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Deformed Space-Time Reactions and Their Phenomenology

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Abstract

Investigations of Piezo-nuclear reactions, Low Energy Nuclear Reactions or Condensed Matter Nuclear Science and E-cat are different ways leading to reactions supposed of nuclear nature, which are not easy to describe in terms of the commonly accepted theories. They are analysed by considering four main phenomenological characteristics: occurrence of an energy threshold; change of atomic weight; absence of gamma radiation and anisotropic emission of nuclear particles in intense beams having very short life span. These characteristics qualify them as consequences of reactions supposed to occur in regions of deformed Space-Time. This paper unifies all the observed phenomena into a unique general phenomenology, corresponding to the predictions of the Deformed Space Time theory. This theory is shortly introduced and is shown to apply not only to the nuclear interactions but also to the other known fundamental interactions.

Keywords

Deformed Space-Time Reactions, Cold Fusion, Low Energy Nuclear Reactions (LENRs), Condensed Matter Nuclear Science, Piezo-Nuclear Reactions, Energy Catalyzer (E-cat)

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1. Introduction

Non-conventional nuclear reactions were obtained in the last twenty years by treading different ways either using different experimental methods or basing on different phenomenology-based assumptions and expectations. New names were coined in order to indicate that not-predicted effects were observed: Cold Fusion (CF), Low Energy Nuclear Reactions (LENRs), Condensed Matter Nuclear Science (CMNS) Piezo-Nuclear Reactions (PNR) and finally Energy Catalyzer (E-cat).

A careful analysis shows that each of these terms is ambiguous. In fact, "cold fusion" can also indicate the nuclear fusion to be obtained by mu-mesic atoms [1]; the locution "Low Energy Nuclear Reactions" could also be attributed to the Uranium fission, as no further energy input is required when the critical mass is reached; the study of slow neutrons inducing Uranium fission could be indicated as "Condensed Matter Nuclear Science"; the same "Piezo-nuclear Reactions" can indicate not-exotic events if the mechanical energy supplied in a large volume can be confined in a small volume, thus attaining an energy density able to induce nuclear reactions: this could be the case of the ultrasound-induced sonication, if the energy of a micrometric bubble can be concentrated into an atomic volume, as it was suggested [2] or fusion obtained by mechanical adiabatic compression of a dense plasma [3]; "Energy Catalyser", on his count, is such a generic definition that can also be attributed to any catalytic agent inducing exothermic reactions.

This paper aims to analyse the behaviour that makes these anomalous effects different from the traditional ones, to

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indicate some common characteristics and to unify them under a general theory. The lack of a theoretical support, in fact, made these effects hard to be accepted by the scientific community up-to-now. The same technological applications are not taken into account in some case, as they cannot be classified following generally accepted schemas.

In the following, the unifying theory (the Deformed Space-Time Theory) and its experimental consequences are presented first; a discussion of the different experimental results at the light of this theory is then reported, in order to finally recognize that all these phenomena belong to a larger class, which is not limited to the nuclear case.

2. The Deformed Space Time Theory

2.1. DST-Theory

The starting point of Deformed Space Time (DST) Theory are the metric parameters b_i (i varying from 0 to 3) of the variety attached at each point x of the standard Minkowski space–time [$x = (x_0,x_1,x_2,x_3) = (ct,x,y,z)$, where c is a constant corresponding to the light speed in vacuum in a not-deformed space-time]: they are assumed to depend on a variable E, having dimension of Energy.

In particular, the local space-time geometry is characterized by a generalized interval ds^2 given by:

$$ds^2 \equiv b^2_0(E) \bullet c^2 \bullet dt^2 - b^2_1(E) \bullet dx_1^2 - b^2_2(E) \bullet dx_2^2 - b^2_3(E) \bullet dx_3^2 \quad (1)$$

The parameters $b_i(E)$ were deduced [4,5] from the experimental data [9-18] and are different for the different interactions. In particular:

- weak nuclear interaction:

$$b^2_0 = 1;\ b^2_1(E) = b^2_2(E) = b^2_3(E) = \begin{cases} (E/E_{0weak})^{1/3} & \text{if } E < E_{0weak} = 180.4 \pm 0.2\ \text{GeV} \\ 1 & \text{if } E \geq E_{0weak} \end{cases} \quad (2)$$

- strong nuclear interaction:

$$b^2_1 = 2/25;\ b^2_2 = 4/25;\ b^2_0(E) = -\,b^2_3(E) = \begin{cases} 1 & \text{if } E < E0_{strong} = 367.5 \pm 0.4\ \text{GeV} \\ (E/E_{0strong})^2 & \text{if } E \geq E_{0\,strong} \end{cases} \quad (3)$$

- electromagnetic interaction:

$$b^2_0 = 1;\ b^2_1(E) = b^2_2(E) = b^2_3(E) = \begin{cases} (E/E_{0\,em})^{1/3} & \text{if } E < E_{0\,em} = 4.5 \pm 0.2\ \mu\text{eV} \\ 1 & \text{if } E \geq E_{0\,em} \end{cases} \quad (4)$$

(in absence of adverse experimental evidence, an isotropic space was assumed)

- gravitational interaction:

$$b^2_0 = \begin{cases} 1 & \text{if } E < E_{0\,grav} = 20.2 \pm 0.1\ \mu\text{eV} \\ [1 + (E/E_{0\,em})]^2/4 & \text{if } E \geq E_{0\,grav} \end{cases} \quad (5)$$

($b^2_1(E)$, $b^2_2(E)$ and $b^2_3(E)$ are not yet determined)

Thus the sentence "geometry tells matter how to move, matter tells geometry how to curve" by Wheeler [16] or the Finzi Solidarity Principle [17] stating that "not only space-time properties affect phenomena, but also phenomena reciprocally affect space-time properties" – both referring to the Einstein General Relativity – now find a wider application to Matter/ Energy in all types of interaction.

In particular, Matter/Energy, which is a variable of the process, is also a variable of the metric. Thus the reference frame used to evaluate it and the involved interaction are of fundamental importance.

Without further entering into details, it is noticeable that we detect any phenomenon by using instruments and the five senses, which both are based on electromagnetic interaction. The detector determines the reference system, while the metrics of the involved interactions are seen through the electromagnetic one.

It is also interesting to note that the metric of weak and electromagnetic interactions is Minkoskyan (i.e. space-time is flat, isotropic and symmetric) at energy higher then the corresponding thresholds, while it is Minkoskyan at lower energy in strong and gravitational interactions.

2.2. Looking for DST - Reactions

The Energy thresholds were evaluated starting from processes involving elementary particles. In more complex systems, like liquid or solid samples, a more appropriate but less easy-to identify quantity was considered: the threshold of energy density. In order to evaluate it, the volume containing the E_0 energy must be defined.

To this aim, the volume of the micro-reactors where DST-reactions were supposed to occur was considered [18]: in the case of solids they are micro-cavities [19, 20] while in the case of sonicated liquids they are micrometric bubbles created during the cavitation phenomenon [21-24], the two types of reactors being of similar size.

Among the nuclear reactions, a DST-reaction is characterised by emissions of nuclear particles - up-to-now alpha particles [25-27] and neutrons [24; 28-31] are reported – without concomitant emission of gamma radiation. This later energy, in fact, is supposed to be used to deform space-time, thus maintaining the condition of deformed space-time. Till this condition is maintained, the process can continue, thus generating beams of high intensity. Their time span, however, is very short.

Peculiar features of nuclear DST-reactions can be summarised as the following:

1 Presence of an energy threshold

In complex systems it can be evaluated as a threshold in energy density. In practice, a delay time can be observed between the beginning of energy supply and the reaction start, so that a critical density is reached.

2 Change of atomic weight

After the DST-reactions, nuclei were found that were not present in the starting material, both in the case of solid and liquid materials

3 Absence of gamma radiation

The energy of gamma radiation is used to deform space-time.

4 Emission of nuclear particles in intense beams having very short life span

A further characteristic of these emissions is their anisotropy, which is considered as a consequence of the anisotropic metric governing the interaction.

3. Phenomenological Features

3.1. Piezo-Nuclear Reactions

Two methods were used to produce nuclear particle emissions by pressure (the term “piezo” indicates pressure): ultrasounds and mechanical presses.

Ultrasounds in water and in water solutions produced the phenomenon of cavitation. In correspondence, neutron emissions [24] were detected while no gamma radiation above the background level was registered. The formation of light and heavy nuclei is also reported. Some hints for an anomalous decrease of Thorium radioactivity were obtained [32]. This last fact was considered as a consequence of changes in atomic weight that transformed some radioactive nuclei into non-radioactive ones.

Ultrasound irradiation in Iron-containing solid materials is reported [33] to produce neutron emissions without detectable gamma radiation. Damage spots appeared on the lateral surface of cylindrical Steel or Iron samples: atoms not present in the sample matrix were detected in correspondence of these spots [33, 19, 20], thus indicating that they are related to nuclear reactions.

Concerning the mechanical press methods, nuclear particle emissions from solid materials were observed during stress/strain cycles of Steel samples [25, 26] and in the rupture test of Iron samples [27] and natural rocks [28-30]. In this last case neutron emission were observed in samples characterised by brittle fracture but not in case of a ductile one. In correspondence to this fact, one can observe that a dramatic emission of energy in a short time is characteristic of the former while a slow release and some energy retention are characteristic of the latter.

These piezo-nuclear reactions respect the four characteristics of the DST-reactions reported in the previous §2.2. In fact delay times were registered, which correspond to the presence of energy thresholds; atoms not present in the starting material were found in the reaction products and/or nuclear particle emission were detected thus indicating that changes in atomic weight occurred; no gamma radiation above the background level was recorded and the emission of neutron or alpha particles was neither continuous nor isotropic.

A further characteristic of these emissions is noteworthy: they are rather observed after a sudden energy concentration or release, as in the case of bubble implosion and micro-cavity compression after ultrasound irradiation or in the case of brittle fracture, but not in the ductile one.

3.2. LENR and CMNS Reactions

Palladium and Deuterium are the most intensively studied materials for Cold Fusion in the field of Low Energy Nuclear Reactions and Condensed Matter Nuclear Science.

Rather than some chemical or nuclear characteristic of these atoms, we presume that the operational methods of the performed experiments are of primary importance for the success or failure of the process. In some case, in fact, due to some fortuitous facts, the conditions of Deformed Space-Time are realized and nuclear reactions are obtained that cannot occur in flat conditions.

It was already discussed [34] that in Palladium/Deuterium co-depositions [35-40] an abrupt energy release is obtained after the Palladium microstructure is deformed and weakened by the Deuterium atoms, by the applied electric and magnetic intense fields and by the electrolysis current increasing from time to time. In analogy with the natural rock rupture, where neutron emission are observed in correspondence of the catastrophic brittle but not of the smoother ductile fracture, the energy release is observed from Palladium but not from Copper [35], due to the lower deuterium absorption of the latter and consequent lower structural deformation.

A latency time is also observed between the beginning of energy inlet and energy detection; this fact, as already discussed, corresponds to the occurrence of a threshold in energy density.

Some hot spots with anisotropic distribution in space and time are also reported to form in the cathode. Due to their similarity to the damage spots produced in Iron and Steel bars after ultrasound radiation [33], they can be attributed to the emission of intense, anisotropic in time and space, short-time beams of nuclear particles, as it is characteristic for DST-reactions.

The same absence of gamma radiation, which caused scepticism on the real occurrence of these nuclear reactions, is a further characteristic indicating that they can be categorised as DST-reactions. Change of atomic weight and neutron emissions can thus occur without emission of gamma radiation.

3.3. E-cat

E-cat [41] is the most recent example of phenomenology that is considered inexplicable following the generally accepted laws of Nature but, on the other hand, got the characteristics of a DST-reaction, as we are going to explain.

The test of E-cat performance, made by an independent group, can be divided into three main stages: a first run without fuel in the reactor aiming to check that instrumentation measured the right balance of input and output energy. After 23 hours the reactor was switched off and this preliminary phase ended.

The following two phases performed in fully operational conditions lasted totally 32 days. They consisted in a 10 day stage where the average temperature of the reactor body was 1260°C, the electric power input around 810 W and the yield was measured as a COP factor of about 3.2; and a final stage at 1400°C obtained by increasing the inlet power to slightly above 900 W, with a COP of about 3.6.

The specific energy obtained from the fuel was larger than in any other known source of energy, apart from the nuclear. With respect to the initial fuel, the isotopic composition of Lithium and Nickel in the ashes was found different but no radioactivity was detected in the reactor. These last two results are in contradiction if one considers the commonly accepted nuclear theory: in fact any imaginable nuclear reaction producing these isotopic changes should produce a detectable radiation in the reactor also after switching the process off. The absence on detected neutrons was considered well explicable.

- The questions left open after this test can find an answer if one considers the phenomenology of the process, which is characteristic of DST-reactions. In fact
- The occurrence of a threshold is not clearly detectable, but it could be inferred from the delay time between the maximum of mean power consumption and the increase of net power production and consequent COP increasing on passing to the last phase of the test. It could be related to a latency time necessary to accumulate locally the required energy density.
- The changes of atomic weight are testified by the different compositions of the initial fuel and the final ashes
- The absence of radiation resulting after the test is a key-point. In fact the absence of gamma radiation is an open question for traditional nuclear theory but a distinguishing feature of DST-reactions
- The absence of detected neutrons is a conceivable result for the authors. On the contrary, we rather believe that intense, anisotropic and short living beams were emitted. They were not detected due to the fact that intense beams of short duration are treated as impulsive noise by the whole detecting system. In particular, the neutron detectors are usually not optimised to record this kind of signal while the related electronics usually eliminate them as an undesirable noise. In previous "piezo-nuclear" experiments [28-31, 33] neutron detectors with a large volume and coated by boron-10 were used and particular care was dedicated to this fact.
- The underestimation of intensity resulting from traditional detectors with respect to these reactions was also discussed in [26].
- Furthermore, the anisotropic direction of the emitted beams can also play its role, when the receiving detectors are positioned in correspondence of some particular directions, where eventually beams are not directed to.

4. Conclusions

The present paper shows that those experimental results, obtained in the last years, that are not fully accepted by the scientific community due to their mismatch with the currently accepted theories, can find an explanation in the framework of the DST-Theory. In particular some of its phenomenological consequence are put in evidence, which are common features of the different experimental observations.

This theory can thus assume the role of unifying different fields, identified by using different names over the years: Cold-Fusion, Low Energy Nuclear Reactions, Condensed Matter Nuclear Science, Piezo-Nuclear Reactions and Energy Catalyzer.

From this unifying vision, suggestions can derive for future investigations. In fact, in order to check if the observed phenomena could be the consequences of underlying nuclear DST-reactions, the four main phenomenological characteristics can be checked: occurrence of an energy threshold; change of atomic weight; absence of gamma radiation; anisotropic emission of nuclear particles in intense beams having very short life span.

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