On Colloquy Between Radically Disparate World-Views and the Role of Simultaneity and Causality

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Abstract— Recently Zangari and Censor [1997], (see also a critique by Gaudiano [1997]), and Censor [2000], discussed the non-uniqueness of the spatiotemporal world-view, and proposed a representative alternative based on the Fourier transformation as a mathematical model. It was argued that this so called spectral representation, by virtue of the invertibility of the Fourier transformation, is fully equivalent to our conventional spatiotemporal world-view, although in the two systems the information is ordered in a radically different manner.

Criticism concerning the validity of this conception is essentially traceable to the question of communication between these disparate world-viewers, and the role of simultaneity, and causality (or more generally their special-relativistic spatiotemporal generalizations—coincidency, and compellency, respectively) in this dual world-view context.

This forum will be used to give a general overview and amplify on certain specific points.

Introduction

In our first study [Zangari and Censor, 1997] we suggested a radically disparate world-view (this slippery term will be explained below) based on the Fourier transformation as the fundamental mathematical tool. The advantage of doing so is based on the invertibility of the transformation, i.e., data, or events f(X) presented in the spatiotemporal domain {X}, as a function of spatiotemporal locales X (quadruplets of coordinates and time
(x, y, z, ict) in Minkowski's space) can be transformed into an associated data set F(K) in the spectral domain {K}, depending on locales K, comprising quadruplets of appropriate coordinates in the {K} domain, see [Censor, 1997]. Due to invertibility, the inverse transformation from {K} to {X} applied to F(K), yields back the original data f(X).

The Fourier transformation has the advantage of being relevant to biological, physiological, and biomedical models used in connection with animal perception mechanisms, which is helpful in pointing out that to some extent we already are "spectral animals", e.g., in the way our auditory sense performs. It also encompasses optical diffraction phenomena, providing an example for "spectral vision as given below. However, the decisive feature for using the Fourier transformation is that it is not a simple 1:1 mapping of each event f(X) for a specific locale X to its counterpart F(K) involving a specific K: In the Fourier transformation *each* event in the {X} domain is mapped onto *all* locales in the {K} domain, and *vice-versa*, with appropriate weights prescribed by the transformation formula. Thus in the spectral domain individual spatiotemporal events cannot be discussed—they became smeared out all over the {K} domain. Therefore space and time as we know them in the spatiotemporal {X} domain do not exist in {K} domain. An intelligent being whose world-view is spectral gleans from reality (whatever the ontic "real reality" might be) the same amount of information that we, spatiotemporal intelligent beings glean in {X}, but ordered, or coded, in a different manner.

It was Kant's contention that it is the representation that makes the object possible rather than the object that makes the representation possible. This "Copernican Revolution" idea is sometimes considered as his most original contribution to philosophy. The idea that what we perceive is not necessarily ontic is by now prevalent, e.g., see Bohm [1980]. But Kant (and nobody as far as we are aware of) has proposed an example of a radically disparate world-view which might replace our familiar space-time paradigm. Consequently the question of language and discourse never came up in this context.

Alas, the transformation itself, which provides the mediating "dictionary" between the two world-views, is neither here nor there, or you could say both here and there. Can colloquy between the two disparate world-views even be contemplated? How then can concepts like simultaneity and causality be discussed across the disparate world-view abyss if on the spectral side time and space *per se* do not exist? Surely without assuming discourse between the two, the whole argument becomes idle.

Once we settle this conundrum, we will have to consider the dialog between the two world-viewers. How can concepts as simultaneity and causality, so deeply rooted in our spatiotemporal world-view, be discussed with the spectral world-viewer? To that end, simple experiments conducted in {X} are devised to investigate their footprints in {K}.

Can Colloquy Between {X} and {K} World-Viewers Exist At All?

In his charming sci-fi novel "The Black Cloud" the celebrated astronomer Fred Hoyle describes an extraterrestrial intelligent being establishing communication with humans. Inasmuch as a common language must be established before a dialog is feasible, the process is started by sending the Cloud a classical music broadcast, assuming this will be recognized as a mark of high intelligence. To everybody's relief and delight, the Cloud learns English and the dialog is on its way.

The voyager deep space craft carried messages in the form of pictures and tapes from earth, which were supposed to be understood by intelligent beings.

In both cases there is a tacit anthropocentric assumption that intelligent beings always have a spatiotemporal, i.e., {X} domain, world-view. Unless at least one consistent example of a disparate world-view is given, this attitude cannot be changed.

We try to make a distinction between simply *versus* radically disparate world-views. This verbal labeling is not an exact statement, but it becomes clear by the mapping we described and the mathematical example given. Simply differing world-views are characterized by a 1:1 mapping between events in the two domains. An oversimplified example is provided by a word-processor whose key labels are permuted. You press the "A" key, and on the screen appears an "U", etc. Even if such a scheme is difficult to adjust to, nevertheless we can comprehend how long practice will enable somebody to learn to use this keyboard to screen-output desired text. When talking about time, this simple mapping would correspond to say using a calendar with a different structure. E.g., Moslem Hijra-, or Hebrew Creation-, Calendar instead of the Common A.D. one. Time is still time, and days are still days, and this is not a radically disparate world-view.

On the other hand, in a radically disparate world-view paradigm, even space and time, terms originating in the {X} domain, become meaningless in the {K} domain. At this point the common language idea is met by a formidable opposition: if we, the {X} domain residents, utter something lastingfor a few seconds, these events will be completely smeared throughout the entire {K} spectral domain. The {K} philosopher will have to scan his whole universe to capture our message. Conversely, a spectrally limited message coming from the {K} domain to our {X} cognizance, will be smeared throughout all space and all time, from minus infinity to eternity. Ergo, communication between these disparate world-views is impossible! Being empirical realists, we must discard such ideas for which even *gedanken* experiments are unattainable in a fundamentally consistent way!

It turns out that this conundrum is a classical problem of signals and spectra, known to every engineer dealing with signal theory, e.g., in Radar technology. Also it acquired its fame in the quantum theoretical context as the Heisenberg's Uncertainty Principle: the more accurately the position of a particle is defined, the greater the uncertainty regarding the determination of its velocity (or more accurately— its momentum) becomes, and *vice-versa*. *Ditto* other pairs of parameters, e.g., time and energy. This characteristics follows as a fundamental mathematical property of the Fourier Transformation, regarding the localization of data in one domain and how the corresponding data is broadened in the other domain.

There are many examples of signals and spectra that are, accurately or approximately, limited in extent in both domains. For our purposes this means that the "pure" (exact) mathematical foue-dimensional spatiotemporal and spectral Fourier transform pairs f(X), F(K), respectively, are only an idealization. Practical approximations will allow truncation of data in both domains, still preserving most of the essential information. An example is our ear, which is a spectral organ. It acts in fact like an inverse flute: While in a flute stopping certain holes, to vary the air pressure there, produces the desired pitch acoustical time signal, in the cochlea of the inner ear, the pressure exerted on the hair cells of the basilar membrane produces the nervous sensation perceived as sound, with its associated spectrum. Although the basic model for understanding the relation of time signals and frequency spectra is the Fourier Transformation, in our perception both the time signals and the associated spectra involved are of finite extent (usually referred to as band limited). The ideal mathematical theory of the Fourier transformation has to yield to approximations in order to make perception feasible. In the context of hearing, the mathematical idealization of the Fourier transformation would prescribe that in order to tune a violin, we have to listen to it for an infinite time. Of course, in real life we have to resort to approximations if we wish to listen to Beethoven's violin concerto.

We will therefore conclude that the {X} and {K} domains philosophers can indeed forge a common language, with band limited signals in both domains. It might be perceived differently on both sides of the world-view chasm, but it still facilitates communication.

Our philosophers are now ready to carry out dialogs about some basic metaphysical ideas.

Tracing the Footprints of Spatiotemporal Processes Into the Spectral Domain

Assuming that the {X} and {K} domains philosophers can communicate does not imply that basic metaphysical concepts can be related. We are familiar with the basic idea of simultaneity (in its simple form of "events occurring at the same time instance"), but how can you explain the concept to somebody for which time as we know it does not exist? Indeed, for us who hold a spatiotemporal world-view, how is it possible to conceive a worldview in which time does not exist?

In the wake of our work [Zangari and Censor, 1997], many questions have been raised by students and colleagues, including the commentary by Gaudiano [1997], whose very title "Being in the right place at the right time" negating a world-view without spatiotemporal properties, points to the problematics: It appears that the doubts and uneasiness with the new conception can be traced back to the fundamental principles of simultaneity and causality, and that we failed in clearly demonstrating how these are displayed in the spectral domain. One way of pinning us down was to ask how the spectral beings perceives simultaneity, and causality, or sometimes birth and death, in a world-view where time and space do not explicitly exist. It must be emphasized that when we talk about causality, we merely address sequential events that *might* be related in a causal way.

Essentially, dealing with this issue of investigating the footprints of spatiotemporal processes as they are perceived in the spectral domain, was the main theme of the subsequent article [Censor, 1997]. As in many other cases, it turned out that the key to the answer is the adequate formulation of the question. The meaningful strategy implemented there was to assume certain spatiotemporal situations, and then consider the outcome in the spectral domain. For example, it was shown that if a temporal sequence of events, which can be assumed to be causal, is flipped over in time, reversing the order of cause and effect, the spectrum will become a mirror image of the original in the spectral domain. Thus the claim that the spectral transformations are invertible, and no information loss is incurred in the spectral world-view, is vindicated: there is something similar in {K} corresponding to a time sequence in {X}. Similarly for simultaneity: if we first have two simultaneous events and then the simultaneity is violated, it is shown that there will be different spectra involved in the {K} domain. We can imagine the {X} philosopher saying: "I have invoked two processes f(t) and g(t) at the same instant t. Mr. K., if you please, make a note of the event (spectrum) you are observing. Now I will delay one process by time interval T, i.e., I am invoking f(t) and g(t+T). Observe the changes please. This corresponds to a violation of simultaneity in my spatiotemporal world-view".

The mathematics involved, in terms of the Fourier transformation, exhibits the so called "shift theorem" associated with the Fourier transformation, another well-known phenomenon with which applied scientists and engineers are familiar.

Similarly, when talking about causality (in the very limited sense defined above, i.e., two sequential events), we invoke two events which are sequential in the {X} domain. Then we change the locales of the two events, so that the earlier one now becomes the later and *vice-versa*. It is shown [Censor, 1997] that this processes yield mirror images spectra, and thus there is something conceptual that can be communicated across the disparate world-views chasm.

Simple, but concise examples are displayed in [Censor, 1997], verbally and graphically clarifying the mathematical ideas involved. The reader should refer to the article in order to avoid the situation where verbal oversimplification like we use here ends up in losing any vestiges of rigorousness.

Spatiotemporal Simultaneity and Causality

At a first glance, simultaneity in the spatiotemporal domain, as we are accustomed to it , seems to be a straightforward concept, simply describing events occurring "at the same time". Unless the events are co-locational, we need synchronized clocks to check time and determine simultaneity. Einstein [1905, 1916], see also [Bohm, 1965] first realized that we are actually dealing with a much more complicated concept: simultaneity involves both time and space. This is already applicable for non-co-locational events in a single inertial frame of reference, let alone when we deal with relatively moving frames. Therefore we refer to simultaneity in the broader context [Censor, 1997] as *coincidency*.

Recall we have reduced the question of causality here to the temporal succession of events. In the Special-Relativistic context we are once again confronted with a more complicated situation that is innately spatiotemporal, not solely temporal. As with simultaneity, the situation is more complicated when inertial frames of reference in relative motion are involved. For want of a generalized term the word *complellency* has been coined [Censor, 1997].

Spectral Domain Coincidency and Compellency

The scheme carried through for simple simultaneity and causality as temporal phenomena, was repeated [Censor, 1997] for the full four-fold dimensionality of the {X} and {K} domains. This time a four-dimensional Fouier Transformation was used for the four-dimensional Minkowski space involved.

The footprints of spatiotemporal coincidency in the spectral domain have been discussed. Once again, non-coincedency is detectable in the {K} domain by the modification of the spectrum, with a four-dimensional version of the shift factor theorem typical to spectra of time delayed signals.

Also compellency yields the same footprints when the spectra due to f(X1) and f(X2) are compared with the spectra due to f(-X1), f(-X2), i.e., when the spatiotemporal order of the events is reversed. The footprint of compellency in the {K} domain is demonstrated by the appearance of a new four-dimensional spectrum, symmetric with respect to the origin of coordinates. Relevant graphical examples are provided too [Bohm, 1980].

The analysis was performed in a single inertial frame of reference and then extended to relatively moving inertial frames of reference.

Diffraction At Your Fingertips

People not well versed in the mathematics involved in the above arguments, often ask for a simple tangible example, like: if we had "spectral vision", what would we see?

Providing such an oversimplified example is easily achieved. Hold your index finger and thumb parallel and close to your eye, against a bright background. Squint at the gap between the fingers and close the gap slowly, almost completely, but not quite. You start to see parallel bands of bright and dark bands as in Fig. 1 below.

You are looking at the diffraction pattern, which is, loosely speaking, a Fourier transformation of the gap image (more accurately, you are looking at the absolute value of the transformation, i.e., $|(1/x)\sin(x)|$, usually referred to in the signal theory jargon as the absolute value of the "sinc" function).

The argument whether such blurred images (for the human spatiotemporal world-view observer that we are) are inferior or superior in comparison with the geometrical- (also called ray-) optics images that we usually see, is irrelevant. What is important is that the two representations within the Fourier Transformation context are equivalent and invertible. Actually there are situations where the diffraction pattern looks simpler than the original object, i.e., seems to be less intricate, than the original scene.

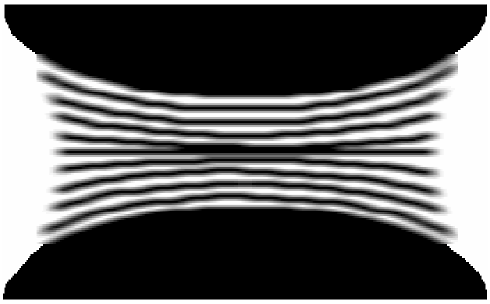

Fig. 1

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