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THREE REMARKS ON THE POSSIBILITY OF MODIFICATION OF CAUSALITY IN THE TIME DOMAIN BETWEEN FUTURE AND PAST

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KOLM MÄRKUST PÕHJUSLIKKUSE MUUTMISE VÕIMALIKKUSEST TULEVIKKU MINEVIKUST ERALDAVAS AJAVAHEMIKUS. Karl K. REBANE

ТРИ ЗАМЕЧАНИЯ К ВОЗМОЖНОСТИ МОДИФИКАЦИИ ПРИЧИННОСТИ В ПРОМЕЖУТКЕ ВРЕМЕНИ МЕЖДУ БУДУЩИМ И ПРОШЛЫМ. Карл К. РЕБАНЕ

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In [1] I supposed that the present has a specific position in the sequence of events. The present should be considered as a stripe of time which transforms the possibilities of the future into the facts of the past. The latter are not the consequences exclusively of the *causally* linked chains of events, but a certain (and an important) extent are formed also by the free will (FW) actions. If so, the causality can not have absolute power over the events taking place in the present – some space for FW actions should be left. FW actually means the ability of a human being (living creature) to control her (his) body [2]. FW is confined to the present.

This situation should not be ignored by physics. If FW is an objectively existing phenomenon (I am convinced that it is. After all this attitude is the simplest but not oversimplified attitude towards FW, i. e. the traditionally best acceptable one for physics), no theory of physics can convince us that FW is impossible. The present-day reality seems to hold the view that physics has put and successfully kept the problems of FW out and far away from the field of its considerations. [1] contains some hints on the existence of examples showing that some of theoretical treatments really

do not deal with the time-domain of the present properly. The aim of this paper is to present, as one more example, a recent experiment [3] (which was not yet completed when [1] was being written) in time-and-space-domain holography (TSH) demonstrating the exclusive status of the present, and make a short remark on dispersion relations.

1. Persistent spectral hole burning (PSHB) in organic dye-polymer systems with very broad inhomogeneous bands enables one to record full TSH scenes of ultrafast events with subpicosecond time resolution [4,5].

The special property of TSH is the fact that it observes and comprises causality and thus stores and enables one to play back the "arrow of time", i. e. the causal order of events [6,7]. If the zero point on the time axis is established by applying a very short reference pulse, then the amplitude of the object scene, which belongs to the time after the reference pulse (the "past") creates a hologram with a different phase and diffraction direction as compared to the hologram belonging to the object scene amplitude arriving at the recording medium before the reference pulse (the "future") does.

If the spatial dimension of the hologram exceeds the coherence length of the light manyfold and the reference pulse is short enough in time, then, by directing the reference and objective pulses onto the PSHB screen under a certain angle to each other it is possible to create a situation where one spatial region of the hologram represents the "past", while the other spatial region of the same image belongs to the "future". Between these regions there is a stripe which corresponds to the zero delay between the reference and object pulses, i.e. between the "past" and "future", and which the authors of [3] call "time-edge". The TSH phenomena in the "time-edge" are studied with femtosecond pulses. More about the experiment and its results can be found in [3]. The main conclusion of the study is that the diffraction properties of the TSH holograms around $t = 0$ are essentially different from those for the past and future domains. In particular, a diffraction pattern of intensities occurs similar to the conventional diffraction picture obtained from an opaque half-plane with a sharp cut-off edge. The diffraction pattern occurs here only because of the time arrow or, in other words, because of the causality properties of the time response are essentially modified for the time domain around $t = 0$. Further, in the far field region the *spectral* properties of the PSHB material can be displayed and studied (in the time-domain setup of the experiment!).

Naturally, the described above says nothing about the FW. But this experiment shows that very clearly and also how new interesting optical phenomena can be displayed in the zero-delay domain of TSH and that the latter can serve as an efficient tool to study that kind of "belonging to the present" phenomena.

2. The mathematical foundation stone of dispersion relations between the amplitude and phase of optical (and other) signals is that they can be described as entire functions on the plane of the complex variables [8]. The description holds directly for signals well limited both in time and space. Nothing essential outside this limited time-space district can be of any

influence. In other words, the signals must have occurred just of themselves, without any initiating outside activities, "precursory" events or strong nonlinearities of the processes or peculiarities of the inner structure of the signal itself.

It is quite natural to think that in reality the situation is essentially different: every signal in fact has its history of preparation and ways of coming into being.

Thus we may conclude that the description of signals as entire functions is, in principle, an approximation. Physics has shown that it is a fruitful approach. Nevertheless there is some space left for phenomena beside or above this very good approximation.

May be the fractal structure of time-and-space is important in what is happening in the specific time domain called "the present"?

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