Status of the WASA-FRS HypHI Experiment: Study of light hypernuclei at GSI-FAIR

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The WASA-FRS HypHI Experiment focuses on the study of light hypernuclei by means of heavy-ion induced reactions. It is part of the WASA-FRS experimental campaign, and so is the eta-prime experiment [1]. The distinctive combination of the high-resolution spectrometer FRS [2] and the high-acceptance detector system WASA [3] is used. The experiment was successfully conducted at GSI-FAIR in Germany in March 2022 as a component of the FAIR Phase-0 Physics Program, within the Super-FRS Experiment Collaboration. Currently, the data from the experiment is under analysis.

In this experiment, the production of the hypernuclei is achieved by bombarding a diamond target with a ^{6}Li beam at 1.96A GeV. In this collision, Λ hyperon can merge with the nuclear fragment, forming a hypernucleus. The production of hypernuclei in the spectator rapidity region, with a similar velocity of the incident beam, allows for the in-flight study of the hypernuclei behind the target material. The hypernuclear events are identified by detecting both the residual nuclei and the π^- particles emitted from the mesonic weak decay of the hypernuclei.

The second half of the FRagment Separator FRS serves as a high-resolution spectrometer for measuring the decay fragments. Additionally, the Wide Angle Shower Apparatus (WASA), placed in the mid-focal plane of the FRS, is employed for tracking the decay π^- particle. The WASA system consists of a superconducting magnet and a group of detectors, including a drift chamber of several layers of strawtubes and plastic scintillator barrel and walls. The hypernucleus is subsequently reconstructed, and its properties, such as invariant mass and lifetime, are analysed.

The primary objectives of this experiment are twofold: to shed light on the hypertriton puzzle [4] and to investigate the existence of the previously proposed nnΛ bound state [5]. Firstly, the significantly shorter hypertriton lifetime reported by three independent state-of-the-art experiments, namely ALICE [6], STAR [7], and HypHI [8], compared to the predictions of theoretical models remains poorly understood. Therefore, obtaining new accurate results for the invariant mass and lifetime of $^3_\Lambda$H (and $^4_\Lambda$H) is crucial to reach a definitive conclusion. Secondly, the observed enhancement in the invariant mass distributions of the $d+\pi^-$ and $t+\pi^-$ final states, as reported by the HypHI Collaboration [5], cannot be accounted for by existing theoretical calculations, which indicate the absence of a neutral nnΛ bound state. Consequently, the WASA-FRS HypHI Experiment aims to produce more precise and statistically significant experimental results that can provide clarification on the potential existence of nnΛ.

My contribution to the conference will provide an overview of the WASA-FRS HypHI Experiment, including its objectives and methodology. Details of the experiment approach that combines for the first time a cylindrical detection system with a fragment separator will be presented. I will also explain the opportunities that such experimental setup provide. Finally, I will discuss the current state of the experiment analysis and show the first preliminary results of track and event reconstruction.

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