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1. First results of JUNO experiment

The JUNO (Jiangmen Underground Neutrino Observatory) collaboration, including Russian researchers from JINR, INR RAS, and MSU, has presented the first results of JUNO experiment measurements of parameters responsible for neutrino oscillations [1]. The JUNO detector, constructed in China, registers neutrinos from nuclear reactors. The distance to the group of reactors is 52.5 km, which is optimal to observe the first oscillation maximum. The detector is located underground, screened from cosmic radiation, and contains 20 kt of liquid scintillator scanned by a photomultipliers. Owing to the unique detector's capabilities and accurate calibration, already within the first 59.1 days of observations, the precision of determining two oscillation parameters was 1.6 times higher than the total precision reached in all the preceding experiments. The values $\sin^2\theta_{12} = 0.3092 \pm 0.0087$ and $\Delta m^2_{21} = (7.50 \pm 0.12) \times 10^{-5}$ eV^2 for direct mass hierarchy was obtained through comparison of the neutrino flux observed in the detector with the known fluxes from the reactors. With increasing numbers of statistics, new important results are expected with a possible clarification of ordering (direct or inverse) of mass states of neutrinos.

2. Relation with spin qubits

One branch in quantum calculations concerns spin qubits on the basis of impurity atoms in semiconductors. A high quality of the crystal lattice consisting of zero spin atoms facilitates a long time of qubit coherence, up to several seconds. However, good isolation simultaneously presented the problem of establishing the interaction of qubits with each other and with external control systems. T. Chang (Bar-Ilan University, Israel) et al. have demonstrated a new effective method of interaction with qubits on the basis of a bismuth atom in a silicon lattice [2]. Strong magnetic coupling was established through additional superconducting qubits. Using microwave pulses in the resonator, the spin qubit was initialized, and quantum information was transferred from it to the superconducting qubits, that is, the spin qubit in this case represented a quantum memory element.

3. Superconductivity in moiré graphene and Volovik effect

In their experiment, J.M. Park (Massachusetts Institute of Technology and Princeton University, USA) and her co-authors have examined three-layered moiré graphene with atomic layers twisted relative to each other at a certain ('magic') angle, which changes radically the shape of the Fermi surface [3]. Investigation of materials with twisted atomic layers is a new promising area, called 'twistronics.' The electron tunneling spectra between layers showed the coexistence of two V-shaped gaps with different energy scales. Due to different reactions to temperature and magnetic field, one of these gaps was unambiguously identified as having a superconducting-order node parameter. The magnetic-field dependence of the density of states corresponds to the theoretical predictions made by G.E. Volovik (Landau Institute for Theoretical Physics RAS) in 1993 [4]. Thus, a nontraditional type of superconductivity probably takes place in moiré graphene, when electron paring is due to their strong interactions and not due to phonons.

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4. Askaryan radiation in ice

In 1961, G.A. Askaryan (Lebedev Physical Institute) predicted Vavilov–Cherenkov radiation generation by an excess of a negative charge in a cascade produced by cosmic rays [5, 6]. The Askaryan effect has already been observed in dielectrics in accelerators, as well as in cosmic-ray showers in the air. The ARA (Askaryan Radio Array) Collaboration has reported on the first observation of Askaryan radiation under the ice surface [7]. The experiment, aimed at superhigh-energy neutrino detection, is being carried out in Antarctica near the South Pole. It includes five independent stations containing vertical and horizontal strings serving as antennas at a depth up to 200 m in ice. Thirteen radio wave bursts in the near-surface ice layer, which correspond in their spectrum, direction, and shape of signals to the Askaryan radiation from cascade events produced by cosmic rays, were registered over 208 days of observation.

5. Possible discovery of population III stars

The first stars in the Universe may have been so-called population III stars formed out of gas with a primary chemical composition. Several candidates are known, but no convincing confirmation that these are population III stars has been obtained. One of the candidates — object LAP1-B at a redshift $z \simeq 6.6$ — was found in 2025 by the J. Webb telescope in the region of the gravitational lens in the line of sight. As has been shown by a new analysis [8], this object satisfies the basic expected characteristics of population III stars. Namely, its spectrum corresponds to an extremely low metallicity and the predicted star mass function, and the total star mass in it makes up several thousand solar masses. This object is most probably a group of population III stars in the halo of dark matter with a mass of $\sim 5 \times 10^7 M_\odot$. The content of oxygen corresponds to an explosion of one supernova with an ejection of heavy elements. Although

LAP1-B is observed at $z \simeq 6.6$ (the Universe is 840 mln years old), the stars in it must have been formed still earlier. Gravitational lens imaging is expected to give approximately one such object at $z \simeq 6.6$, and to discover them in earlier epochs is difficult.

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