Properties of heavy and superheavy nuclei in supernova environments

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In this talk we present results concerning the structure and stability of nuclei embedded in the hot and dense stellar matter, calculated within a relativistic mean-field model. The emphasis is made on possible formation of heavy and superheavy nuclei in supernova environments. The electron gas is treated as a constant background in the Wigner-Seitz cell approximation. The presence of electrons leads to two important changes in the nuclear properties. First, due to the attractive interaction with electrons, the proton levels shift downwards as compared with the vacuum. Second, the nuclear Coulomb potential is reduced due to the screening effect of electrons. As the result, the proton dripline shifts to more proton-rich systems, and the stability line with respect to β-decay moves to more neutron-rich nuclei, and finally reaches the neutron dripline. This signals appearance of free neutrons in the system (the "neutronization" process). We investigate the stability of nuclei with respect to α and β decay, as well as to the spontaneous fission. We find that the presence of the electrons leads to stabilizing effects for both α decay and spontaneous fission for high electron densities. Implications for the existence and creation of very heavy systems are discussed. Our main conclusion is that the formation of heavy and superheavy elements (SHE) is favored by the electron screening in dense stellar matter. Therefore, one can expect that these elements can be synthesized in supernova environments and ejected in space in the course of explosions. If long-lived SHE exist, they may be present in cosmic rays.