Detectability of Strange Matter in Heavy Ion Experiments *

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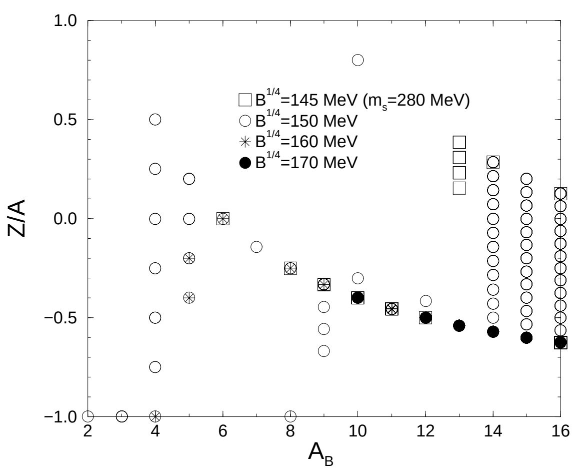
Strangeness and antistrangeness is abundantly produced in heavy ion collisions. Baryonic objects with a high strangeness fraction may be formed, like small droplets of strange quark matter (strangelets) or metastable exotic multihypernuclear objects (MEMOs) consisting of nucleons and multiple hyperons [1]. Both are expected to possess properties quite different form ordinary nuclei, like a negative charge while carrying a positive baryon number. We examined the properties of both forms of strange matter for low masses, its decay properties and its detectability for heavy ion experiments.

The MEMOs were treated within the framework of an extended relativistic mean–field theory. We extended the calculation of [1] to small mass numbers which are most interesting for heavy ion physics. We found that the two smallest bound systems for $A = 4$ are ^{4}He and the corresponding Ξ–system, i.e. two Ξ^- and two Ξ^0. The next heavier ones ($A = 6$) are the combinations $^{6}_{\Lambda\Lambda}$He, $\{2\mathrm{n}, 2\Lambda, 2\Xi^-\}$, $\{2\mathrm{p}, 2\Lambda, 2\Xi^0\}$, and $\{2\Lambda, 2\Xi^0, 2\Xi^-\}$. Note that the double Λ hypernucleus $^{6}_{\Lambda\Lambda}$He has already been seen experimentally. These objects live, if formed, on the time scale of the weak hyperon decay, i.e. $\tau \approx 10^{-10}$ s. They can not be seen with the present experimental setups, as they are only sensitive to much larger lifetimes.

We calculated the binding energy of strangelets for an arbitrary number of up, down, and strange quarks using the MIT bag model. Afterwards we look for possible strong decays, i.e. nucleon, hyperon and pion emission. We checked also for fission of a strangelet into another strangelet and an arbitrary number of hadrons. This allows for example for a decay where the a strangelet emits a neutron and a pion. A strangelet stable against weak hadronic decays can then only decay via weak leptonic decay or via weak radiative decays and lives on the time scale of $\tau_l = 10^{-4} - 10^{-5}$ s which is well in reach of present heavy ion experiments.

The long–lived strangelets found are mainly lying on a chain which starts from the triple magic strangelet ($6u6d6s$). The 'valley of stability' continues then towards negative charges by adding one unit of negative charge when going to a higher mass number. The reason for this stability line is a pronounced shell effect as e.g. the first candidate is also triple magic ($6u6d18s$ or $6u18d6s$). Note that these candidates are all highly negative charged contrary to common belief, while most experiments are, however, designed to detect only particles with small charge–to–mass ratio.



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[1] J. Schaffner, C.B. Dover, A. Gal, C. Greiner, H. Stöcker, Phys. Rev. Lett. 71, 1328 (1993)