Commentary 05 on
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Review of 'PHYSICS FROM FISHER INFORMATION'
By Chris Nunn

INFORMATION, PHYSICS AND ANIMAL SUBJECTIVISM

by Paul Jones

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Unfortunately, I haven't read Frieden's book, and I doubt I could ever get it. Nevertheless, I feel that I have right to discuss its contents, because it is not novel to me, and I read all that before, in a different edition. As far as I can judge, Frieden reproduces, with minor differences, the results obtained by Italian physicist E. R. Caianiello, who worked on the same problem since early 50s [1]. It is up to historians of science to trace the relations between Frieden and Caianiello – they are not relevant to the theme of this commentary. Personally, I have nothing against plagiarism, provided it serves to bring something valuable to as many people as possible [2].

Attempts to somehow employ the notion of information in physics are older than the very term "information". A historical review in [3] traces them down to 1867 – though I recall Hegel saying something of the kind, and the ancient Pythagorean school could be readily associated that line. However, one can rarely find a scientific work that would recourse to information in order to solve a physical problem proper (as in [4]) – most likely, such works would deal with philosophy rather than physics, trying to play on term indeterminacy to advocate some kind of philosophical idealism.

One popular direction ascends to L. Szillard (1929) [5] trying to find a direct correspondence between information and energy. The corner stone of this approach, Landauer's principle [6], has been discussed in tons of papers and books, as if it were something well established and experimentally proven. Many scientists have been seduced by the apparent simplicity of such a correspondence, and there have been numerous attempts to refine theory to accommodate information along with the other thermodynamic quantities. However, no significant progress has been made, except designing numerous sophisticated constructions designed to explain a number of mental experiments. Modern thermodynamics can do well without information, as it seems. It has entropy already, and another quantity of the same kind would be excessive.

Ideas of a different scope originate from the universality of variational principles in physics. Physicists are accustomed to think that all kinds of equations of motion should be derivable from action minimization, with appropriate action functional. This approach is closely related to universal geometrization, since the value of action functional can be treated as curve length in a space of a certain kind. Fischer metric [7], obtained from the functional of cross-entropy, which is also called information, can be used to construct action functionals like any other metric, and, choosing an appropriate form of the density that enters the definition of Fischer metric, one can obtain almost any result. This is how all physics gets derived from Fischer information in Caianiello's and Frieden's works.

It should be stressed that variational derivations are little sensitive to the exact form of the action functional used, and the same equations of motion can be obtained from quite different variational considerations [8]. Even with the same Lagrangian approach, all Lagrangians differing by the full derivative of any function of coordinates and momenta produce the same equations of motion; also, a Lagrangian can be multiplied by the full derivative of any function vanishing on the boundary, without changing the equations of motion obtained – this essential arbitrariness is often used to express the variational principle in a simpler way [9]. One can easily comprehend it, recalling that there can be uncountably many functions on the interval $[a, b]$ possessing minimum in a fixed point x

between *a* and *b* – the more so for functionals taking their minimum on a certain function class.

The two ways of introducing information in physics are not entirely uncorrelated. Thus, since Lagrangians can be represented as the difference of kinetic and potential energy, one can employ proportionality of energy and information to obtain the same Lagrangian as the difference of "actual" and "potential" information, like in the Frieden's case.

Astonishingly, why many people tend to associate inequalities of the Kramer-Rao type with quantization. The famous Heisenberg relations of quantum mechanics are merely a special case of a general principle valid for any wave motion, and, in particular, applicable to acoustic waves, tension waves, gravitational waves on water surface etc., which are all classical, as well as classical optics, which used such relations for centuries, and which lent them to quantum physics as a kind of metaphor. The appearance of such limiting inequalities in measurement theory is also quite natural, and one can develop an entirely physical interpretation involving no characteristics of the observer other than physical [10].

It is quite admissible that people try various conceptualizations and get engaged in intellectual play of any sort. However, a sound person will always distinguish such play from what can be actually done in the world, and it is in application to practical problems that formal constructions become justified. As long as Landauer, Caianiello or Frieden speak about just another approach to theorizing in physics, this is a physical study like any other, and it certainly has right to exist. The development of physics will show which parts of these conceptual constructions can be used to describe physical systems, and what in them is not feasible enough. It is also quite natural that, in the first (syncretic) phase of its development, any physical theory has to seek for substantiation other than that provided by applications, and new directions of research are bound to be guided by philosophy. One could only regret that this is not always a philosophy of a better sort – and it is shame for the society that makes scientists advertise their results by ascribing them an inappropriate philosophical background just because such a philosophy is more socially acceptable. Definitely, is Frieden had not felt that presenting the human mind as the source of reality would promote his theory better, he would have well done without any conscious observer, staying within the objective framework he was used to in his image recognition studies.

As D. Lindley has clearly expressed it [11], all physical problems can be solved using physical means, and there is no physical situation that would require conscious intervention being included in the description. Any recourse to the mind of the observer drives consideration out of physics to some other science, or philosophy. One could consider the apparently physical influence of a distant star on the course of a ship, mediated by a human navigator – however, such a consideration would refer to the interaction of different levels of material motion, rather than be restricted to the physical level only; physics can be engaged on the extremes of the mediation chain, in explaining the positions of stellar bodies and light propagation, or the mechanics of rudder declination – physics has nothing to do with the people's intention to move in a preferred direction. One could trace the influence of physics on mentality, rather than the other way round. Trying to derive physics from consciousness is like to assert that the motion of the centre of mass of the system of two bodies is the cause of their individual motion. That is what M. Szirko characterized as putting the cart before the horse [12].

As for the ways of subjectivist re-interpretation of physical theories, one could find term substitution to be a basic mechanism. Physicists (and other scientists) use many common words in a terminological meaning, which can be entirely different from their meaning in the ordinary language. Thus, it would be naive to literally understand such physical terms as flavor, color, spirality, frame etc. The same care should be exercised about such terms as force, energy, entropy, signal etc. I admit that it might be difficult to always remember that the words like space, time, particle, interaction, measurement, observation etc. can only be physically meaningful within certain physical theories, having little in common with the everyday word usage. Also, information, as it may enter a physical theory, will have a meaning different from that of other sciences, or philosophy, or ordinary language. The persistent prejudice that the content of a message may be "measured" with the quantity of information as defined in systems theory is due to illegal term identification; some handbooks on

mathematical information theory clearly indicate that they deal with a specific quantity that does not have all the connotations of the ordinary word [13; 14, ch.5]. It should also be noted that the well-known Shannon information (or Fisher information related to it) is only one of the many measures of uncertainty, indeterminacy, nonspecificity, fuzziness etc. [14]. One has to be careful in applying one of those measures to a problem of a certain level (physical, biological, social), selecting a measure that would adequately describe the system under consideration. Beside the quantitative measures, there are also various qualitative aspects of information [15], and one could also consider creative communication, which can in no way be described by the parameters of the physical signal [16].

When a physicist speaks of an observer, no human observer is meant – the term is a mere abbreviation for a certain physical situation, when a number of physical bodies can reflect the motion of the system "observed" without too much perturbation in their own motion. The meaning of "too much" depends on the level of description. A heavy particle, or a plasma cell, can be an "observer" of an electron as readily as a human being, from the physical standpoint. The act of "observation" can be specified in purely physical terms, without any recourse to consciousness. It is only poor philosophers who identify this metaphorical usage of the word with a reference to a conscious being – on the same grounds, one might claim Maxwell's demon to be a kind of human being, with superhuman capabilities! No need to repeat the same for "measurement", or "information".

Originally, all the words are anthropocentric, and the ability to overcome this innate anthropocentrism is one of the greatest achievements of science. One has to go beyond mere experiences to get knowledge, and the socialization of the ways of handling external things is the only instrument for that. An idealist may be convinced that he/she produces anything (whatever it can be: a car, a painting, a scientific theory or philosophical treatise) merely for amusement, without any thought of the others – this is either lie or delusion, since *everything* people do is designed to be used by other people (which may or may not include the author), and this is what distinguishes humans from most animals, who can do something for the other, but only in certain cases, not universally. Well, one can lose that universal social orientation of activity – this would mean the loss of consciousness and reason as well, degrading to the animal state. Unfortunately, in a poorly organized society, many people get compelled to behave that way, competing with each other and robbing each other of the human appearance. This is the worst kind of violence, since it kills the spirit, the very ability to be human.

Subjectivistically minded people are like animals, their minds are too weak to penetrate the barrier of their immediate experience, and eventually they refuse to try. For an animal, everything occurring between the animal's action and the sensory input is absolutely irrelevant, since the animal's "mind" is centered on the animal itself, its well-being and sensory ease. The same holds for certain sorts of people, regretfully.

Experimental study of animal conditioning has shown that there is a phenomenon called hyper-generalization: when an animal has a positive experience, it tends to associate it with the current situation in a syncretic way, including its both relevant and irrelevant aspects. It is much later, with repeating instances of confirmation and discourage, that the animal learns to recognize the relevant stimuli among the rest of experiences. Thus, a cat who has caught a mouse in the corner will look for a mouse in the same corner for quite a while, though there may be no trace of the mice frequenting the place.

When Frieden (and the army of subjectivist philosophers) argues that, since all we measure in a physical experiment is a response to the act of measurement, all Nature may be nothing but a response to some conscious act, they employ the same syncretic reasoning – and shy materialists like Nunn have to invent something like time loops to avoid the ghost of god arising as a response to such an inadequate generalization… A scientist (and every layman) understands that any experimenting makes sense only if the experiment triggers some natural process in the same way as it gets triggered in industry, or in natural circumstances – otherwise, the experiment would be justly criticized as improperly staged. The ability to analyze what occurs between one's action and the environment's response to that action is a distinctive feature of humans as conscious beings.

The logical analogue of hyper-generalization could be illustrated by the following examples:

> Theorem: The sine is an even function.
> Proof: Indeed, $\sin(\pi)=\sin(-\pi)$; consequently, the sine is even.
>
> Theorem: All the odd integers are primes.
> Proof: 1 is a prime, 3 is a prime, 5 is a prime, 7 is a prime… Obviously, every odd integer is a prime.
>
> Women: All men are villains, 'cause I knew one…
>
> Men: All women are stinkers…
>
> Philosophers: Anything I observe is certainly my observation. Consequently, anything in the world is nothing but my observation.

This scheme is known as empirical induction, and it may be useful to generate hypotheses, but it certainly cannot be used in an argument.

To summarize:

> There is nothing wrong in that Caianiello, Frieden, or anybody else tries to employ the notion of information (or, rather, one of the possible formalizations) in physics. Physical theories are flexible, and they allow various interpretations, some of which may be more suitable than the others.
>
> Any attempts to introduce information in physics must be consistent with the physical methodology, and they should not refer to consciousness (or any other phenomena of a different level) to explain the dynamics of a physical system.
>
> The attempts to interpret physical results in a subjectivist way have nothing to do with physics, and, in general, they are politically prompted.
>
> The logic of subjectivism is nothing but reduction of conscious reasoning to the primitive forms similar to those observable in higher animals.

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http://unism.narod.ru/kjf/index.htm
unism@ya.ru