Recent progress of the HypHI project at GSI and its perspective at FAIR

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The HypHI collaboration has successfully conducted two experiments with ^{6}Li and ^{20}Ne projectiles at 2 *A* GeV on a carbon target, and the analyses on the data with ^{6}Li beams have been completed. Recent results on $^{3}_{\Lambda}$H and $^{4}_{\Lambda}$H as well as the signals in the d+π^- and t+π^- final states obtained in the experiment with the ^{6}Li beams are summarised. Future experimental plans with better precision with FRS at GSI and super-FRS at FAIR are also discussed.

KEYWORDS: hypernuclei, heavy ion beam, invariant mass, lifetime, production cross section

1. Introduction

Hypernuclei have been studied for more than six decades in order to address one of the key issues in nuclear and hadron physics to investigate the baryon-baryon interactions under the flavor SU(3) symmetry. Lambda-hypernuclei until now have mainly been investigated experimentally with emulsion techniques [1], secondary meson beams [2] and primary electron beams [3]. In the hypernuclear production with direct reactions of those beams on stable target nuclei, the isospin of the produced hypernuclei was limited by the reaction mechanism since a nucleus in the stable target material is converted to a Λ-hypernucleus by production or exchange of strangeness in a single nucleon. Proton- and neutron-rich hypernuclei can be produced as hyperfragments by absorbing stopped-K$^-$ beams in the nuclear target, however, the production of very neutron- and proton-rich hypernuclei may not be abundant. With heavy ion beams, a central collision of platinum projectiles at 11.5 GeV/c on a gold target was used successfully to produce and identify $^{3}_{\Lambda}$H (hypertriton) and $^{4}_{\Lambda}$H hypernuclei [4]. Recently, the STAR and ALICE collaborations used relativistic heavy ion collisions to study hypertriton and anti-hypertriton [5, 6]. However, the latter two experiments to date have not been proven as suitable techniques for the production of hypernuclei with the mass number A $\geq$ 4.

A different approach to studying hypernuclei by using projectile fragmentation reactions of heavy ion beams was employed for the present work. In such reactions, a projectile fragment can capture a hyperon produced in the hot participant region to produce a hypernucleus. In this reaction, the velocity of the produced hypernucleus should be similar to that of the projectile, since the energy of heavy ion beams should exceed the energy threshold for the hyperon production. Thus, the produced hypernucleus has a large Lorentz factor, and the decay of the hypernucleus takes place well behind the production target. This makes it possible to study hypernuclei in flight. Since a hypernucleus is