Insight into the Theory of Relativity

ANALISYS OF THE THEORY OF RELATIVITY FROM THE STANDPOINT OF TWO OBSERVERS THAT OBSERVE THE SAME PHYSICAL PHENOMENON .

Presentation of the online paper:

"Insights into the Theory of Relativity"

"part I"

"Basic Principles and Starting Points"

www.relativityworkshop.com

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INTRODUCTION

In this presentation I intend to develop new insights in the theory of relativity.
I think I throw some new concepts in a new light.

For the moment, the main outcome I get is the deduction of Lorentz transformation regardless of some principles as the homogeneity and isotropy of space, rigidity of bodies, constancy of velocity of light and Maxwell equations.

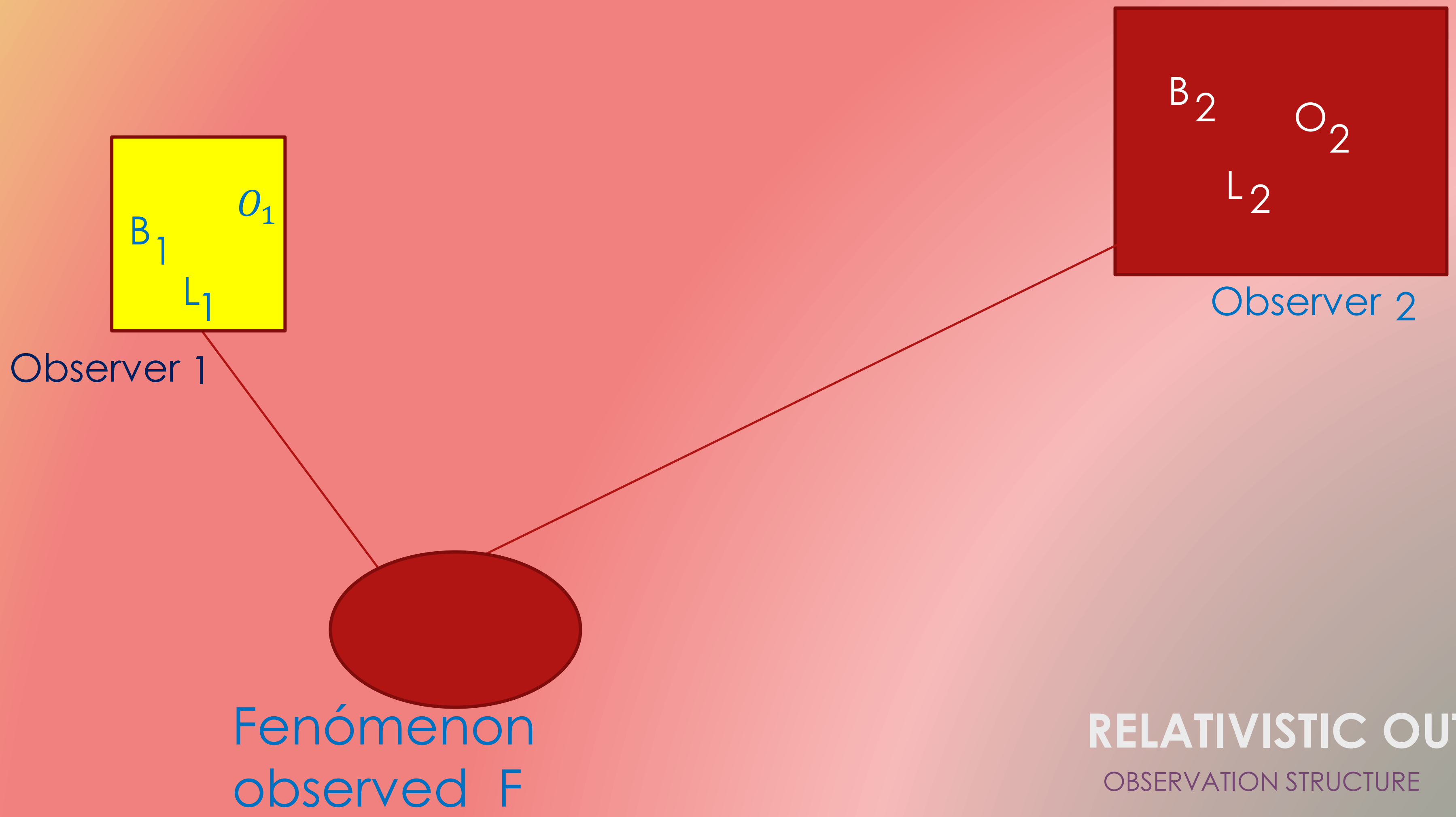
Partially I agree to the relativity principle.

We rediscover orthogonal transformation between two reference frames, namely, the Lorentz transformation, even if in a more general way.

On this basis it is derived Lorentz boost transformation for inertial reference frames .

From the beginning we are working on the basis of two observers that have their own space-time with the same features (namely, dimension, the same signature, etc..) everyone.

These space-times are real vectorial lorentzian space-times with signature (-1,1,1,1) endowed with a metric non degenerated, although, in the starting, the theory developed here is independent of the dimension and signature of the space-time of the observers.



RELATIVISTIC OUTLOOK

OBSERVATION STRUCTURE

Fig. 1 Observation diagram . Observer 1, O_1,
and Observer 2, O_2 ,observe and measure the physical phenomenon F.

The observer O_1 (observer 1) and O_2

(observer 2) observe the same physical fenomenon F.

Each observer has his own lorentzian vectorial space-time.

The space-time of observer 1 is L_1

The space-time of observer 2 is L_2

The observer 1 has a vectorial basis B_1

The observer 2 has a vectorial basis B_2

From a classical physical relativistic standpoint, vectorial basis are seen like three measuring roles and a clock.

Observer O_1 and observer O_2 observe the same physical phenomenon F. O_1 gets the measures F_1, and O_2 gets the measures F_2.

In this paper it is relevant to single out the known importance of electromagnetic field in the theory of relativity. Poincaré set up and gave a great relevance to the role that equations of Maxwell play in the theory of relativity. The electromagnetic field is so closely related to the theory of relativity that the theory of relativity is to be constructed out of the electromagnetic field structure.

That is because electromagnetic fields together gravitational fields are the only fields that make the macrocosm.

Actually electromagnetic fields penetrate deeply into the mechanics of the physical world.

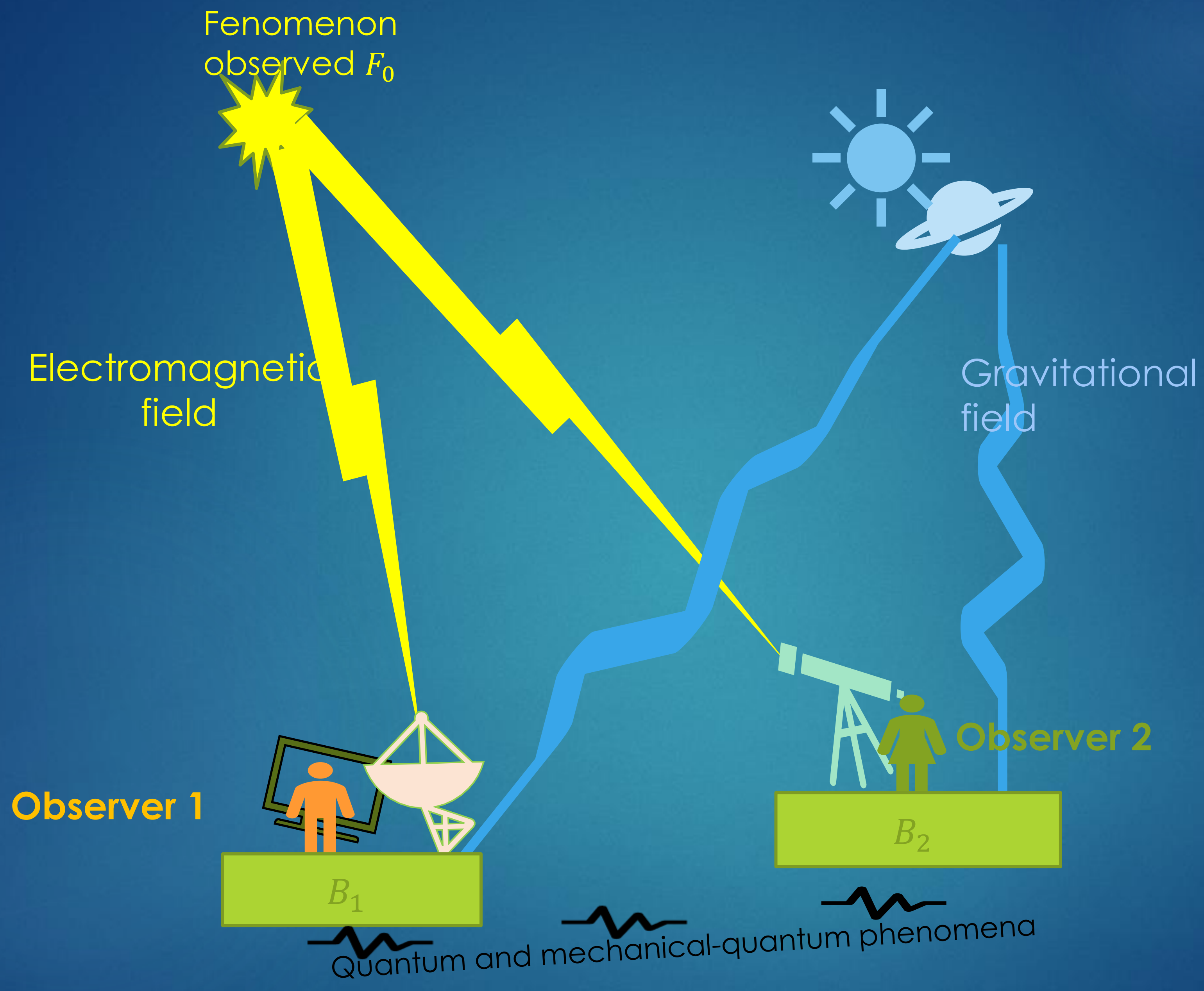


Fig.2- macroscopic fields

The dominant fields in the macrocosm are the electromagnetic field and the gravitational field.

The electromagnetic field is involved in a direct or indirect way in the physical phenomena of the macrocosm, (apart from gravitational). It determines the physical processes in the macrocosm.

Principle of coupling of observers.

This principle is:

Eah observer (see fig. 1), has a base from which, both obervers see the same phenomenon F_0, and get the same electromagnetics fields measures; (see fig. 2).

- Thereby, from whatever other two bases, B_1 of oberver O_1, and B_2 of observer O_2, is derived a mathematical similarity relation **R** between the matrices of components of F_1 and F_2 (see fig. 3); (this is proved in he online publication "Insights into the Theory of Relativity",; part I; pág. 5, subsection 2.1-Principle of coupling of observers; www.relativityworkshop.com).

- Therefore, we have an homomorphism **R** between the matrices of measures of F_1 and F_2 :

- $F_2 = \mathbf{R} F_1 \boldsymbol{R}^{-1}$.

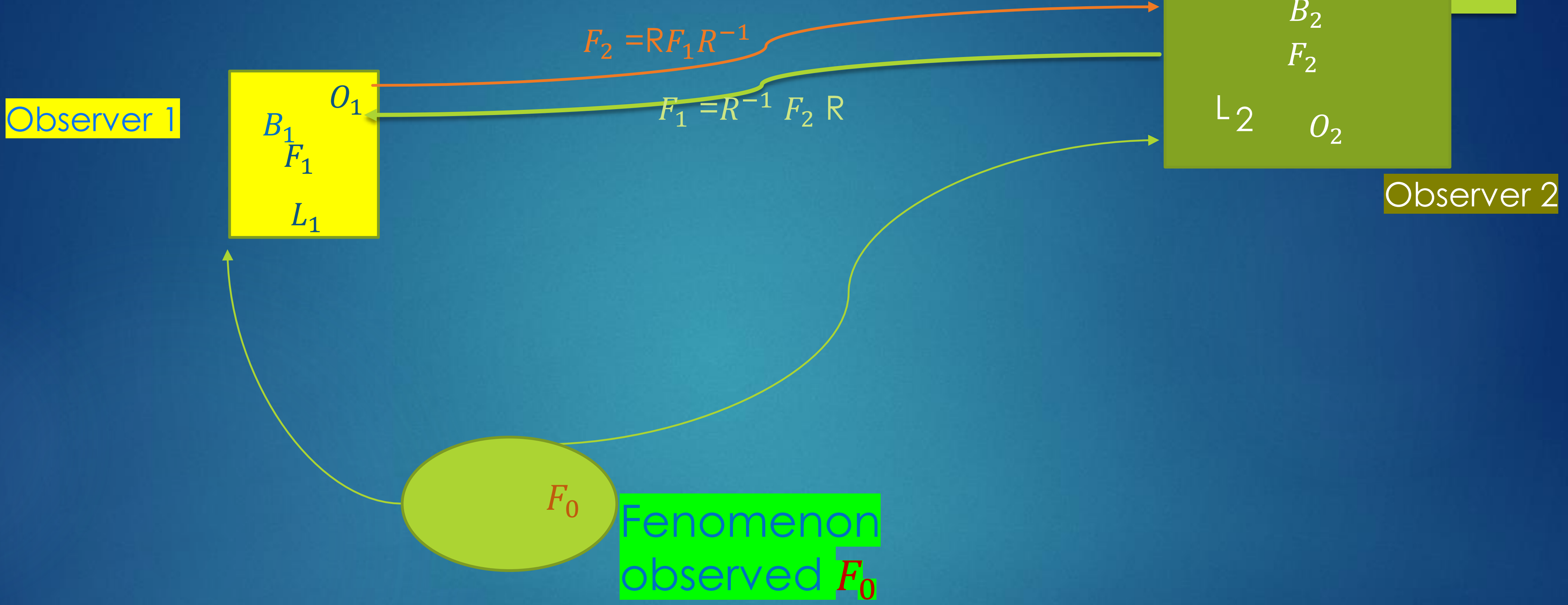


Fig. 3 Diagram of observation . Observer 1, O_1, and observer 2, O_2, coupled. They observe and measure the same physical phenom F_0.

Coupled for us, mean:
Everyone observer has a base from which both observers , observe and measure the same physical phenomenon F , **geting the same measures**. We call it coupling of observers.

Electromagnetic field structure.

- Then, we begin on the next basis:
- The electromagnetic field is a second order antisymmetric tensor, in a Lorentzian vector space, in accordance with the structure currently involved in relativistic physics (see Note 2).

  This antisymmetric structure must be preserved in any transformation to hold the physical meaning of the electromagnetic field.

Note 2-

F_i , $\mathrm{i} = 1{,}2$ are second order skew-symetric tensors in a vectorial lorentzian spacetime . In this context, Maxwell equations in the empty space, in classical relativity, are:

$$d_{ext}F_i=0\ ;\ d_{ext}F_i^*=0\ ;\ \mathrm{i} = 1{,}2\ ;$$

where * is the Hodge operator and d_{ext} is the differntial exterior.

Orthogonality between the space-times of observers.

Definition:

The homomorphism R between the space-time L_1 of O_1, with metric G_1, and the sapace-time L_2 of O_2, with metric G_2 is ortogonal if the scalar producto is preserved and viceversa. That is:

$G_1(X_{o_1}, Y_{o_1}) = G_2(X_{o_2}, Y_{o_2})$; $\forall X_{o_1}, Y_{o_1} \in L_1$; $\forall X_{o_2}, Y_{o_2} \in L_2$, being:

$$X_{o_2} = R\left(X_{o_1}\right);\ Y_{o_2} = R(Y_{o_1})$$

- Notice the concept of homorphism between two differents vectorial space-times differs of the concept of homomorphism into a vectorial space (also called endomorphism).
- In the first case the linear maping is stablished between vector components only. It is not a mapping between base vectors. It is a coordinates tranformation.

R is transformation between space-times L_1 and L_2

If tensors F_1 and F_2 are skewadjoint then it is proved that **R** is to be orthogonal.

This is taking into account that fields F_1 and F_2 are the observed electromagnetics fields and these fields are measured by observers O_1 and O_2.

In short, the homomorphism **R** that **preserves** the features (skewadjoint) of electromagnetic tensor fields **is to be orthogonal**.

- See the prove of this assumption in
- "Insights into the Theory of Relativity" ,; Part I; P. 7 and 8, subsection 3.1-Principle of coupling of observers; www.relativityworkshop.com).

- It is previously proved that an orthogonal transformation R keeps the tensor operation of adjoint endomorphism.
- Note 3- If the tensor is symmetric, the symmetrical characteristic of the tensor is also preserved in an orthogonal transformation.

Reduction of observer space-time to an affine space

In the begining, following the perspective of classical relativity, we establish that observers and the observed fenomena are immersed into a space-time of points **O** , **associated to a lorentzian vectorial space-tima L.**

That is O_1, O_2 and O_0 are points of an affine space.

Within this context, O_0 is the point linked to the observed phenomenon F_0

- Their reference frames are represented into the associated vectorial space **L.**
- **Now, in this way and into this context, L_1 and L_2 can be treated as subespaces of L**
- **Now, R acts as an endomorphism into L.**
- **The bases B_1 and B_2 now can work into L, as well.**
- **See fig. 4**

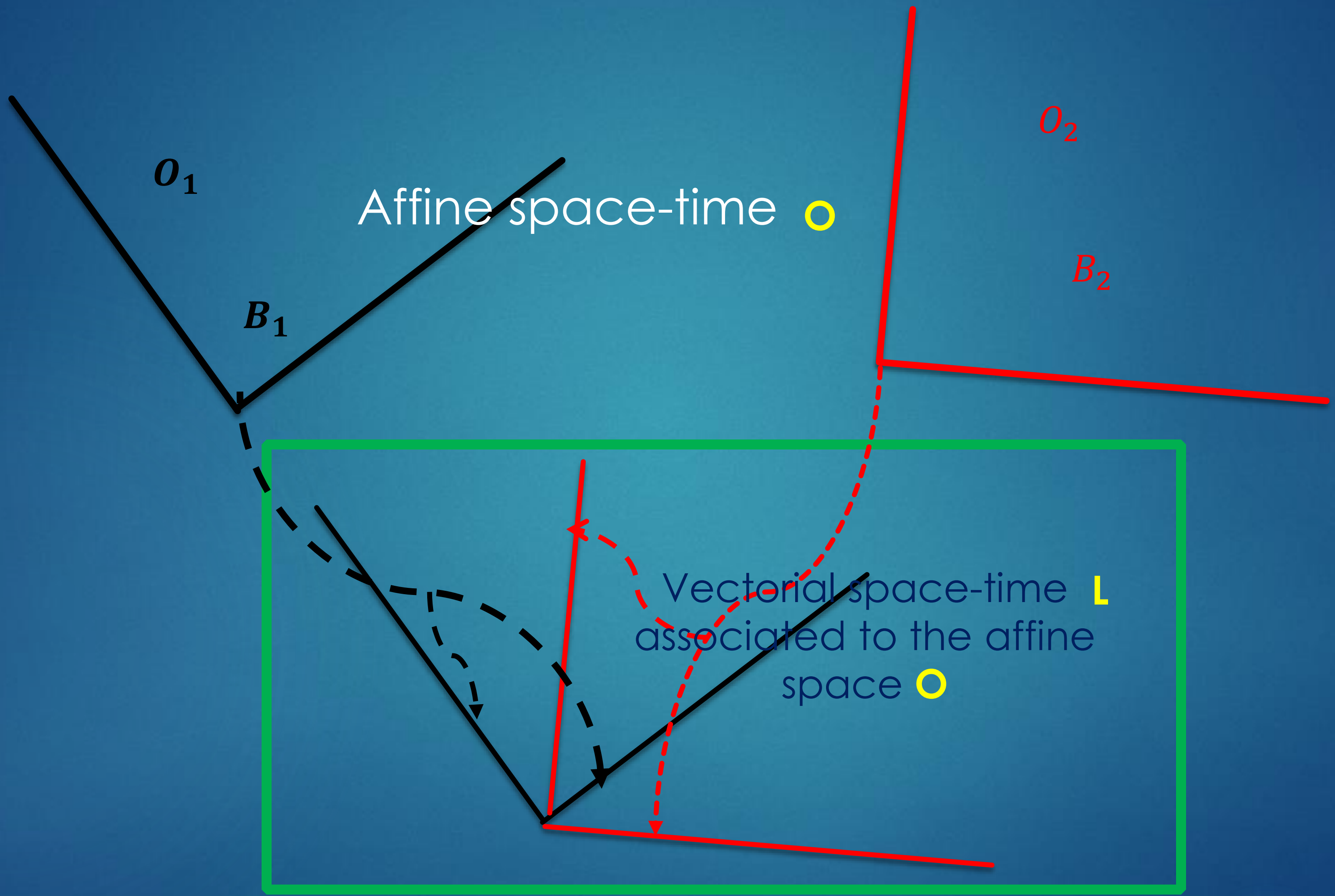


Fig. 4 . Affine space-time and associated vectorial lorentzian space

Reduction to classic theory of relativity

Restricting to the field of the classical theory of special relativity, that is, to inertial reference frame, we have: $G_1 = G_2 = G$;

where universe Interval is

$$s^2 = -x_0^2 + x_1^2 + x_2^2 + x_3^2$$

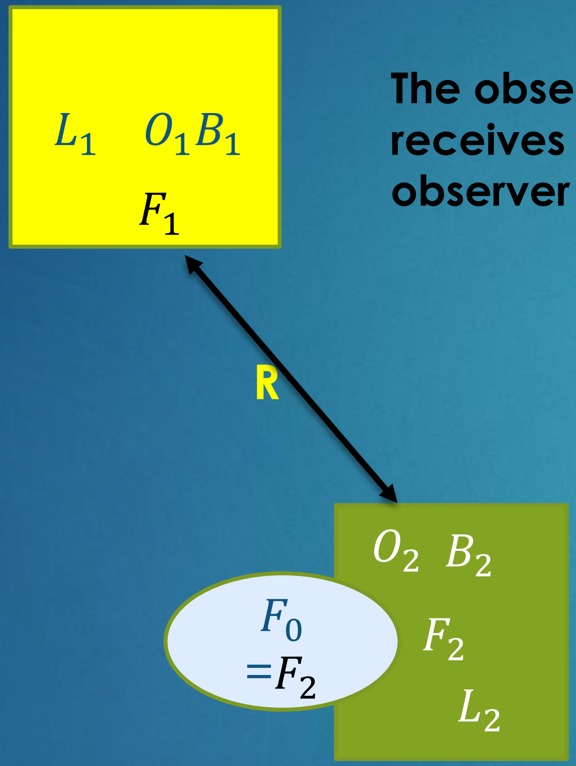
$$x_0 = c\, t$$

Besides F_2 coincides with F_0 . Or rather the oberver o_2 coincides with the observed phenomenon.

See Fig, 5.

$$s^2 = -c^2\, t^2 + x_1^2 + x_2^2 + x_3^2$$

Observer 1



The observer 1, O_1, receives signals from observer 2, O_2

Structure of the observation for the case of the special relativity.

Observed phenomenon ≡ Observer 2

Fig. 5 Observation diagram.
The observer 2, O_2 , coincides with the observed physical phenomenon F_0.

Steadiness of the speed of light.

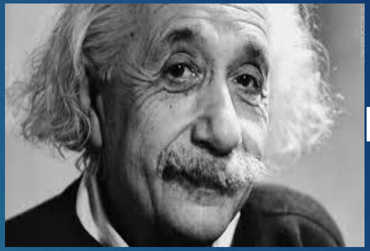
We shall use similar reasoning to those of special relativity.

The metric is:

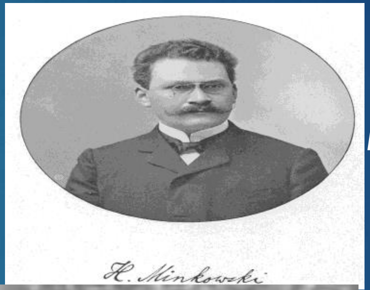
$s^2 = -\boldsymbol{c}^2\ t^2 + x_1^2 + x_2^2 + x_3^2$

Th ortogonal transformation R leaves invariant the skew-adjoint feature of electromagnetic field.

It leaves invariant the coefficients of the metric, as well. Among them **c**, the velocity of the light, remains invariant.



Einstein



Minkowski

Lorentz

Poincaré

In this way we attain the starting point of special relativity: **The constancy of the speed of light for inertial reference frames.**

- So, into a context of space-time and from the tensorial and skewadjoint features of electromagnetic fields, we infer the next two points :

- a)—Between two inertial references frames there is an orthogonal transformation or rather, Lorentz transformation.

- b)—The speed of the light remains constant for inertial reference frames.

The elecgtromagnetic field and the special theory of relativity

Electromagnetic field and the Lorentz transformation

The basis of the special theory of relativity is the electromagnetic field, according with the Poincaré-Einstein starting points.

- Thereby, the theory of special relativity is only valid in the domain in which are involved the electromagnetic fields.
- The Lorentz transformation leaves invariant the skewadjoint structure of electromagnetic field.

Other non electromagnetics fields

- In the domains in which there are not electromagnetic fields, the theory of special relativity is not fulfilled.
- When the conclusions of spatial relativity are not fulfilled, we must rule out, for example the equivalence between matter and energy, in the domain of the aforementioned non-electromagnetic fields.

However, as we saw earlier, (see pag 11, note 3) , there are other fields, as symetric tensor fields, that are invariants under an orthogonal transformation, or rather, under a Lorentz transformation. This would be aplicables to stress enegy tensor.

The electromagnetic field and the theory of relativity

Electromagnetic field and Lorentz transformation

The theory of special relativity is basicaly a theory for the electromagnetic field..

- Some texts develop the theory of relativity from several postulates without taking into account the electromagnetic field; see for example "The Classical Theoryy of Fields"; L. Landau and E Lifshitz; Chapter I.
- However, at the end, **the constancy of the speed of light appears.** That is, the intervention of the electromagnetic field. And it also appears as a maximum limit.

Other fields not electromagnetics.

- If other fields appear in the macrocosm, it would be necessary to look for new transformations that conserved their characteristics (in a suitable space-time frame).
- The physical interpretation of these transformations would lead us to find out another theory, couterpart to the relativity. This would be applicable only in areas of the macroscopic universe where such fields exists.

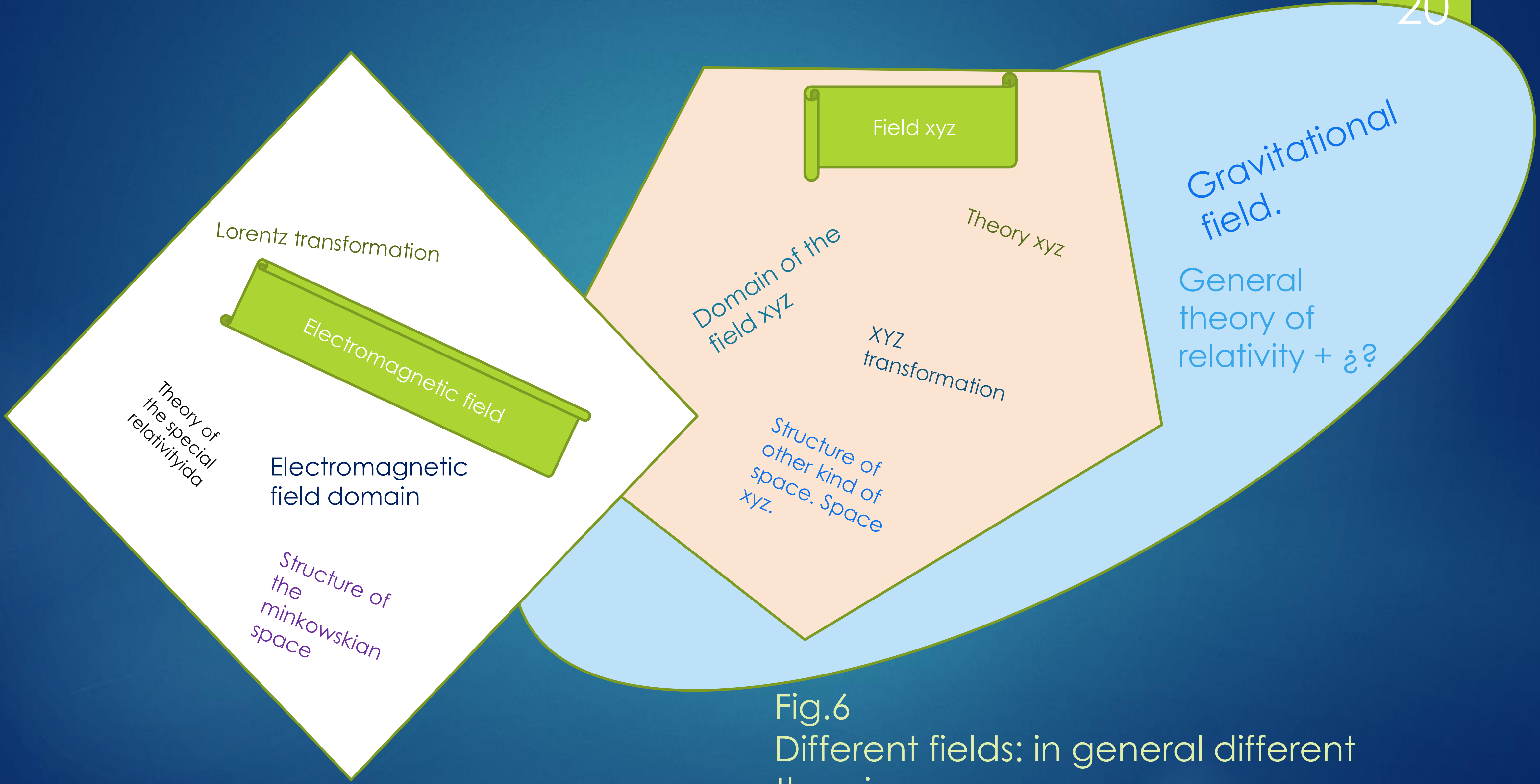


Fig.6
Different fields: in general different theories.

The minkowskian space-time structure is suitable for the description of the electromagnetic field. In another structure, Maxwell's equations could not be represented with all their characteristics and invariances.

In the intermediate between macrocosm and microcosm, that is, for example at molecular scale, the theory of relativity could be applied with caution.

It is possible that other non-electromagnetic fields would have to be represented in different space-time structures, counterpart to the space-time structure that represents the electromagnetic field in relativity.

The microcosm is another different world. In it, quantum physics is applied with totally different concepts and structures.

In neutral media (formed by particles composed of a charge + and another -, (that is, formed by particles with zero resulting charge), such as molecular atomic media, electromagnetic fields are made up and the action of these fields is vanished.

However, the components of these fields exist. Therefore they are transformed by the Lorentz transformation.

Therefore in the neutral media (charge = 0) the Lorentz transformation is applicable.