A few questions related to information and symmetries – in physics from certain view of philosophy of science

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Goal

The main goal of this session aims at

identifying

the nature of physical information.

Questions (1)

What do we consider physical information?

Can one speak about physical information when there is no live percipient to accept, evaluate and use it?

Can one speak about physical information
(e.g., signal exchange)
between inanimate physical objects ?

(Cf., e.g., Feynman diagrams.)

Questions (1)

If so, what is it for?

Is (physical) information a passive phenomenon,
or its existence presumes activity?

What does, e.g., a signal represent if it is not perceived and used at another end,

and

where is that end when one can say:
that signal was lost without perception or use?

Interpretation of ‘activity’

Interpretation 1:

Activity is an antropomorph phenomenon.

Interpretation 2:

There is inanimate activity,
i.e., reception of information between physical agents
and their reaction to it.

I argue for the latter!

Example:
interaction between two *electric charges*

Coincidence of *two types of interaction*:

- Coulomb-type (*scalar* part of *H*)
- Lorentz type (*vector* part of *H*)

1st type of theories:

1st approx: *interaction between the scalar parts*
2nd approx: *effect of the vector potentials as perturbation*

2nd type of theories:

1st approx: *action of the Lorentz force*
2nd approx: *effect of the Coulomb force as perturbation*

Are the roles of the interacting charges equivalent?

Conflict between the approaches by

C. Møller and *H. Bethe*.

Today's position: their roles are *a*symmetric (Møller).

If two particles – ready to interact – must be in different physical states:

how do they get information from (the state of) each other?

Information content of a physical signal

What do intermediate bosons transmit?
Do they convey information?

Yes.

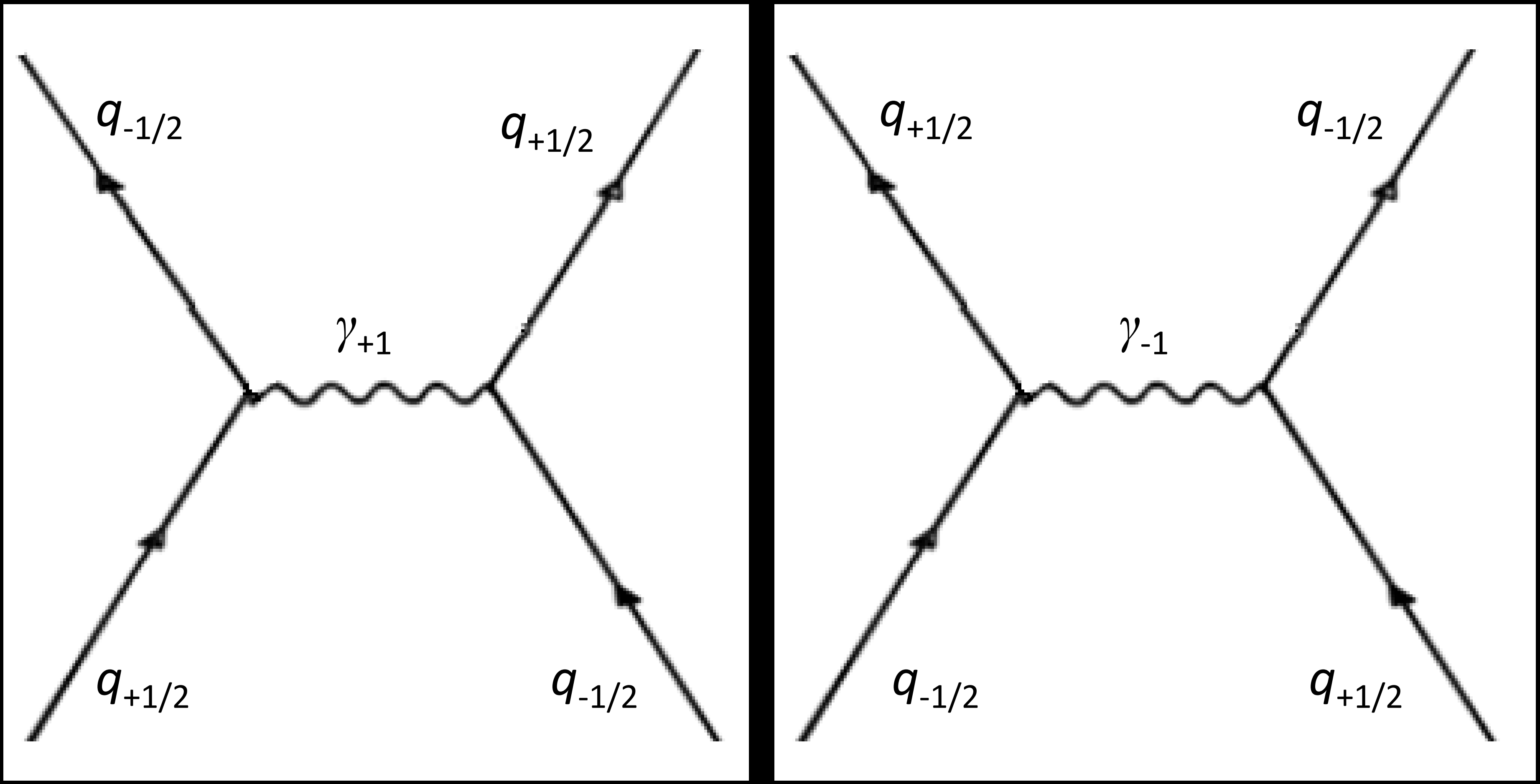
When an emitted boson does not meet a partner fermion which is able to absorb it,

does this mean that

- it did not convey information, *or*
- it conveyed, only that information has *not* been used?

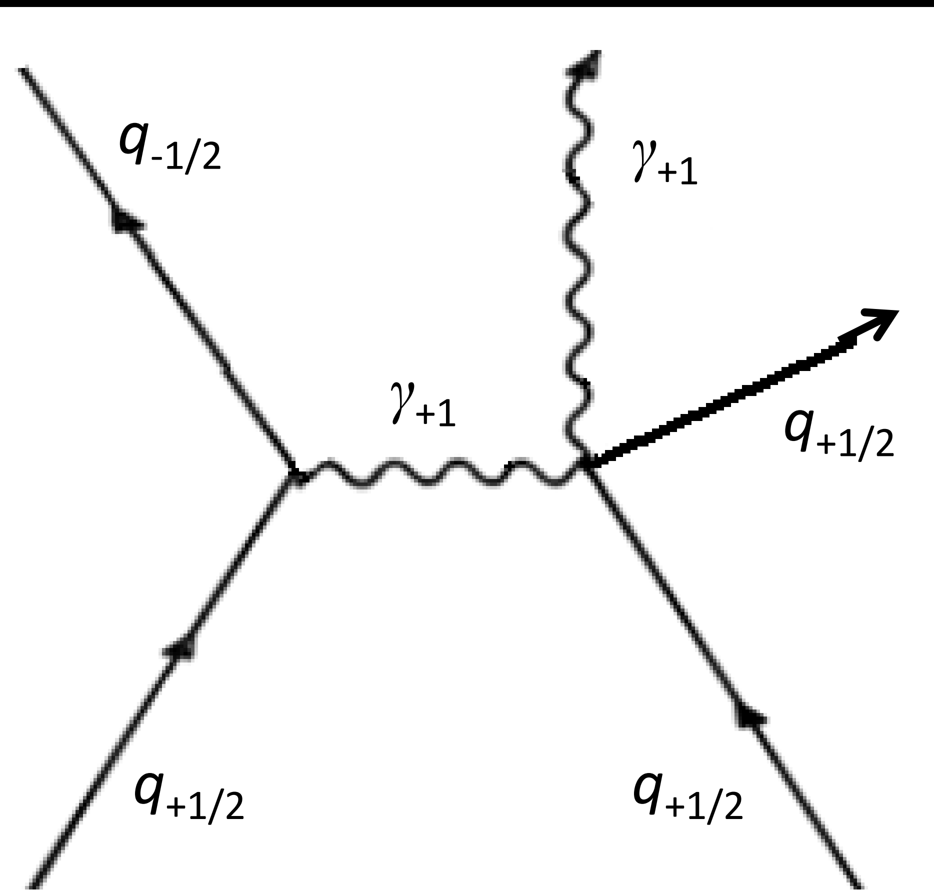
The latter.

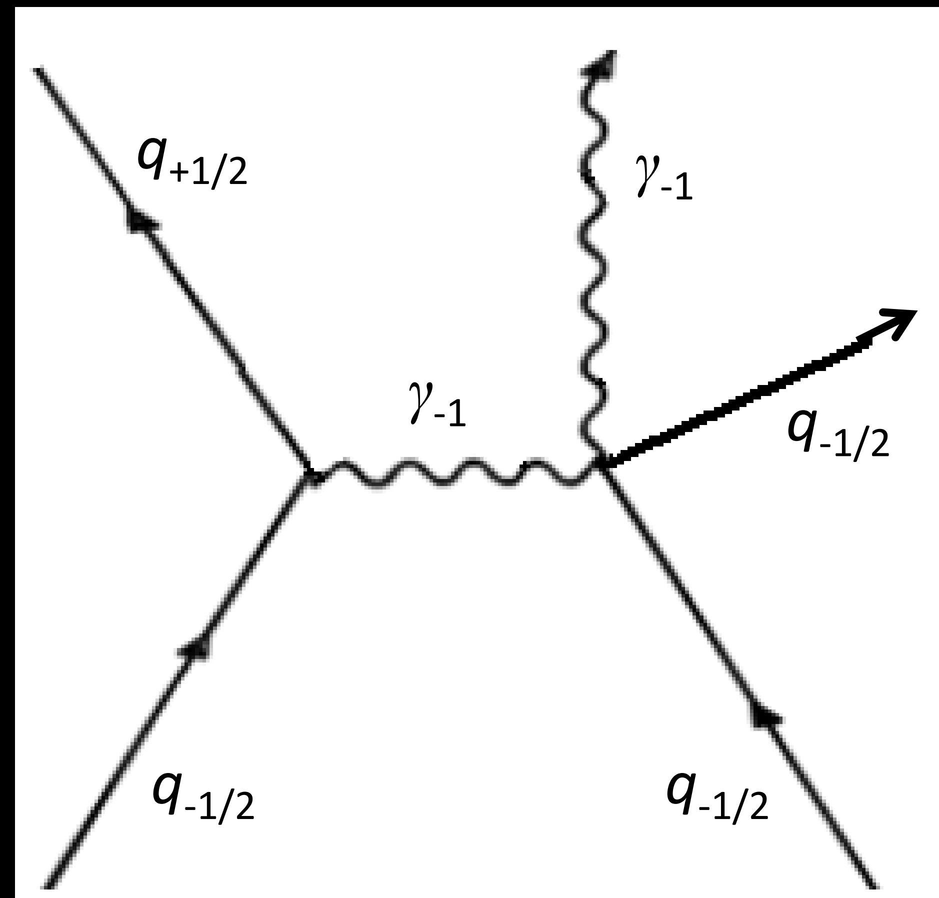
How do interacting fermions get information on the state of each other? (1)



Subscript indices ½ mark spin

How do interacting fermions get information on the state of each other? (2)





Compton scattering. Do not happen in bound states!

Questions (2)

Free particles interact in different way than *bound* ones.

What distinguishes (if any)
(closed and open) systems,
from the aspects of *information* and of *symmetries*?

What is the role of *information* in this delimination?

- Is (physical) information a passive phenomenon, or its existence presumes activity?
- If so, how wide can we extend the meaning of activity to be still accepted for generating information?

Questions (2)

What are the roles of different appearances of *symmetries* in taking a stand in the mentioned questions?

What kinds of symmetry

(e.g., reflexivity,
circulation,
thermodynamic temporal asymmetry,
gauge invariant phenomena,
scale invariance,
Lorentz invariance, etc.,
or their absence)

may play a role in making decision in the listed problems?

Invariance of physical laws under the choice among reference frames

The role of Lorentz invariance.

- from STR to other theories
- are there distinct (odd) reference frames in the universe?
- what tell us the two Noether theorems?

Surprise:

Physical quantites are conserved, but the amount of this conserved quantity varies according to the chosen reference frame !!!

(Is there one in which this amount is minimal or maximal?)

Invariance of physical laws under the choice among reference frames

Is there any *invariance* that

compensates this

lost equivalence of all reference frames?

Activity of inanimate objects

perceiving information received from another

e.g., evaluating the source of a
(gravitational or inertial)
force

or between
(Coulomb charges and the Lorentz-type (current))
charges

and so on ...
e.g., between effects of the *scalar* and *vector* parts of *H*

There should be something hidden behind,
at least at high relative velocities (energies).

Isotopic field-charges

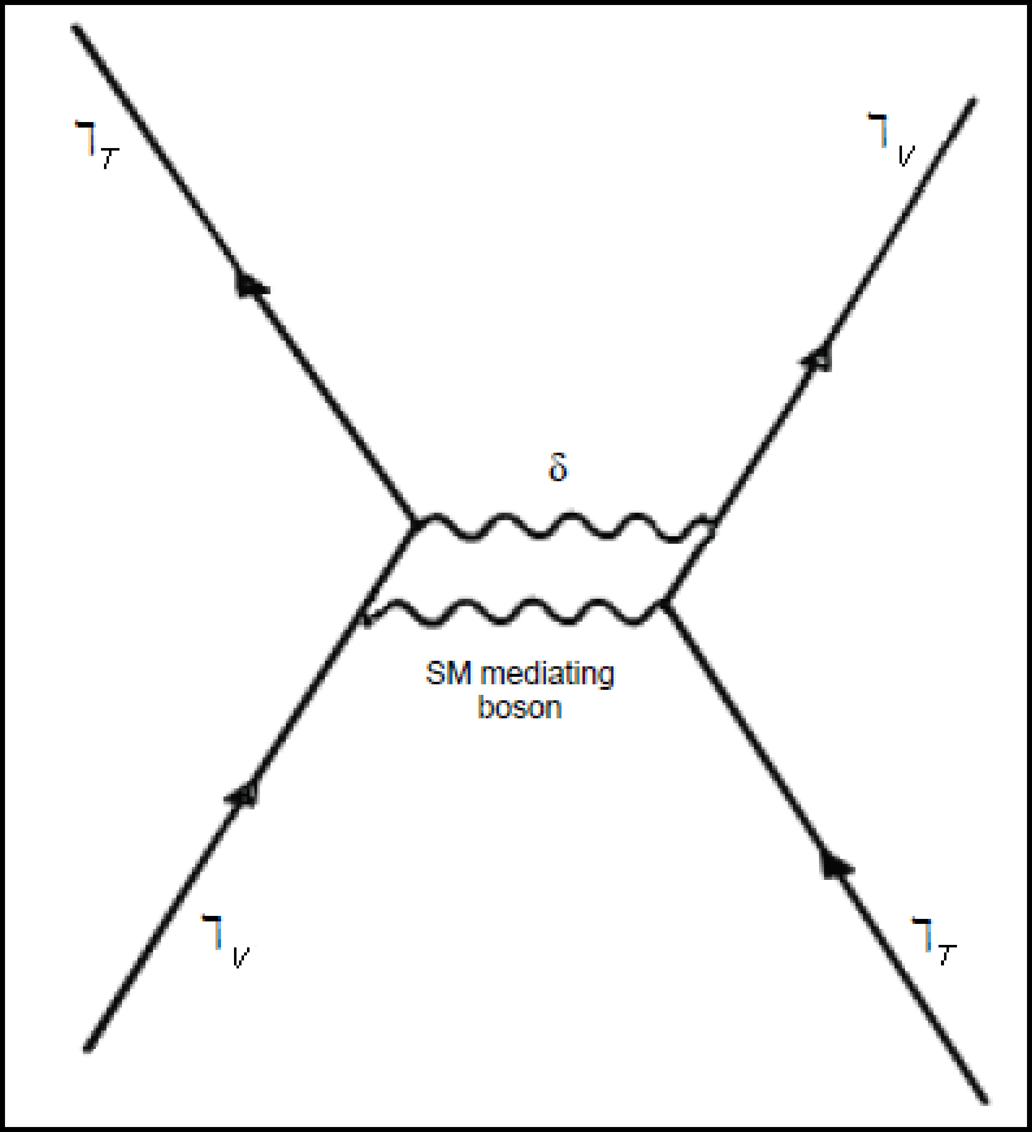
Sources of fields appearing in the
scalar and vector
(potential and kinetic)
parts of the system's Hamiltonian

These pairs are subject of a common gauge invariance

Properties of the isotopic field-charges

- they are subject to a group transformation – similar to that of the spin;
- can exchange their roles (switch into each other);
- they do this by the exchange of a gauge boson (additional to the graviton and the photon, respectively);
- we call them delta bosons (dions).

Boson exchanges between isotopic field-charges



Spin-like behaviour of the isotopic field-charges

As a consequence of the
additional invariance and the corresponding
additonal mediating gauge boson,
the respective systems of the two interacting isotopic
field-charges (masses or electric charges, etc.)
are not subjects of the Lorentz invariance *alone*.

They are subject of a
convolution of the Lorentz- and this additional invariance.

Conclusion 1

There is no more sufficient to demand
invariance under the Lorentz transformation *alone*.

At extended conditions, one should demand the invariance under a combination of
the *Lorentz invariance* and *an additional invariance*.

In short:
we demand invariance
under (applicable) transformations.

Conclusion 2

Two interacting charges *make a system*.

They *exchange information*.

They *obey each other's state* and *follow the Pauli principle*:
they must be in different quantum states.

According to the two-boson exchange model :
even in free-state 'systems'
the states – in which they differ –
should be characterised by *two properties;*
one of which should be
the newly introduced property.

Conclusion 2

The state of this two-particle system must be characterised also by the newly introduced property.

I.e.: each of the particles must be in
one of the two stable positions
of the isotopic field-charge
that are rotated into each other
by an S'U'(2) like symmetry group
in the isotopic field-charge field.

These two stable positions are called,
by an analogically given name,
the isotopic field-charge *spin* (IFCS)
(not identical
either with the *angular momentum spin* or the *isotopic spin*).

Conclusion 2

Consequently:

the IFCS is a conserved property.

Conclusion 2

When two field-charges interact,
they must be in the *opposite IFCS states*.

In the Møller-model (at least in the unperturbed state) they do not have information about each other's angular spin.

The *information* that they exchange about each other is about this state:
- they check whether the partner is in the opposite state.

Otherwise they were 'not allowed' to interact (Pauli's exclusion principle).

Conclusion 2

The *information exchange* takes place by

the exchange of a δ boson (called also dion) between them,

in addition

to the exchange of the traditional mediating bosons

(like graviton, photon, weak charged and neutral bosons, or gluons).

That *delta boson* switches

the *emitting charge*

from *inertial* to $\longrightarrow$ *potential* state,

and the *absorbing charge*

from *potential* to $\longrightarrow$ *inertial* state.

Summary

The asymmetry of the interacting charges has been explained.

It was subject of
information exchange
between the interacting particle partners.

In order to meet the Pauli principle,
physical objects should exchange information
about the (opposite) states of each other
before getting into active *interaction.*

Summary

The explanation led to the loss of an invariance property.

However,

this loss has been restored

- *by introducing a new physical property*

(isotopic field-charge spin)*,*

- *by proving its* conservation*,*

and

- completing the Lorentz invariance

with the respective invariance

attributed to the newly proven conservation.

Summary conclusion

This additional invariance embodied by

the associated intermediate bosons

convey also

information
between the interacting fermions.