Solution of Einstein's Causality Problem: The AHK Theorem

By

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Using terms and categories as „causality‟ or „chance‟ in scientific debates means to leave the field of physics or other natural sciences. These terms/categories are in fact philosophical terms. Even if they occur in both areas, the most general science of human thinking and in many single sciences, the meaning is sometimes completely different. This results often in superb misunderstanding, even because people are not aware when they are on the other level and have in mind completely different definitions of terms. Recently one could read in the scientific part of the most serious German newspaper „Frankfurter Allgemeine Zeitung‟ of "physics and the individual sciences". This is actually a completely wrong definition. Since when is physics the Universal Science and all other sciences individual sciences? This is obviously a special type of reductionism and hypertrophy of physics at the same time. Actually, as an example, Michael Esfeld, Professor of Philosophy of Science at the University of Lausanne, understands that physics – not presumptuously – explains even „the world‟.[1]

What are the resulting misunderstandings and how are they expressing?

The start of all those misunderstandings was that the ostensibly intimate term causality which was further used in its „old‟ meaning although the upcoming quantum physics in the beginning of 20th century was enforcing new thinking and definitions of old terms. Although required by Heisenberg and Einstein nobody was prepared to undergo such efforts to define significant terms in a new way, implementing chance into a new concept of causality.

The „old‟ meaning of causality was derived from the paradigm of mechanical determinism; according to the worldview of almost all natural scientists the connotation of "causal" stood for an exactly defined cause and an exactly foreseeable effect. Chance showing unpredictable effects was excluded. The epigone of this conception of deterministic ideology is the eminent French mathematician and astronomer of the 18th/19th century Pierre-Simon Laplace (1749-1827). The corresponding citation of Laplace on „Weltgeist‟, later called Laplace‛s Demon, is as follows:

„We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect which at a certain moment would know all forces that set nature in motion, and all positions of all items of which nature is composed, if this intellect were also vast enough to submit these data to analysis, it would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes."[2]

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[1] That means, also human society, because this is part of the world (Michael Esfeld and Christian Sachse, Kausale Strukturen. Einheit und Vielfalt in der Natur und den Naturwissenschaften, Berlin 2010, S. 2; see also M. Esfeld, Naturphilosophie als Metaphysik der Natur, Berlin 2008).

[2] Pierre-Simon Laplace, A Philosophical Essay on Probabilities, translated into English from the original French 6th ed. by Truscott,F.W. and Emory,F.L., Dover Publications, New York 1951, Introduction, p.4

Laplace's wording is subjunctive or irrealis, i.e., he by himself believed never that such knowledge of the universe could be possible. For mankind the universe is forever locked, it remains „forever infinitively remote".

In the 1920s the development of quantum mechanics enforced all natural scientists to think about the role of objective chance, because certain effects in the sphere of atoms and elementary particles could not be described without the idea of chance or randomness. In front of the prevailing mechanical *Weltbild* the idea of objective chance was unbearable, even for most of the philosophers. Beyond that, interpretation of chance without any other cause violated ostensibly the term causality because this idea was – completely unnecessarily – associated with deterministic prognosis and exact calculability.

Instead of new and consistent definition of the term causality a new demon was summoned, videlicet Maxwell's demon. The corresponding statement of one of the most important physicist and philosopher of the 19th century, James Clerk Maxwell (1831-1879) was interpreted extremely imprecise to conserve the obsolete idea of a „law of causality" in contrast to the – correct – „Principle of Causality". Differentiation into „strong" and „weak" causality was introduced to that end (nobody knows who was the first). To explain other, random effects, e.g. in the field of chaos research, the violation of causality was additionally introduced.[3] The example of the fractal geometry of the Mandelbrot sets was one of the most aesthetic forms resulting from chaotic effects.[4]

However, the so-called „classical" physics exhibits not only mechanical-deterministic movements and processes; series of random events can be identified not allowing exact prediction.[5] The following definitions were introduced:

„Strong Causality" should mean: *similar causes produce similar effects*; „Weak Causality" should occur in processes when *identical causes result in identical effects every time*.

Apart from that that Maxwell is over-interpreted, those definitions lack the logic of speech or predication. Maxwell wrote solely:

„It is a metaphysical doctrine that from the same antecedents follow the same consequents. No one can gainsay this. But it is not of much use in a world like this, in which the same antecedents never again concur, and nothing ever happens twice .... The physical axiom which has a somewhat similar aspect is 'That from like antecedents follow like consequents.' But here we have passed ... from absolute accuracy to a more or less rough approximation. There are certain classes of phenomena, as I have said, in which a small error in the data only introduces a small error in the result. Such are, among others, the larger phenomena of the Solar System, and those in which the more elementary laws in Dynamics contribute the greater part of the result. The course of events in these cases is stable. There are other classes of phenomena which are more complicated, and in which cases of instability may occur, the number of such cases increasing, in an exceedingly rapid manner, as the number of variables increases."[6]

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[3] One of the first authors, as far as I could detect, were the chaos researchers Uli Deker and Harry Thomas, Die Chaos-Theorie. Unberechenbares Spiel der Natur, Bild der Wissenschaft Heft 1, 96-75 (1983). These have read this into Maxwell. Other physicists attribute this strange idea to Max Born. However, Born has never made such a statement. Later the scheme, finally presented as a graphic, circulated in the scientific community. It can be read in University lectures, countless papers, textbooks written by philosophizing natural scientists, power point presentations, always and almost using identical wording. Apparently nobody registered that the logic of those terms is completely inconsistent.

[4] Benoît B. Mandelbrot, The Fractal Geometry of Nature, New York 1990

[5] For example Pohl's Pendulum, magnetic pendulum, coupled pendulum etc. showing completely incalculable trajectories.

[6] J.C. Maxwell, Matter and motion, London 1920; cited from Brian R. Hunt and James A. Yorke, Maxwell on Chaos, Non-linear Science today, Springer, Vol. 3 No. 1, 1993, pp. 1-4.

Maxwell imagined clearly that the same causes resulting in same effects could never be realized and that this idea can be referred into metaphysics. So, he anticipated brilliantly the theory of irreversibility of all real processes. Even more important is the consequence that there is obviously no „weak causality" (same cause – same effect). **If this is not existent it could not be violated.**

Nevertheless violations of both types of causality were introduced to explain the particular effects in quantum world; nobody intended to define the term causality in a new and finally correct way.

What was going wrong? If causality is a principle and not a law it cannot be violated, because otherwise it would never be a principle, i.e. highest and basic precept. Causality should be treated like an axiom; it could never be demonstrated by any natural science.[7]

Now „objective chance" must be explained in the light of a consistent theory of causality. It is well-known that Einstein struggled with its existence and wanted to hold determinism, whereas quantum physicists came hard to declare random events as causal processes. Unfortunately they didn't read Hegel and therefore no idea of a dialectical contradiction. Tentatively many natural scientists introduced therefore somewhat like „probabilistic" causality, an illogical term presenting 'contradictio in adjectu'. Heisenberg, for example, often spoke of causality, but he meant predictions, i.e., he was still captured in the „old" definition.[8] However, he was so clever to avoid terms like „statistical" or „probabilistic" causality.

How can we solve this dilemma?

At first we have to define causal reactions (in contrast to correlations) and when under what circumstances random effects occur.

Causal reactions must be connected substantively and timely and start and completion must be sufficiently known. In case of a reaction chain with numerous single reactions it is only possible to determine causality between defined single reactions. Causality between start and end of such a chain cannot be determined because a lot of random events or reactions could be in between and cannot be influenced by antecedent causes. This is the main argument against the co-called butterfly-effect: the butterfly can only influence and control its direct environment causally and in most of the cases nothing further happens. Only if the effect is escalating further consequences can occur, showing a certain probability. This probability has absolutely nothing to do with the start situation. Every particular reaction within the chain, from one link to the next, is nevertheless causally conditioned (Fig. 1).

Exactly the same holds true for chance, for random events. Those events can only occur at an exactly defined, real point of the (imagined) reaction chain. Random event is, however, not „acausal". There is no „acausality" in real world, known for us, otherwise the principle of causality would again be violated. The result of a random reaction is unforeseeable, but not arbitrarily. It should be prohibited to speak about 'absolute chance'. There is no 'absolute chance' in the sense of capriciousness.

I assume that Einstein's unwillingness to acknowledge objective randomness could be traced back to this misunderstanding of the role of „objective chance".

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[7] Also a law knows no exceptions; otherwise it would be no law. Only rules could show exceptions. As first approximation one may define: laws are rules without exceptions.

[8] Werner Heisenberg, Der Teil und das Ganze – Gespräche im Umkreis der Atomphysik, München 1981, especially section „10. Quantenmechanik und Kantsche Philosophie", pp. 141.

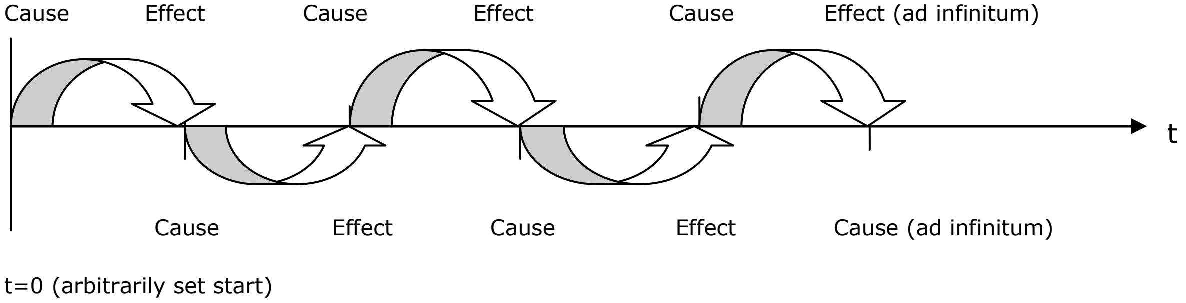

Fig. 1 Cause-effect chain (t = time). As already noted by Hegel an effect is always a cause at the same time with respect to the next reaction in the chain. Start of the chain is arbitrarily selected (t = 0). Time axis is simplified as mathematical line; in reality it should be three-dimensional in the sense of dendritic time logic. However, this could not be presented in two-dimensional plain.

Physicists differentiate between the terms „reaction" and „event": „A process the result of which is only dependent by chance is called *Random Experiment* and possible results of a random experiment is called *Events*."[9] Effects of deterministic experiments where we know the results sufficiently (i.e., showing only small or smallest errors playing no significant role in human practice) will be called consequently *Reactions*.

Now we can solve the secret of objective chance maintain the principle of causality. Only then terms and categories are logically and philosophically consistent. There is no more indissoluble contradiction between physics and philosophy.

We take the favorite example of all physicists with which they appreciate to putatively demonstrate the powerlessness of the principle of causality again and again: radioactive decay. Einstein was immoderately confused that the electron breaking out of a metal foil under high vacuum and UV radiation (photoelectric effect; Hallwachs effect[10]) should determine time and direction by itself (exactly randomly). But this was an anthropomorphic misunderstanding, Nobel price doesn't help.

Today most of the physicists are perturbed by the effect radioactivity of certain elements that nobody knows which atom is the first to decompose and – again – in which direction the impulse is channeling the decomposed parts. But, this is not the right question to derive the law of radioactive decay, because:

1. It is an irreversible process;
2. In every renewed trial another atom is tunneling and decomposing at first, and
3. The point of time for the first decomposing event is always different.

Because of those reasons nobody must know the atomic details; atoms of one class are undistinguishable, even elementary particles. Experiments cannot be repeated exactly.

The real cause (and therefore correct explanation) for radioactive decay is the instability of that defined atom. *This* is the reason why it decays. The law of decay is, however,

[9] Habbo Hait Heinze, Die Permanente im thermodynamischen Viel-Bosonen-Pfadintegral sowie die Bestimmung von Phasenübergängen aus experimentellen Streuspektren atomarer Cluster, Diplomarbeit an der Carl von Ossietzky-Universität Oldenburg, Oldenburg 1998, p. 85 (translation by author). Results of a random experiment which was defined with the aid of abstract set, i.e. the *Set of Elementary Events* within a factual *Sample Room* or *Event Room* is the basis of Monte-Carlo calculation procedures. This could not be explained here in detail. Monte–Carlo calculations are used in general to simulate abstract mathematical random experiments numerically. Monte-Carlo procedures play also an important role in quantum chemical calculations of molecular electron structures using *ab-initio* procedures supposedly dispensing with empirical parameters (see, for example, Enrico Clementi, Ab initio computations in atoms and molecules, IBM Journal of Research and Development 44, 228-245 [2000]).

[10] Wilhelm Hallwachs, an ancestor of my step-father, was the assistant of Heinrich Hertz and continued his experimental work on the photoelectric effect (Hallwachs, W. [1907] "Über die lichtelektrische Ermüdung", Annalen der Physik 328 (8): 459–516).

deduced from reactions of a huge collective of decaying atoms. This can only be measured: decay of first-order kinetics showing the geometrical form of an e-function with negative exponent. Half-life and all other parameters of the reaction can be calculated. No other parameters must be known quantitatively for any practical application to construct atomic bombs, nuclear plants or atomic submarine.

We learn: by chance means precisely there is a lack of knowledge with respect to some particular processes regarding elements of an entire collective showing a total and probabilistic process; however, such particular processes, trajectories of elements, cannot be foreseen and therefore they are completely unnecessary to know exactly because they are irreproducible. They are inappropriate to determine parameters of laws. Nothing happens 'acausal', without any reason. We propose to use preferably the term "explanation" in those cases as James Woodward and others discuss it.[11]

The *philosophical* solution of the problem – what is the cause for chance – is as follows: there is no antecedent event on the axis of time, chance is occurring directly, instantaneously. That means, in that case cause and effect are synchronizing at t=0.

The principle of causality is retained; in other words **chance is its own cause** (Fig. 2).

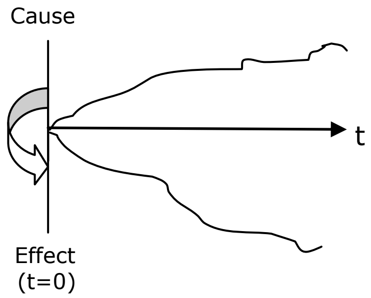

Fig. 2 Chance as cause and effect identically. There is no other cause for chance before t=0 on the time axis. Possible „products" of the random event are conventionalized.

As already Aristotle[12] and approximately 2000 years later Hegel[13] had preformulated this idea, I call that approach Aristotle-Hegel-Kaiser Theorem, or shortly AHK Theorem.[14]

[11] James Woodward, Making Things Happen. A Theory of Causal Explanation, Oxford University Press: Oxford 2003; J. Woodward, "Scientific Explanation", The Stanford Encyclopedia of Philosophy (Winter 2011 Edition), Edward N. Zalta (ed.), URL = http://plato.stanford.edu/archives/win2011/entries/scientific-explanation/; Juda Pearl, Causality. Models, Reasoning, and Inference, Cambridge University Press: New York 2000; Joseph Keim Campbell, Michael O'Rourke, and Harry Silverstein (Eds.) Causation and Explanation, MIT Press, Massachusetts 2007.

[12] Aristoteles, Physics. Lecture on Nature. Greek-German, ed. by Hans Günther Zekl, Vol.: Book I–IV. Meiner: Hamburg 1986, Book II, Capitel 4 and 5. See also the excellent interpretation by Helene Weiss, Kausalität und Zufall in der Philosophie des Aristoteles, Wissenschaftliche Buchgesellschaft: Darmstadt 1967.

[13] Georg Wilhelm Friedrich Hegel, Wissenschaft der Logik, Erster Teil. Die objektive Logik. Erster Band. Die Lehre vom Sein (1832). According to the text of GW, Bd. 21 newly edited by Hans-Jürgen Gawoll with an introduction of Friedrich Hogemann and Walter Jaeschke. PhB 385. 2nd improved Edition, Meiner: Hamburg 2008 (in German). The entire text can also be found in Gutenberg-Project in the Internet.

[14] I owe the suggestion to introduce this term Hans Fogedby, retired Prof. of Statistical Physics at the University of Århus, Denmark.