*Physics – Uspekhi* **66** (4) 435 – 436 (2023) 

*PHYSICS NEWS*

PACS numbers: **01.10.–m**, **01.30.–y**, **01.90.+g**

# Physics news on the Internet (based on electronic preprints)

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DOI: https://doi.org/10.3367/UFNe.2023.03.039341

## 1. $p^{11}B$ fusion reaction in a stellarator

Naturally occurring isotopes participate in the nuclear fusion reaction $p^{11}B \rightarrow 3\alpha + 8.7$ MeV with no neutrons at the output, and therefore this reaction is fairly attractive for fusion energy. However, this reaction requires a temperature 30 times higher than in the deuterium-tritium mechanism. This results in high-power electromagnetic plasma radiation preventing a positive energy release. Nevertheless, theoretical calculations have shown that the radiation loss can be decreased by violating thermal equilibrium between electrons and positive ions through electron temperature lowering. Till now, the $p^{11}B$ reaction was only observed in plasma produced by powerful laser pulses and at accelerators. R M Magee (National Institute for Fusion Science, Japan and TAE Technologies, USA) and his co-authors have demonstrated for the first time the $p^{11}B$ reaction in a magnetically confined plasma [1]. Boron powder in a glow discharge was introduced in a superconducting stellarator LHD (Large Helical Device) (plasma boronization process) and was concentrated near the core of the confined plasma. High-energy protons were also injected there. Nuclear reactions were registered by a silicon detector by bursts of alpha particle fluxes. Solutions to many complicated technical problems are needed for a practical application of the $p^{11}B$ reaction in a reactor.

## 2. Room-temperature hydride superconductivity

Some data indicate that hydrides can have a high superconducting transition temperature $T_c$, and $CaH_6$ superconductivity at $T_c = 220 - 235$ K has already been revealed at a pressure of 150 GPa. Along with a $T_c$ increase, the problem of pressure lowering resulting in the occurrence of high-temperature superconductivity is topical. Doping that heightens atomic lattice stability was considered a promising method. A new experiment performed by N Dasenbrock-Gammon (University of Rochester, USA) and his co-authors has confirmed this expectation [2]. In nitrogen-doped lutetium hydride, room-temperature ($T_c = 294$ K or 21 °C) superconductivity was observed at a pressure of only 10 kbar. The presence of superconductivity was shown in several ways: by a lack of electric resistance, by the behavior of magnetic susceptibility and thermal capacity, etc. The structure of nitrogen-doped lutetium hydride has not yet been completely clarified. To understand it, investigations using the neutron diffraction method will be needed. Obtaining room-temperature superconductivity is now one of the most topical problems of modern physics [3]. For ambiguous results in the examination of superconductivity in carbonaceous sulfur hydride, see [4].

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*Uspekhi Fizicheskikh Nauk* **193** (4) 462 (2023)
Translated by A N Tsaplin

## 3. Light localization in a moire lattice

Moire lattices are structures formed by identical sublattices mutually twisted at a certain angle in their plane. Unusual superconductivity and other interesting effects were observed in systems with atomic layers in the form of moire lattices. A A Arkhipova (Institute of Spectroscopy RAS and the Physics Department of the Higher School of Economics) and her co-authors have demonstrated for the first time a photon moire lattice created with a femtosecond laser [5]. The moire lattice was limited to a square area, which made it possible to investigate edge excitations in both linear and nonlinear regimes for different orientations of the primary lattice. The moire lattice was found to maintain linear modes localized in the corners and at the edges of the lattice with a weak background inside, and the transfer from the linear quasi-localized states to surface solitons occurring at higher light intensities was observed.

## 4. Time reflection

Ordinary signal reflection proceeds from a spatial interface between media with different properties. However, the version of 'time reflection' after a synchronous variation of the properties of a homogeneous medium was theoretically considered. In this case, the reflection occurs not at the spatial but at the temporal boundary. A similar effect was earlier observed for monochromatic signals only, when the properties of the medium were modulated by another signal with double frequency. H Moussa (City University of New York, USA) and his co-authors have become the first to demonstrate the time reflection effect for broadband electromagnetic signals [6]. Employed to this end was a metamaterial — a large array of microchips simultaneously connecting additional capacitors, thus changing the electric properties of the medium. As a result, the incoming signal was divided to reflected and transmitted signals with frequency conversion. The use of two such metamaterials made it possible to observe the interference of transmitted and time reflected signals.

## 5. Black holes and cosmology

In the theory of gravitation, models of nonsingular black holes (BH's) exist with masses increasing due to the Universe's expansion. D Farrah (University of Hawaii, USA) and his co-authors have verified this mass growth hypothesis for BHs in galactic nuclei at redshifts $0 \leqslant z \leqslant 2.7$ [7]. Evidence was found that within this time the BH masses did actually increase 8 to 20 times relative to the galactic star masses, the whole increase being hard to explain by gas accretion. If the BH mass dependence on the Universe scale factor is expressed in the exponential form $M \propto a^k$, then $k = 3.11^{+1.19}_{-1.33}$. For $k \simeq 3$, the internal part of the space-time of such BHs under the horizon can be determined by a certain type of dark energy [8–10]. Another interesting possibility is to explain the accelerated expansion of the Universe by the increase in the total BH mass, including BHs resulting from the stellar evolution. The authors of [7] have shown that an increase in BH mass by the law $M \propto a^k$ with $k \simeq 3$ can imitate the presence of dark energy in the Universe, leading to an accelerated expansion. To verify this model, further studies are needed using more extensive statistical material.

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