Accessing The Long-time Isospin Drift And The Symmetry Energy In Heavy Ion Collisions

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The light charged particles (LCPs) have been measured in coincidence with the fission fragments in Ar+Au reactions at 30 and 35 MeV/u. The neutron richness of the LCPs decreases with the laboratory angle over a wide range and with the beam energy at large angles, underlining the long timescale of isospin drift process referring to the transport of isospin degree of freedom (IDOF) from the high density region to the low density region. It is viewed that a nuclear liquid drop with finite size cools itself down by vaporization with decreasing neutron fraction carried by the LCPs sampling the nuclear gas. The feature of long timescale of isospin drift is distinguished from the fast relaxation of the IDOF in isospin diffusion. Therefore, the equilibrium of IDOF in heavy ion collisions, which is widely discussed in literatures, seems not to be a universal conclusion. When one talks about the equilibration of IDOF, it is necessarily to refer to a certain process because the time scale can be very different. Due to the accumulation of the effect of the symmetry energy $E_{sym}(\rho)$ in the long-time isospin drift process, the angular distribution of the relative neutron excess of the LCPs representing the gas phase turns to be a sensitive probe to $E_{sym}(\rho)$. With the simulations of ImQMD transport model followed by a GEMINI burner, the slope of $E_{sym}(\rho)$ at ρ_0 is constrained, indicating a soft $E_{sym}(\rho)$, consistent with the current knowledge within uncertainty but situates at the softer side.