# The problem of creating neutron matter and hyperheavy nuclei in the laboratory

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The report discusses possible mechanisms for the creation of hyperheavy nuclei by electron-nuclear collapse [1] and neutron matter by condensation of ultracold neutrons (UCN) [2]. The fundamental possibility of the creation of such objects was previously substantiated by A.B. Migdal, who suggested that the well-known set of proton-neutron nuclei with mass numbers from 0 to 300 and a specific binding energy of about 8 MeV / nucleon at $A\approx60$ corresponds to the first region, behind which (starting from about a charge $Z\approx1700$) there is one more a region of a possible state of nuclear matter stabilized by a pion condensate. In this region the specific binding energy corresponds to 20 MeV / nucleon at $A \approx 100000$. Analysis shows that neutron matter, which, due to the Tamm interaction, as well as the Hund beta equilibrium, should be sufficiently stable at the microlevel, can be stable not only at the mega-level (neutron stars) due to gravitational interaction, but also on the scale of "ordinary" macromatter. The formation of such systems due to the effect of neutronization is possible not only during critical gravitational interaction, but also through fundamentally different mechanisms (supercritical increase in the atomic number of elements due to electron-nuclear collapse and condensation of ultracold neutrons), which opens the way to the fundamental possibility of obtaining both neutron matter in laboratory conditions [2] and hyperheavy nuclei [1]. Possibility of existence (and obtaining in laboratory conditions) of stable neutron matter (at $Z >> 175$, $N >> Z$, $A \geq 10^3–10^5$ with a size of 200–300 femtometers and more) at the microlevel, and not only at the mega-level, as is now believed in astrophysics, based on the works of Migdal, Tamm and Hund. The following technical approaches for the implementation of UCN condensation are considered: 1. Slow isothermal compression; 2. Use of a conical concentrator for UCN focusing (Vysotskii cone) [3]; 3. Magnetic trap; 4. Additional deep cooling of UCN.

Neutron matter is also seen as a potential candidate for cosmological latent mass. The possibility of the formation of fragments of neutron matter as part of a dark matter (neutrality, femto-, pico- and nanoscale, relic cooling complicates their detection at the present time) is considered already at the initial birth of the Universe, which is the dominant process, and not the fusion of the initial smaller number of protons, since neutrons predominate due to the fulfillment of the neutronization conditions in the synthesis of baryons. Further, as it cools, this process can proceed according to the generally accepted scenario of the Big Bang model with thermonuclear fusion (with the formation of light nuclides) and the observable part of the Universe is formed from the residual part of protons and subsequently decayed single neutrons and unstable fragments of neutron matter (with $Z > 175$, $N >> Z$, but $A <10^3–10^5$).

**Key words**: neutron, neutron matter, superheavy nuclei, electron-nuclear collapse, neutronization, condensation of ultracold neutrons, dark matter.

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