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Energy spectra and fluence of the neutrons produced in deformed space-time conditions

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In this work, spectra of energy and fluence of neutrons produced in the conditions of deformed space-time (DST), due to the violation of the local Lorentz invariance (LLI) in the nuclear interactions are shown for the first time. DST-neutrons are produced by a mechanical process in which AISI 304 steel bars undergo a sonication using ultrasounds with 20 kHz and 330 W. The energy spectrum of the DST-neutrons has been investigated both at low (less than 0.4 MeV) and at high (up to 4 MeV) energy. We could conclude that the DST-neutrons have different spectra for different energy intervals. It is therefore possible to hypothesize that the DST-neutrons production presents peculiar features not only with respect to the time (asynchrony) and space (asymmetry) but also in the neutron energy spectra.

Keywords: Neutrons; energy; deformed space-time; local Lorentz invariance; spectra measurements.

1. Foreword

Emissions of nuclear particles, neutrons and alphas, from liquid or solid materials that have undergone changes in energy density induced by ultrasound pressure or other mechanical processes have been studied in past papers.[1–6] It has been verified that such emissions are asynchronous or rather that they lack any temporal structure displaying periodicity or any recurrence, and that they are asymmetric, i.e. they have a spatial distribution which is anisotropic, yet dependent on direction.[6–9] However, testing has confirmed that the peculiarities of the emissions displaying

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the above-mentioned features, fit and can be explained by space-time deformation (DST), which is a consequence (and is consistent with) of a violation of the local Lorentz invariance (LLI) triggered by interactions involved in the process.[8–12] For this reason, we refer to such emissions and the related particles with the prefix DST. It has been verified that these emissions occur when critical densities of energy occur in matter.[13] Although preliminary, the statistical tests of these emissions give sufficiently convincing results to justify a follow up study of their features focusing on the DST-neutrons.[14]

2. Materials and Methods

We subjected some cylindrical steel bars (AISI 304) with mass 180 g to sonication by ultrasounds with a frequency of 20 kHz and power of 330 W for a time interval of 180 s.[1,7,8] We measured the DST-neutron emissions using the double system of detection. The first system was the PADC Polycarbonate-CR39 (Boric acid) developed and calibrated at the ENEA Research Centre of Rome-Casaccia. It is an imaging system that gives a passive measurement of the integral neutron dose released in the device (the PADC plate) during the time interval of the sonication (and related emission).[15,16] The PADC-CR39 (AB) was placed around a sonicated steel bar to record the signature of the actual neutron emission for comparison with those produced during LLI violation.[8] The second system we used was the MICROSPEC2 Neutron Probe made by firm BTI, which was utilized to measure dose, fluence and spectrum of DST-neutrons coming from the sonicated steel bar.[17,18] For a more comprehensive evaluation, we also used a gamma-ray detector, the HDS 101 GN by MIRION, to confirm the absence of gammas above laboratory background during the DST-neutron emission, as recorded in all past experiments.[19] The MICROSPEC2 Neutron Probe is a rather complex system. Therefore, this system was tested and its unique features reported by the firm-maker were verified during measurements performed at the ENEA Research Centre of Rome-Casaccia using three different neutron sources: Americium–Beryllium, nuclear reactor TRIGA and nuclear reactor TAPIRO (for information about these sources see for e.g. Refs. 15 and 16). The DST theory states that an interaction violating LLI in a nucleus results in a reaction characterized by emissions of nuclear particles in DST conditions.[10,19] However, once produced, such particles travel in a flat Minkowskian space-time, which is also the space-time of the detector and of the physical processes giving rise to detection.[10,12] Consequently, we positioned a PADC Polycarbonate-CR39 (AB) along the ideal segment connecting the neutron probe with the surface of the sonicated steel bar, at a distance between the neutron probe and the bar. In this way, the bar-PADC and bar-Neutron Probe distances were different but oriented along the same direction. We verified that the doses measured by the two systems had an inverse square relationship with the above defined distances.[1,7] This was evidence that, after being emitted, the DST neutrons moved in a flat Minkowskian space-time and were detected by both detectors in flat Minkowskian conditions. Consequently, the requirements of the DST theory were fulfilled.[8,10,12] In fact, as reported above, this theory affirms that an interaction violating LLI in a nucleus brings about a reaction characterized by emissions of nuclear particles that takes places necessarily in DST conditions. However, once emitted, such particles travel in a flat Minkowskian space-time, which is also the space-time of the detector and of the physical processes giving rise to detection. Before and after the sonication tests, we performed background measurement runs each lasting an interval time of 15 min, i.e. five times the time interval of sonication, using the MICROSPEC2 Neutron Probe. The background resulted quite negligible since in each run few neutrons (less than 10) have been registered only over the energy interval 0.5–2 MeV (see also Refs. 1, 7 and 8). This result was compatible with the electronic noise of the system used.[17,18]

3. Spectra Measurement

For each spectrum, we performed a set of measurements which proved consistent, displaying neither significant nor substantial differences among them. In Fig. 1, we report the energy spectrum and the fluence. In Fig. 2, we show the high energy

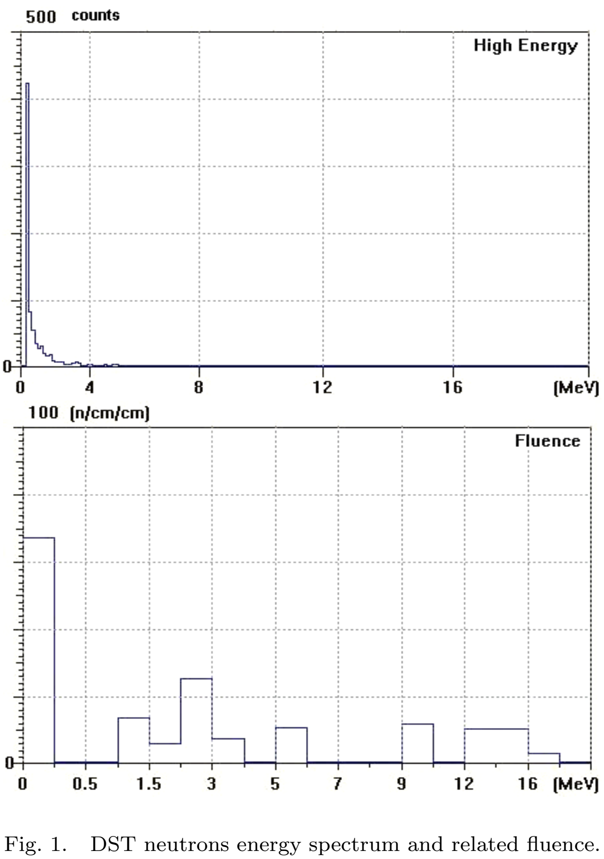
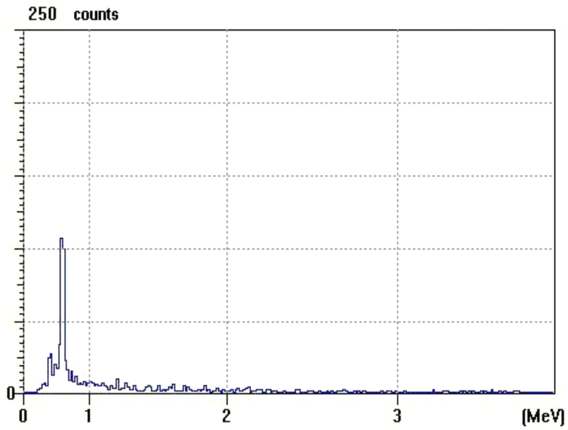
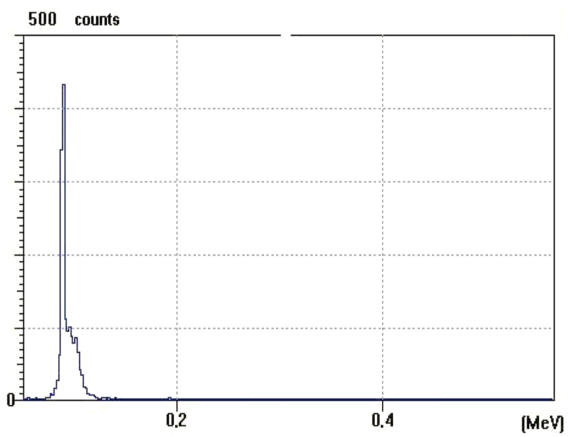


Fig. 1. DST neutrons energy spectrum and related fluence.



(a)



(b)

Fig. 2. DST neutron spectrum in details: (a) 0.3–3 MeV, NE-213 liquid scintillator detector. (b) 0–0.3 MeV, Helium-3 gas detector.

spectrum, i.e. up to 4 MeV (Fig. 2(a)), obtained by the NE-213 scintillation counter, well suitable for this task due to its detection stability characteristics and low energy spectrum, i.e. less than 0.4 MeV (Fig. 2(b)), obtained by the He-3 counter.

The peculiar features of these spectra deserve further investigations. For now, we think that it is worth comparing these spectra with the graph in Fig. 3, showing the asynchrony of DST-neutron emissions, and the diagram in Fig. 4, showing the anisotropy of these neutron emissions. Collecting altogether the graphs of the spectra, the diagram of the spatial emission and the graph of the emission in time, we have the first complete, although preliminary, characterization of DST neutrons. This characterization shows that the DST-neutron emissions have peculiar

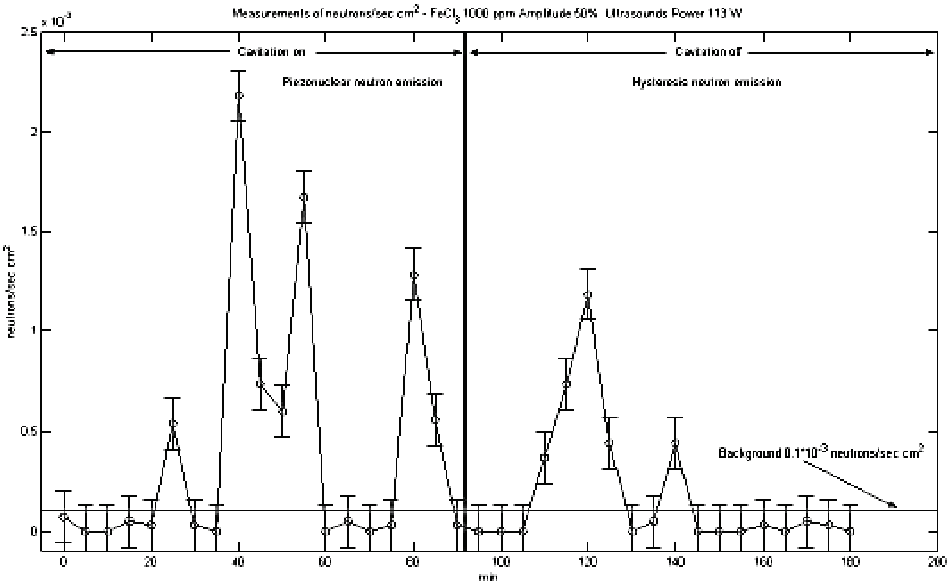


Fig. 3. Time asymmetry of neutron bursts from DST emissions.[6]

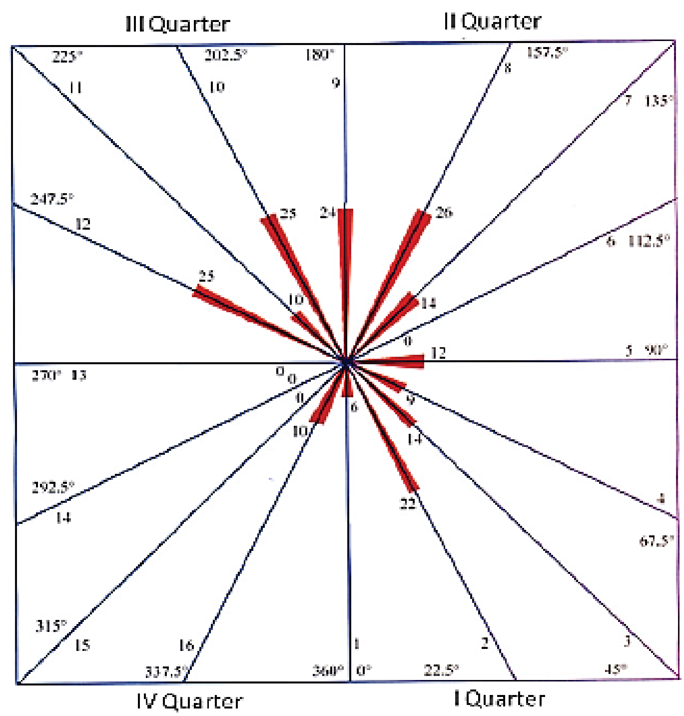


Fig. 4. Spatial asymmetry of neutron bursts from DST emission.[1,7,8]

features not only with respect to space and time, but also with respect to the energy spectrum of the emitted neutrons. There exist, in fact, two different neutron spectra: one at low energy and one at high energy, apparently not correlated with each other. Conversely, the neutron spectra of known sources (Americium–Beryllium, fast neutron reactors, thermal neutrons), present single trend for the whole neutron spectrum (see, for instance, the spectra of these three mentioned sources in Ref. 16).

Moreover, we have to keep in mind that the emission of nuclear particles in DST conditions was recorded to occur in bursts in all past experiments.[3,6,10,13,14,19] Therefore, in accordance with the detectors used, a careful study of the energy, space and time effects (including dead-time effect) that these features (asynchrony, asymmetry, anisotropy, burst emission) have on the measurement efficiencies will be necessary in order to ensure improved accuracy of future measurements.

4. Concluding Remarks

In the past, a lot of experimental effort was directed at the discovery of new kinds of nuclear reactions and emissions related to them, with many experiments being performed.[20] Although a great deal of attention was paid to new types of nuclear reactions, less was given to the fact that they can give rise to particle emissions with new characteristics and peculiar features. Characteristics and features that current detectors, especially active detectors, and available techniques are incapable of adequately detecting, which limits our understanding of these new features, see for e.g. Refs. 21 and 22. In the case of neutron emissions, some methods have been proposed, including neutron activation of Indium foils and the use of Uranium fission chambers.[23] It is evident that the DST-neutron spectra shown in Figs. 1 and 2 have a poor, or even no correlation with the behaviors shown in neutron cross-sections of Indium and Uranium, both U-235 and U-238. Moreover, it is our opinion that it will not be an easy task to plan and prepare an absorber and moderator for use in the detection of DST-neutrons due to the asynchrony, asymmetry and anisotropy of their emissions. Nevertheless, the measurement of these spectra can be an important step toward the exploitation of the energy produced in the DST-reactions.[24–27]

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