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Zdzisław Augustynek

REALISMS

Temporal and Spatial

CONTENTS

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1. Introduction

Conceptual realism acknowledges the existence of abstract objects: theoretical realism acknowledges the existence of non-observable objects; whereas classical realism acknowledges the existence of observable objects. Similarly, temporal realism accepts the existence of future and past events along with present ones, and spatial realism accepts the events which occur there (elsewhere) as well as those that occur here.

We dealt earlier with the three former kinds of realism and their opposites: nominalism, instrumentalism and (ontological) idealism [2]. This paper contains an examination of the two latter forms of realism: temporal and spatial, and their counterparts: temporal and spatial irrealisms. Analogies and connections between these standpoints will be the focus of the paper.

2. Notions and assumptions

If we speak about events we have in mind objects which are space-time non-extended, i.e. point-events (in the everyday, non-defined sense). The set of all such events is called 'the world of events' and we denote it by S, and its elements — point-events, by x, y, z,... etc. The ontology based on point-events is called 'point-eventism', which is widely presented in [4]. Its main thesis states that every empirical object is a point-event or a (set-theoretical) set founded on point-events; for instance things are specific sets of point-events; from now on we shall use the term 'event' instead of 'point-event'.

We assume that the following relations are determined in the set S: temporal – W (and $\breve{W}$, R and $\bar{R}$); spatial – $\bar{L}$ (and L); spatio-temporal – K; causal – H (and $\breve{H}$, and H^*).

All these relations are relativisticly absolute, i.e. independent of any arbitrary inertial reference system. We shall use only these relations, therefore my considerations are located in the absolute layer of Special Theory of Relativity. Certainly, in the set S the relative temporal and spatial relations are determined.

W is the relation *earlier*, which is irreflexive, asymmetrical and transitive in S. The relations: $\breve{W}$ *later* and R *quasi-simultaneous* (where $R = \bar{W} \cap \breve{\bar{W}}$) are derivative from the relation W. $\breve{W}$ has the same formal properties in S as W, R is reflexive and symmetrical but not transitive in S, ergo it is

relation of time similarity only, and $\bar{R}$ is irreflexive and symmetrical in S, ergo it is a relation of time difference.

$\bar{L}$ is the relation of *space separation*, which is irreflexive and symmetrical in S, ergo it is a relation of space difference. The relation L — derivative from $\bar{L}$ — is the relation of *quasi-co-location*, which is reflexive and symmetrical but not transitive in S, ergo it is a relation of space similarity.

K is the relation of *space-time coincidence*, which is equal to $R \cap L$; it is reflexive, symmetrical and transitive, ergo equivalence in S.

H is a *causal relation*; $H(x, y)$ means: *x is the cause of y*. It is irreflexive, asymmetrical and transitive in S. $\breve{H}$ is a causal relation derivative from H; $\breve{H}(x, y)$ means: *x is the effect of y*. H^* is also a causal relation derivative from H; $H^*(x, y)$ means: *x is the cause or the effect of y*, i.e. $H^* = H \cup \breve{H}$ (we call it "the causal connection"). $\breve{H}$ has the same formal properties in S as H, and H^* is irreflexive and symmetrical in S.

The world of events S has some definite structures: temporal, spatial, spatio-temporal and causal.

The temporal structure of S is expressed by the following statements:

C1. $\bigwedge_x \bigvee_y W(y, x)$ (principle of precedence)

C2. $\bigwedge_x \bigvee_y \breve{W}(y, x)$ (principle of succession)

C3. $\bigwedge_x \bigvee_y R(y, x)$ (principle of quasi-simultaneity)

C4. $\bigwedge_x \bigvee_y \bar{R}(y, x)$ (principle of time separation)

The spatial structure of x is expressed by the statements:

P1. $\bigwedge_x \bigvee_y \bar{L}(y, x)$ (principle of space separation)

P2. $\bigwedge_x \bigvee_y L(y, x)$ (principle of quasi-co-location)

The space-time structure of S is expressed by the statements:

CP1. $\bigwedge_x \bigvee_y [R(y, x) \wedge L(y, x)]$ (principle of coincidence)

CP2. $\bigwedge_x \bigvee_y [R(y, x) \wedge \bar{L}(y, x)]$ (principle of space extension)

CP3. $\bigwedge_x \bigvee_y [\bar{R}(y, x) \wedge L(y, x)]$ (principle of time extension)

CP4. $\bigwedge_x \bigvee_y [\bar{R}(y, x) \wedge \bar{L}(y, x)]$ (principle of space-time extension)

The causal structure of S consists of the statements:

K1. $\bigwedge_x \bigvee_y H(y, x)$ (principle of causality 1)

K2. $\bigwedge_x \bigvee_y \breve{H}(y, x)$ (principle of causality 2)

K3. $\bigwedge_x \bigvee_y H^*(y, x)$ (principle of symmetrical causality)

Each of the above mentioned principles concerning the world of events expresses a certain property of this world. We shall discuss only some of them. The principle C1 (of precedence) states the lack of the time beginning of this set and the principle C2 (of succession) states the lack of the time ending of this set. NB. these topological properties does not exclude a temporal limitation (one or two-sided) of the set S. The principles: CP2 (of space extension) and CP3 (of time extension) entail respectively: the time extension and the space extension of the set S. The principles: K1 (of causality 1) and K2 (of causality 2) states respectively: the lack of the causally ending event (of the first cause), and the lack of the causally beginning event (the last effect) in the set S.

There are some connections between different structures of the world of events.

We assume here the following statements, which connect temporal and causal relations:

A $\quad \bigwedge_{x,y}[H(x,y) \to W(x,y)] \qquad$ (the postulate of causality)

Note, that C1 (the principle of precedence) immediately follows from A and K1 (principle of causality 1). In the same way C2 follows from the principles: A and K2 (for $\breve{H}(y,x) \equiv H(x,y)$ and $\breve{W}(y,x) \equiv W(x,y)$).

According to the Special Theory of Relativity each event is connected with the (double) light-cone characteristic of it. It divides the set S into the conical areas, the sets of events related to this event. Let us consider the event x, then $\alpha_1(x)$ is the lower internal part of the light-cone of x, $\alpha_2(x)$ is the upper internal part of the light-cone of x; $\gamma_1(x)$ and $\gamma_2(x)$ are respectively: its lower and upper surface, and $\beta(x)$ is external area (called sometimes — extraconical area); finally $[\![x]\!]$ comprises the events which coincides spatio-temporally with x (then it comprises also x).

Therefore the light-cone areas of (every) event x can be defined by the following time and space relations:

$$\alpha_1(x) = \{y : W(y,x) \wedge L(y,x)\} \qquad \gamma_1(x) = \{y : W(y,x) \wedge \bar{L}(y,x)\}$$
$$\alpha_2(x) = \{y : \breve{W}(y,x) \wedge L(y,x)\} \qquad \gamma_2(x) = \{y : \breve{W}(y,x) \wedge \bar{L}(y,x)\}$$
$$\beta(x) = \{y : R(y,x) \wedge \bar{L}(y,x)\} \qquad [\![x]\!] = \{y : R(y,x) \wedge L(y,x)\}$$

If $\alpha(x) = \alpha_1(x) \cup \alpha_2(x)$ and $\gamma(x) = \gamma_1(x) \cup \gamma_2(x)$, then $\alpha(x) = \{y : \bar{R}(y,x) \wedge L(x)\}$ and $\gamma(x) = \{y : \bar{R}(y,x) \wedge \bar{L}(y,x)\}$.

The definitions of the conical areas have two consequences: first, that each two of these areas are disjoint and, second, that they cover in sum the set S:

$$S_x = [\![x]\!] \cup \alpha_1(x) \cup \alpha_2(x) \cup \beta(x) \cup \gamma_1(x) \cup \gamma_2(x),$$

briefly: $S_x = [\![x]\!] \cup \alpha(x) \cup \beta(x) \cup \gamma(x)$. Note, that S has an index x to indicate that it is divided relatively to x. This statement is based on the fact that the sum of all relations which define all conical areas is a full relation in the set S. This sum-relation has the form: $W \cup R \cup \breve{W}$ or $L \cup \bar{L}$.

3. The past, the present and the future

The above mentioned standpoints: temporal realism and temporal irrealism are extreme ones in the controversial issue: do future and past events (and present events) exist? In order to articulate this question, as well as other standpoints, we must first define what we mean by the future, the present and the past. In my book [1] I present, within the Special Theory of Relativity, two conceptions of these notions: the standard one (based on relative time relations) and the non-standard one (based on absolute time relations). In this paper we shall use only the latter.

The past (P), the present (N) and the future (F) are related to a definite event. Therefore we have: the past of the event x (relative to x), i.e. P_x, the present of the event x (relative to x) i.e. N_x, and the future of the event x (relative to x) i.e. F_x.

Within the above mentioned conception we define these notions using the absolute time relations in the following way:

DC $P_x = \{y : W(y,x)\}$, $N_x = \{y : R(y,x)\}$ and $F_x = \{y : \breve{W}(y,x)\}$.

In words: the past of the event x (P_x) is the set of all the events (absolutely) earlier than x; the present (quasi-present) of the event x (N_x) is the set of all the events quasi-simultaneous with x; the future of the event x (F_x) is the set of all the events (absolutely) later than x.

These definitions refer to any event from the set S. Thus there are so many sets P_x, N_x, F_x as there are events; if two events do not coincide spatio-temporally, then the (above mentioned) respective sets are different. It is necessary to say that the sets P_x, N_x, F_x have a (relativisticly) absolute character. It is a consequence of the fact that time relations: W, R, $\breve{W}$, which define these sets are (relativisticly) absolute. This fact is characteristic of the non-standard conception *PNF* used here.

The above mentioned definitions indicate that the past, the present and the future are clearly of relational nature. It results from the egocentric nature of expressions such as "now" and "not now" (which comprise "past"

and "future"). This relationality is rooted in defining P_x, F_x, N_x with the help of respective time relations. Accordingly, we cannot talk about P, N, F «in general» but about P_x, N_x, F_x which are related to definite event. Therefore expressions such as $y \in P$ (y is past), $z \in N$ (z is present), and $v \in F$ (v is future) are meaningless, and only expressions: $y \in P_x$ (y is past relatively to x), $z \in N_x$ (x is present relatively to x) and $v \in F_x$ (v is future relatively to x) make sense.

The definitions of P_x, N_x and F_x entail that each two of these sets are disjoint. Indeed, the relations W, R, $\breve{W}$, which define them (respectively) exclude one another. The statement that the sets P_x, N_x, F_x in sum cover the set S is the second important consequence of these definitions:

TR $$S = P_x \cup N_x \cup F_x$$

In words: every event (y) is prior to or simultaneous with or posterior to every event x (x including).

TR is based on the fact that the sum of the relations which define the sets P_x, F_x, N_x, i.e. $W \cup R \cup \breve{W}$, is a full relation in the set S (i.e. that every two events belong to this relation). We call **TR** the statement about temporal partition of the set S relatively to the event x. If some y does not coincide spatio-temporally with x, we have quite different partition of the set S: into sets P_y, N_y, F_y.

The past P_x, the present N_x and the future F_x can be expressed as the (respective) sums of conical areas; thus they acquire the conical interpretations: $P_x = \alpha_1(x) \cup \gamma_1(x)$; $N_x = [\![x]\!] \cup \beta(x)$; $F_x = \alpha_2(x) \cup \gamma_2(x)$. In words: P_x is the lower internal part of the light-cone of x with its corresponding surface, F_x is the upper internal part of the light-cone of x with its corresponding surface, and N_x is the external conical area of x together with x. Note that $\bar{N}_x = \alpha(x) \cup \gamma(x)$. The above mentioned equalities follow from: (1) the definitions of the conical areas and (2) the definitions of the sets P_x, N_x and F_x.

4. Problem 1

In order to formulate this problem and find different solutions to it, it is necessary to introduce the notion of relational existence. Let E_x be the set of all the events which exist relatively to the event x; then the expression '$y \in E_x$' means the event y exists relatively to the event x. The existence of an event is not simply a property of that event (it is questionable if the existence is a property at all) but its relational property.

As such a property it allows situation in which a definite event, for instance y, exists relatively to the event x, however it does not exist relatively to (another) event z; that is to say the situation: $y \in E_x$ and $y \in \bar{E}_z$. It depends on the assumed standpoint whether this possibility is acceptable or not. We shall see that it is accepted in the temporal irrealism, but it is not in temporal realism (so called global realism). Thus the notion of the relational existence is necessary to embrace different standpoints and, certainly, to formulate our problem.

This problem can be expressed as follows:

P1 Are the following statements true:

$$P_x \subseteq E_x \quad \text{and} \quad N_x \subseteq E_x \quad \text{and} \quad F_x \subseteq E_x?$$

In words: if an event y belongs to the past (the present, the future) relatively to an event x, then y exists relatively to x. (No restrictions are imposed on y and x, since the problem is quite general.)

The different solutions to our problem, i.e. different standpoints, form two classes. The first of them comprises the above mentioned temporal irrealism, according to which only present events exist. The second one comprises standpoints which go beyond the thesis of irrealism, i.e. accept the existence of (at least some) future or/and past events. These standpoints we call "realistic". The second class splits into two subclasses. The first comprises the global temporal realism which apart from present events accepts the existence of all the future and of all the past events. The second subclass comprises the temporal partial realisms, which accept the existence of only some of the past events or/and some of the future events. Some of the standpoints are temporal-causal realisms and some are temporal-non-causal realisms.

5. Temporal standpoints

The temporal irrealism — called this way by L. Sklar [6] — has in our framework the following form:

IrT $$E_x = N_x.$$

In words: an event y exists relatively to x iff y belongs to the present of x, i.e. iff y is quasi-simultaneous with x. The conclusion below follows from this thesis:

$$\bar{E}_x = P_x \cup F_x, \text{ ergo } P_x \subseteq \bar{E}_x \text{ and } F_x \subseteq \bar{E}_x.$$

In words: past and future events do not exist (relatively to x).

Therefore, according to **IrT** the present events exist ($N_x \subseteq E_x$) and only they exist ($E_x \subseteq N_x$). Why? What are the reasons for it? The adherents of the temporal irrealism appeal first of all to everyday opinion (,of the man in the street.) which is expressed by the common sentence: «only present events exist, the past events already do not exist and the future events do not yet exist». We think that this argument is not conclusive: if common opinion says that it is so and so then it does not follow from this that it is indeed so and so. Moreover, we think that nobody has made till now a logically correct and essentially adequate analysis of this opinion.

L. Sklar in his book [6] points to another argument of supporters of temporal irrealism. Namely, some authors say that present events are «epistemically near» as accessible to immediate experience, however, past and future events are «epistemically distant» as accessible only through inference.

Firstly, if even it is so as this argument says it is not a reason for the refusal of the existence of past and future events. The majority of the objects investigated by physics (particles and fields) are epistemically distant. Thus only for instrumentalists this argument has some force. Secondly, we reject the thesis of this argument that what we perceive (= immediately experience) are present events (more precisely: that somebody's perception of x is simultaneous with x). Actually, if we limit the question to the extraspection, assume the postulate of causality, and assume so called causal theory of perception (according to which the perception of x is an effect of x) then we obtain the conclusion that we perceive the past events, more precisely: if y is the perception of x, then x is past relatively to y.

Among the objections against temporal irrealism one of them seems to me of special interest. Let's assume that event y' is earlier than event x', i.e. that we have $W(y', x')$. Then according to the thesis of **IrT** the event y' does not exist relatively to x' (since y' is past relative to x'), and vice versa: x' does not exist relatively to y' (since x' is future relative to y'). Therefore the relation W takes place between two objects x' and y' which do not exist (relatively one to another). Certainly, the same concerns the other time relations as $\breve{W}$ and $\bar{R}$ and also causal relations: H and $\breve{H}$ (and H^*), which (according to the postulates of causality) entail the corresponding relations W and $\breve{W}$ (and $\bar{R}$). The relation of quasi-simultaneity R makes an exception: if we have $R(y', x')$ then x' exists relatively to y' and vice versa (since x' is present relatively to y' and vice versa).

This consequence seems to be at least a paradoxical one. From the point of view of Quine's conception of existence it cannot be accepted. Indeed, because the statement: $W(y', x') \to \bigvee_x \bigvee_y W(y, x)$ is true (it is a substitu-

tion of some thesis of predicate calculus), and by the assumption we have $W(y', x')$, then the statement $\bigvee_x \bigvee_y W(y, x)$ is true; according to Quine we read it existentially: there exist such x and y, which enter into the relation W. Therefore, the person who shares the Quinean conception must reject the temporal irrealism, because in everyday life and in empirical sciences at every step we meet the true statements of the forms: $W(x, y)$ and $\breve{W}(x, y)$. At the same time this conception is an argument for the global temporal realism.

Among the partial realistic standpoints the realisms which we call 'temporal-causal realisms' seem interesting. According to them the present events exist (all of them), and also past and future events exist but only as far as they are connected causally with present events. Thus the causal relation plays the role of an agent which transfers the existence from present events to future and past ones. Two realisms of this kind were considered in my book [1]: one was created by Łukasiewicz [5] and the second is my own invention. We present here only the latter as an example:

RH1 $$\bigwedge_{x,y} [y \in E_x \equiv (y \in P_x \wedge H(y, x)) \vee y \in N_x \vee (y \in F_x \wedge H(y, x))]$$

In a short form: $E_x = P'_x \cup N_x \cup F'_x$, where $P'_x \subsetneq P_x$ and $F'_x \subsetneq F_x$. In words: y exists relatively to x iff y belongs to the present of x, or y belong to the past of x and is the cause of x, or it belongs to the future of the x and is the effect of x.

Thus according to this realism besides the events that belong to the present relatively to x, only some of the events that belong to the past relatively to x and only some of the events that belong to the future relatively to x exist. Namely those events which satisfy the above mentioned causal conditions: they are causes or effects of the event x. **RH1** entails that the past and future events, which do not satisfy these conditions, do not exist: the first if they are not causes of x, the second if they are not effects of x.

The strongest realistic standpoint, opposed to the temporal irrealism, is the temporal global realism **RTG** (in my book it is called the Putnam's assumption). It can we formulated as follows:

RTG $$E_x = P_x \cup N_x \cup F_x.$$

In words: an event y exists relatively to x iff y belongs to the past of x or to the present of x or to the future of x. Briefly, not only all the present events but also all the past and future events exist.

The thesis of **RTG** and the statement **TR** entail an important conclusion W2; here is its proof:

1.	$P_x \cup N_x \cup F_x = E_x$	(**RTG**)
2.	$S = P_x \cup N_x \cup F_x$	(**TR**)
W1.	$S = E_x$	(from 1 and 2)
3.	$\bigwedge_{y,x} y \in S$	(obvious assumption)
W2.	$\bigwedge_{y,x} y \in E_x$	(from W1 and 3)

In words: every event (y) exists relatively to every event (x), or: any two event exist relatively to one another (see W1).

The conclusion W2 indicates that according to **RTG** (and only **RTG**!) the following situation is impossible: some event, for instance y, exists relatively to x and, at the same time, it does not exist relatively to z, that is to say: $y \in E_x \wedge y \in \bar{E}_z$; as we know such situation is not excluded by the very notion of the relational existence. Therefore, if we assume the **RTG** standpoint then we can give up the relativization of existence (of events) to events and instead of writing '$y \in E_x$', simply write '$y \in E$'. Of course this conclusion does not eliminate the relativization of P_x, N_x, F_x to events.

Note that the thesis of **RTG** is sometimes formulated in such a way: "all the events exist" (with additional assumption: "independently of the fact whether they are past or present or future"). In this form **RTG** has the name: the theory of «block universe» (see Williams [7]).

All standpoints different from **RTG** in the question of existence of past and future events (**IrT** including) do not entail the conclusion W2 but a statement weaker than it. Let temporal irrealism be an example.

1′.	$N_x = E_x$	(**IrT**)
2′.	$\bigwedge_{y,x} (y \in N_x \equiv y \in E_x)$	(from 1′)
3′.	$\bigwedge_{y} (\bigvee_{x} y \in N_x \equiv \bigvee_{x} y \in E_x)$	(from 2′)
4′.	$\bigwedge_{y} \bigvee_{x} y \in N_x \equiv \bigwedge_{y} \bigvee_{x} y \in E_x$	(from 3′)
5′.	$\bigwedge_{y} \bigvee_{x} y \in N_x$	(principle of quasi-simultaneity C3)
W1′.	$\bigwedge_{y} \bigvee_{x} y \in E_x$	(from 4′ and 5′)

In words: every event (y) exists relatively to some event (x).

As we see according to **IrT** (and to any of partial realisms) the situation that an event, for instance y, exists relatively to x and does not exist relatively to z, i.e. $y \in E_x \wedge y \in \bar{E}_z$ — is possible. This situation according to these standpoints really takes place: for **IrT** when for instance $y \in N_x$ and $y \in P_z$ (then $y \in E_x$ and $y \in \bar{E}_z$), and for **RH1** when for instance $y \in N_x$ and $y \in \bar{N}_z$ and $\bar{H}(y,z) \wedge \breve{\bar{H}}(y,z)$ (then $y \in E_x$ and $y \in \bar{E}_z$). Therefore, if we

accept some of these standpoints then we cannot give up the relativization of the existence (of events) to events. We think that above mentioned difference (between conclusions W1 and W1′) is an argument for **RTG**. Since only when the relationality of the existence of events is eliminated — as just in **RTG** — it is possible to talk about the existence of events in the same manner as we talk about the existence of other kinds of objects: crocodiles, electrons, natural numbers and so on.

Having to choose from many standpoints concerning the problem 1 we accept the global temporal realism. It is also the opinion of the majority of the contemporary philosophers of science (including philosophy of time). It is sufficient to mention such names as Russell, Quine, Putnam. Grünbaum, Fraassen. Now we shall try to justify this option. We shall first criticize the standpoints opposing the **RTG** (partial realisms including). Later we shall consider arguments for and against the **RTG** itself.

As we have shown the only serious reason for the temporal irrealism, appealing to the «epistemic nearness» of present is an illusion, and the paradoxical consequence of it (the successive events do not exist relatively to one another) disqualifies it. In this viewpoint and also in almost all partial realisms the status of the present is singled out. It consists in that every of these standpoints: (1) accepts the existence of all present events, and (2) refuses the existence of all past and future events (**IrT**) or accepts the existence of some past events and some future events only in the case if they are causally connected with present events.

One can ask: what is a foundation of this special ontic status of the present against the past and the future? The literature from the philosophy of time does not give us a justified answer to this question. We have to do only with the argument of «epistemic nearness» put forward by **IrT**. It is a duty of partial realisms to answer it, but in that case we meet silence.

Considering this question we constructed so called pure causal temporal realism [3] which ... does not assume the existence of the present. We denote it by **RH** and we expresses it by the short formula: $E_x = P_x^k \cup F_x^k$. The developed version of it is as follows:

$$\textbf{RH} \qquad \bigwedge_{x,y} \left[y \in E_x \equiv (y \in P_x \wedge H(y,x)) \vee (y \in F_x \wedge \breve{H}(y,x)) \right].$$

In words: y exists relatively to x iff y belongs to the past of x and it is a cause of x, or y belongs to the future of x and is an effect of x. Therefore — according to this realism — there exist only some events past relatively to x and some events future relatively to x. These events form the sets P_x^k and F_x^k, which are proper parts of sets P_x and F_x.

The thesis of **RH** entails that present events do not exist. It is obvious in the face of the fact that the quasi-simultaneous events are not at all causally interrelated. Note, that also the event x does not exist relatively to x, since it is not causally connected with itself: the relation H^* $(= H \cup \breve{H})$ is after all irreflexive.

If we compare the realisms: **RH** and **RR1**, we see that the only difference between them is the question concerning the present: RH1 accepts its existence and **RH** does not. This negation makes this realism paradoxical in the face of the fact that all remaining temporal realisms (and also **IrT**!) assume the existence of present events.

As an adherent of the global realism we do not support the purely causal realism. We invented it only in order to show that we can dispense with the assumption of the existence of the present and therefore it is by no means obvious that this assumption can serve as an argument against the (ontically) unfounded special status of the present.

Now, we shall consider arguments for and against the global realism. **RTG** is often accused of implying: (1) the strict determinism, (2) the fatalism (in the connection with (1)), (3) the negation of the «creativity» of nature (rise of new objects and phenomena), and (4) so called *totum simul* (i.e. simultaneity of all events). Since these conclusions are generally considered false, **RTG** also appears false.

Many authors (we recommend the brilliant and still up-to-date paper "The myth of passage" [7]) convincingly showed that the above mentioned statements did not follow from the global realism in any way, thus — it is difficult to attack this realism on their basis. Therefore the matter of these objections we consider closed.

The global temporal realism has many advantages.

Firstly, among all conceptions of the existence of P_x, N_x, F_x it seems the only one logically compatible with the Special Theory of Relativity and as we guess with the General Theory of Relativity. **STR** describes 4-dimensional space-time domain, which is the set of all space-time points (which, certainly, have different properties). Therefore **STR** must presuppose its existence, thus also the existence of the above mentioned points. This fact presupposes in turn the existence of all the events occurring at these points. This assumption of **STR** is — as we think — the very heart of **RTG**. This is the main argument for this kind of realism.

Secondly, according to **RTG** the present does not have a special ontic status in relation to past and future: in **RTG** we have to do with full democracy, all the events, present as well as past and future exist *al pari* in the

same way. The question of why the ontic status of the present is singled out disappears for global realism. As far as this question is concerned this standpoint is simpler than the other ones.

Thirdly, in **RTG** it is not necessary to apply other than temporal relations (for instance causal relations) as transferring agents of the existence from present events to past and future events (which takes place in causal realisms). As we know, earlier or later events in relation to an event exist, according to **RTG**, independently of the fact that they are or are not connected causally with it. Since according to **RTG** every event exists in relation to any other. In consequence, if the events enter into the relation W ($\breve{W}$ or R) then they exist relatively to one another.

Fourthly, in **RTG**, contrary to all the other conceptions, we do not have to use the notion of the relational existence of events. This notion was necessary for the formulation of our problem and for the unified description of **RTG** and all the other conceptions. The rejection of all these standpoints entails the elimination of this notion, because according to **RTG** every event exists relatively to every other event. Therefore there is not a situation: $y \in E_x$ and $y \in \bar{E}_z$. It is sufficient to apply a usual (attributive, not relational) notion of existence. This point is very important since only **RTG** allows to treat this realism on a par with such ontological realisms as: classical (opposed to idealism), theoretical (opposed to instrumentalism) and conceptual (opposed to nominalism), which use the notion of existence in its non-relational sense. Exactly speaking — observational objects, non-observational objects and abstract objects simply exist (not relatively to some other objects).

Finally, the so called global spatial realism supports **RTG**. In the next chapter we are discussing the spatial realism.

6. Here-ness and there-ness

Having in mind the problem 1 it is possible or even necessary to ask the question: do the events exist there (elsewhere) apart from the events which exist here? We do not know a philosopher who asks this question, let alone one who answers it in a negative way. This matter is not so simple, however, as it seems at the first glance.

Indeed, using the same notions, general assumptions and formal constructions as in the case of the problem 1, it is possible to formulate the other problem 2 with its different solutions. To this end observe that within **STR** it is possible to construct non-standard (i.e. relativisticly absolute) conception of the notions “here” and “there”, in the same manner as we

constructed the non-standard conception of **PNF**. In this place we limit myself to its most essential parts.

Here-ness (T) and *there-ness* ($\bar{T}$) are related to a definite event. Therefore we have the here-ness of an event x (relatively to x), i.e. T_x, and the there-ness of an event x (relatively to x), i.e. $\bar{T}_x$. In our conception we define these notions with the help of the respective spatial relations as follows:

DP $$T_x = \{y : L(y,x)\} \text{ and } \bar{T}_x = \{y : \bar{L}(y,x)\}.$$

In words: here-ness of an event x, i.e. T_x, is an set of an events quasi-co-local with x, and there-ness of an event x, i.e. $\bar{T}_x$, is an set of the events spatially (absolutely) separated from x.

The above mentioned definitions refers to any event from the set S. Thus there are so many sets T_x and $\bar{T}_x$ as there are events; if two events does not coincide spatio-temporally then the above mentioned sets are different. The sets T_x and $\bar{T}_x$ have a (relativisticly) absolute character. It is a consequence of the fact that space relations L and $\bar{L}$ which define these sets are (relativisticly) absolute.

Our definitions express the fact that here-ness and there-ness are of relational nature in the same way as the past, the present and the future. It is based on the fact that the expressions "here" and "there" are of egocentric nature (as the expressions "now" and "not now"). This relationality is rooted in the defining of T_x and $\bar{T}_x$ with the help of respective space relations. Consequently we cannot talk about T and $\bar{T}$ «in general» but it is necessary to talk about T_x and $\bar{T}_x$, i.e. these sets are related to a definite event. Thus the expressions of the kind: $y \in T$ (y is here) and $z \in \bar{T}$ (z is there) are meaningless, but only the expressions of the kind: $y \in T_x$ (y is here relatively to x) and $y \in \bar{T}_x$ (y is there relatively to x) make sense.

The definitions of T_x and $\bar{T}_x$ entail that these sets are disjoint; indeed the relations L and $\bar{L}$, which define them, exclude one another. Secondly, these definitions imply that the sets T_x and $\bar{T}_x$ in sum cover the set S:

TR′ $$S = T_x \cup \bar{T}_x$$

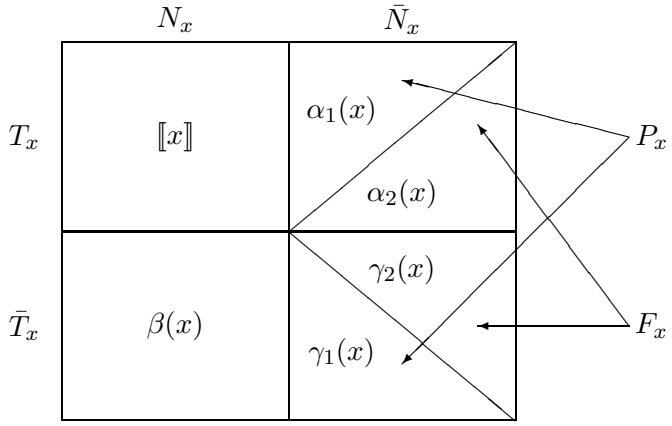
The statement **TR′** is based on the fact that the sum of the relations which define the sets T_x and $\bar{T}_x$, i.e. the relation $L \cup \bar{L}$, is a full relation in the set S, i.e. that every two events enter into this relation. We call **TR′** the statement about spatial partition of the set S relatively to the event x; certainly, if we choose another event y which does not spatio-temporally coincide with x we obtain different partition of the set S relatively to the event y: into sets T_y and $\bar{T}_y$.

Likewise P_x, N_x, F_x, here-ness T_x and there-ness $\bar{T}_x$ can be expressed as the sums of conical areas; in this manner they obtain the following conical interpretations:

$$T_x = [\![x]\!] \cup \alpha(x) \quad \text{and} \quad \bar{T}_x = \beta(x) \cup \gamma(x).$$

In words: the set T_x (of events quasi-co-local with x) is the lower and upper internal part of the light-cone of x, x including; the set $\bar{T}_x$ (of events spatially separated from x) is the external part of the light-cone of x with its corresponding surface (lower and upper). Note that T_x is space-extended and N_x is time-extended (according to **STR**). The above mentioned equalities follow from (1) the definitions of cone-areas and (2) the definitions of the sets T_x and $\bar{T}_x$.

The diagram below illustrates the relations between P_x, N_x, F_x and T_x, T_x according to their conical interpretations:



7. Problem 2

Now we can formulate the problem 2 and different solutions to it. As in the case of the problem 1 we are also using here the notion of the relational existence E_x, where $y \in E_x$ means: y belongs to the set of events which exist relatively to x, or simply — y exists relatively to x. Thus the problem of the existence of events «there» (elsewhere) and «here» can be expressed as follows:

P2 Are the following statements true:

$$T_x \subseteq E_x \quad \text{and} \quad \bar{T}_x \subseteq E_x?$$

In words: if an event y is here relatively to x, then y exists relatively to x; and if an event y is there relatively to x, then y exists relatively to x.

Let us now consider a few possible solutions to the problem. The first of them is the spatial irrealism (only the events here exist). The second — some partial spatial realism (only some events here and there exists). The third — global spatial realism (all the events here and there exist). We shall also consider the solution which is the «conjunction» of temporal irrealism and spatial irrealism (only the events here and now exist).

8. Spatial standpoints

The spatial irrealism (**IrS**), which we name as such in a parallel way to temporal irrealism, has the form:

IrS $$E_x = T_x.$$

In words: an event y exists relatively to x iff y is here relatively to x; i.e. iff y is quasi-co-local with x; in other words only the events belonging to here exist. The thesis of **IrT** entails the conclusion

$$\bar{E}_x = \bar{T}_x.$$

In words: the events there (relatively to x) do not exist (relatively to x).

We know nobody who supports this view. Note that although temporal irrealism seems to be obvious (and many regards is as such), spatial realism seems very far from being obvious. The partial spatial realism (**RSC**) has the following form:

RSC $$E_x = (T_x \cap N_x) \cup (\bar{T}_x \cap N_x).$$

In words: an event y exists relatively to the event x iff y is here and now relatively to x or y is there and now relatively to x. Therefore the events exist here and there now.

This standpoint (**RSC**) — as we guess — is a silently assumed viewpoint in the question.

The strongest answer to the problem is global spatial realism (**RSG**); its form is as follows:

RSG $$E_x = T_x \cup \bar{T}_x.$$

In words: all the events here and there exist. In other words, not only the events here and there now but also here and there not now exist.

The thesis of this realism and the statement $\mathbf{TR}'$ entail the important conclusion, inference of it we present below.

1.	$T_x \cup \bar{T}_x = E_x$	(**RSG**)
2.	$S = T_x \cup \bar{T}_x$	(**TR**$'$)
W1.	$S = E_x$	(from 1 and 2)
3.	$\bigwedge_{y,x} y \in S$	(obvious assumption)
W2.	$\bigwedge_{x,y} y \in E_x$	(from W1 and 3)

In words: every event (y) exists relatively to every event (x). In other words — every two event exists relatively to one another.

This final conclusion eliminates the possibility of the situation that for an event, for instance y, we have: $y \in E_x$ and $y \in \bar{E}_z$. This situation is admissible by the very notion of the relational existence. Thus if we accept the standpoint **RSG**, then we can give up the relativization of existence (of events) to events. This conclusion does not eliminate the relativization of T_x and $\bar{T}_x$ to events.

The standpoints different from **RSG**, concerning the existence of the events belonging to T_x and $\bar{T}_x$ (including **IrS**), do not entail the conclusion W2, but a statement weaker than it. Let spatial irrealism **IrS** be an example.

1$'$.	$T_x = E_x$	(**IrS**)
2$'$.	$\bigwedge_{y,x}(y \in T_x \equiv y \in E_x)$	(from 1$'$)
3$'$.	$\bigwedge_y (\bigvee_x y \in T_x \equiv \bigvee_x y \in E_x)$	(from 2$'$)
4$'$.	$\bigwedge_y \bigvee_x y \in T_x \equiv \bigwedge_y \bigvee_x y \in E_x$	(from 3$'$)
5$'$.	$\bigwedge_y \bigvee_x y \in T_x$	(principle of quasi-co-location P2)
W1$'$.	$\bigwedge_y \bigvee_x y \in E_x$	(from 4$'$ and 5$'$)

In words: every event (y) exists relatively to some event (x).

Therefore according to **IrS** (and **RSC**), the above mentioned situation: $y \in E_x \wedge y \in \bar{E}_z$ is possible. This situation according to **IsR** takes place, if, for instance, $y \in \bar{T}_x$ (then $y \in E_z$). Thus if we accept **IrS** or **RSG** we cannot give up the relativization (of events) to events.

If we add theses of temporal irrealism and those of spatial realism we obtain spatio-temporal irrealism. We denote it by the symbol **IrTS** and express it in the thesis:

IrTS $\qquad E_x = N_x \cap T_x.$

In words: y exists relatively to x iff y is present relatively to x and is here relatively to x. In other words — only the events now and here (relatively to x) exist, thus only the events which coincide in space and time with x

(including the x alone) exist. Therefore this irrealism can be called 'spatio--temporal solipsism'.

Note that spatial standpoints were constructed here parallelly to the temporal standpoints. It means — among other things — that here-ness T_x was hypothetically singled out (in the same way as the present N_x). Therefore we named the standpoint $E_x = T_x$ "spatial irrealism" (as $E_x = N_x$ — "temporal irrealism"). And every step beyond T_x, i.e. to there-ness $\bar{T}_x$, we called "spatial realism" (in the same way as a step beyond N_x to $\bar{N}_x$). We think that these analogies are justified.

9. The connections of problems and standpoints

The important connections take place between both problems under consideration. They consist in that: (1) every spatial standpoint entails some temporal standpoint, and (2) every temporal standpoint entails some spatial standpoint. We shall have a closer look at those, sometimes surprising, connections.

We shall focus attention only on some important examples. The above mentioned spatial irrealism (**IrS**) implies some kind of temporal partial realism denoted by **RTX**. Indeed, it follows from the thesis of **IrS**: $E_x = T_x$ that there are some past events (P'_x), some present events (N'_x) and some future events (F'_x). The thesis of this new temporal realism says:

RTX $$E_x = P'_x \cup N'_x \cup F'_x,$$

where $P'_x = P_x \cap T_x$, $N'_x = N_x \cap T_x$ and $F'_x = F_x \cap T_x$.

Proof. From the thesis of **IrS**: $E_x = T_x$ and by the fact that $P_x \cup N_x \cup F_x$ is the universal set, we obtain $E_x = T_x = T_x \cap (P_x \cup N_x \cup F_x)$ and then the thesis of **RTX**: $E_x = (P_x \cap T_x) \cup (N_x \cap T_x) \cup (F_x \cap T_x)$. *q.e.d.*

This implication is now obvious — if we assume the existence of events here, then we have in mind not only the present event (now) but also past events (here) and future events (here). In other words — it is so because here-ness is time extended. We see from the proof that also the inverse implication is true: the realism **RTX** entails spatial irrealism **IrS**.

The temporal irrealism (**IrT**) entails the spatial partial realism (**RSC**), which we presented before. Actually, it follows from the thesis of **IrT**: $E_x = N_x$ that there exist some events here (T'_x) and some events there ($\bar{T}'_x$). The thesis of **RSC** says:

$$E_x = T'_x \cup \bar{T}'_x,$$

where $T'_x = T_x \cap N_x$ and $\bar{T}'_x = \bar{T}_x \cap N_x$.

Proof. From the thesis of **IrT**: $E_x = N_x$ and by the fact that $T_x \cup \bar{T}_x$ is the universal set, we obtain $E_x = N_x \cap (T_x \cup \bar{T}_x)$, then we obtain the thesis of **RSC**: $E_x = (T_x \cap N_x) \cup (\bar{T}_x \cap N_x)$. *q.e.d.*

This implication is also obvious: if we assume the existence of events now, then we have in mind not only the events here (now) but also the events there, elsewhere (now). In other words it is so because present is space extended. From the proof we see that also the inverse implication is true: realism **RSC** entails irrealism **IrT**.

Therefore if **IrT** is a belief of the «man on the street», then **RSC** must also be his belief (and of course — vice versa). Just this we have in mind writing before, that **RSC** is a everyday belief. It does not mean that we support this spatial realism. On the contrary, we think that there exist events not only here (and) now, and there (and) now but also the events — here (and) anywhere, and there (and) whenever.

Finally, it is easy to prove that *the global spatial realism* (**RSG**) *entails global temporal realism* (**RTG**) *and vice versa*.

Proof 1: From the theses of **RSG**: $E_x = T_x \cup \bar{T}_x$ and **TR**$'$: $S = T_x \cup \bar{T}_x$ we obtain the conclusion: $E_x = S$, using in turn **TR**: $S = P_x \cup N_x \cup F_x$ we obtain the thesis desired of **RTG**: $E_x = P_x \cup N_x \cup F_x$. *q.e.d.*

Proof 2: From the theses of **RTG**: $E_x = P_x \cup N_x \cup F_x$ and **TR**: $S = P_x \cup N_x \cup F_x$ we obtain the conclusion $E_x = S$, from it and **TR**$'$: $S = T_x \cup \bar{T}_x$ we obtain the thesis of **RSG**: $E_x = T_x \cup \bar{T}_x$. *q.e.d.*

The both realisms **RSG** and **RTG** consistently implies that all events exist, in other words — that every event exists relatively to every event, i.e. they imply bilateral inclusion $E_x = S$. We was writing about this, considering **RSG** and RT separately. In this connection the thesis of **RSG** may be expressed in this form: (all) events exist independently of where (here or there) they occur, and the thesis of **RTG** can be expressed in this manner: (all) events exist independently of when (in the past or the present or the future) they occur.

In the face of the presented connection between **RSG** and **RTG** everybody who accepts global spatial realism must accept global temporal realism. Therefore **RSG** is a very important argument for **RTG**, certainly for those who accept **RSG**. It seems to me that it is difficult not to admit it: since it is difficult to reject the existence of the events occurring here but not now (here and whenever) and also the events occurring there but not now (there and whenever); in other words — to accept the existence of events occurring only here and now, and there and now.

Certainly, there also exists the inverse dependence: everybody who accepts global temporal realism must accept global spatial realism. Thus **RTG** is an essential argument for **RSG**. Therefore the two global realisms support each other.

The discussed connection between some kinds of realisms demonstrates how close is the nexus between time and space. It is easy to show that this nexus appears not only on the relativistic level but also on the classical level.

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References

[1] Z. Augustynek, *Przeszłość, teraźniejszość, przyszłość*, PWN, Warszawa 1979. In English: *Time: Past, Present, Future*, Kluwer and PWN, Dordrecht · Warszawa 1991.

[2] Z. Augustynek, "Trzy realizmy" (Three Forms of Realism), Studia Epistemologiczne 1990, pp. 43–65.

[3] Z. Augustynek, "Kauzalna teoria przeszłości i przyszłości" (Causal Conception of Past and Future), [in:] T. Bukczyński (ed.), *Współczesna filozofia nauki*, UAM, Poznań 1991, pp. 99–104.

[4] Z. Augustynek Z. and J. J. Jadacki, *Possible Ontologies*, GA, Rodopi, Amsterdam · Atlanta 1993.

[5] J. Łukasiewicz, *Z zagadnień logiki i filozofii* (Some Problems of Logic and Philosophy), PWN, Warszawa 1961.

[6] L. Sklar, *Philosophy and Space-time Physics*, Berkeley 1985.

[7] D. C. Williams, "The Myth of Passage", The Journal of Philosophy 48 (1951), pp. 457–472.

ZDZISŁAW AUGUSTYNEK
Institute of Philosophy
Warsaw University
Krakowskie Przedmieście 3
00-047 Warszawa, POLAND