basic notions' – suggesting certain ontological options - are not at all as important as the dualist-representational model tries to make us believe. Instead the true core of physical knowledge consists in these *systemic, relational* values. This fact can also be confirmed by the way in which we construe physical identity. Take visible light, tangible infrared-heat, imperceptible radio-waves and x-rays: these phenomena incompatible for the witnessing of our senses are all identified by physics as being 'the same': electromagnetical waves at different wavelengths. The postulated 'identity' is based on a complex mathematical judgement, affirming that these phenomena obey the same laws - Maxwell's equations - agree in central numerical determinations and fall under the same constant: the velocity of light. Fixing individual 'identity' is thus a complex logical achievement which can only take place thanks to the same systemic values and the holistically interrelated network of physics' symbolic system - and does not in the least give us a simple 'basis' of 'independent substances' we could start with. It is the whole that constitutes the 'elements' and not vice versa.[31]

Cassirer's functional model of the constitution of meaning can thus help us to solve the interpretational problems of modern physics:

1. By differentiating Symbolic forms according to their aim of orientation - as physics, language and the linguistically shaped perception - we can disentangle their diverging claims and admit that their respective symbolic system might *differ in any of their components* including their fix-points, without any contradiction to other Symbolic forms, each of them being perfectly valid for their respective domain.
2. By becoming aware of the actual constitutive functions of the objectivation process we can distance ourselves from its historically given forms and perceive changes on all levels as a necessary and welcome ingredient of successful and truthful objectivation.

It would thus be possible to view Cassirer's pluralistic position as a kind of 'relativity theory of knowledge' - it is not by accident that he first mentions his idea of a 'philosophy of symbolic forms' in his essay on relativity theory[32] - for his holistic model re-installs 1. the equivalence between all elements - fundament and principles - within a specific knowledge system itself and 2. the equivalence of different types of objectifying knowledge, affirming that their claim of veracity is equally justified, just as Einstein has claimed the equivalence of all possible inertial systems. There as here it is the discovery of deeper preconditions and the underlying dynamics which allows for the unifying, more encompassing view of the ancient parameters.

As a summary Cassirer shows that the objectivation of physics presupposes:

1. Symbolic reference as the primary condition which enables the physicist to constitute the differentiatedness, stability, identifiability and re-identifiability without which he would not be able to refer to 'something' as 'this phenomenon' at all
2. the choice of a particular aim which provides the direction, the driving force and the criterion for progress
3. the constitution of the symbolic means that structure and organise its specific symbolic system, fulfilling the transcendental functions of finding adequate fix-points (constitute 'basic entities'), of determining their relations and of anticipating a coherent and maximally simple unity of all components
4. the choice of quantifying experiments that will operate physics' crucial 'trans-substantiation' and can put to test the concrete questions its entire symbolic system allows to anticipate
5. the search for an equilibrium, driven and guided by the different transcendental demands of its symbolic system - determinateness, univocity, stability, coherence, simplicity, unity - satisfying the measurement results which have been objectified thanks to this entire process of constitution
6. concrete criteria for its pragmatic success and justification, given by the functional, transcendental demands of its symbolic system

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31 Cassirer has learned from Leibniz's struggle to conceptualize dynamical processes mathematically that epistemically speaking the determinateness of the 'single element' is the result of a *process of discretisation.* Therefore Cassirer no longer starts with 'basic elements', the seemingly 'simple', in order to arrive at a higher order by 'syn-thesis' as Kant does. But on the contrary he considers that it is already *part* of the open 'problem of knowledge' to arrive at the determination of something *as discrete by differentiation*. For we can only righly claim and reason logical determinateness if it is itself the product of a precise process of determination.

32 E. Cassirer, ZMP, 108-110.

Having thus made the vital, concrete role of the transcendental conditions explicit, Cassirer can liberate us from limiting beliefs, surreptitiously conveyed by language and cultural tradition, and thus set free our full potential of comprehension and objectivation. Physics shows a similar critical potential - sometimes even in spite of itself - because it uses the neutral, prejudiceless language of mathematics following its own unambiguous rules: both can thus be precious allies, leading to an ever more concrete and demystified vision of objectivation. Refining our understanding by tracing back objectivity to objectivation, form to formation and 'Gestalt' to 'Gestaltung' Cassirer completes the critical 'desubstantialisation' of our conceptual means that Kant had begun. He succeeds in fluidifying our cognitive reifications by leading us back to the living source of all knowledge: the non-rationalizable capacity to choose, to give rules, to create orders, and to fearlessly abandon the judgement about their epistemic value to time and the circumstances. Thus Cassirer's position does not only relate back each structured objectified element to its initial process of open symbolical structuring, but it also relates back abstract epistemology to the concrete situation of the 'conditio humana' and its worldliness. In this view knowledge appears as the result of a complex creative ordering process, brought forward by the anthropological need for orientation, driven by different freely chosen aims of objectivation, devising sensitive symbolical tools and order-patterns to achieve these goal and finally exposing the results of all these efforts to their relentless pragmatic testing. The human is thus characterized as an 'animal symbolicum'[33], free yet forced to forge his own understanding of himself and the world he experiences, relying on free creativity and honest pragmatism – as well as cultural tradition - to face this fact.

Interestingly enough it is precisely when we give up the hope of a 'direct grasp' of 'reality as such', of a 'final justification', and when we accept the irremediable openness of the 'conditio humana', our 'being on the way', that we gain access to a mode of understanding that offers us all we could ask for: perfect determinateness of our objectified knowledge, clarity, unlimited adaptability, testability and concrete criteria for success. Ironically it is when we humbly concentrate on our own indirect symbolic mediation and adopt a standpoint of sober immanence, that we can really enter a process of true discovery of the unknown.

It looks as if the transcendental method is the best way to fulfil the realist's dream.

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