Referee report on the project

Strangeness in nucleon and nuclei
The HyperNIS project

JINR activity with a hypernuclei investigation has begun many years ago since 1963 when the recoilless strangeness transfer method was suggested by M.Podgoretsky. Due to Λ location inside the nuclei does not limited by the Pauli principle it works as a sort of glue ensuring a nuclei stability. The study of properties of light neutron-rich hypernuclei is of great interest, first of all, to clarify the theory of the intranuclear nucleon-nucleon interactions: the neutron halo, ΛN interaction including ΛN – ΣN conversionand the spin-dependent ΛN interaction etc. Besides, the knowledge, obtained from this study, will give a feedback to other fields like astrophysics: it has been discussed that hyperons in a high-density nuclear matter in neutron stars play a significant role concerning of its maximalmass and a thermal and structural evolution of neutronstars and black holes. Namely, the presence of hyperons in a neutron star makes the equation of state much softer than that without hyperons.

The present hypernuclear programin Dubna was started in 1988 with the investigation of production and decay of the light hypernuclei. It was shown that the approach, in which the momentum of hypernuclei produced in the beams of relativistic ions is close to the momentum of beam nuclei, was quite effective for measuring the lifetimes and production cross sections. The relativistic hypernucleus flies through the detector which provides additional opportunities due to simplified trigger conditions, good identification of hypernuclei and minimization of systematic errors. The special interest to this investigation is because of absence of reliable data on ${}^{6}_{\Lambda}H$ properties and theoretical predictions that are strongly depend on model and controversial. Simultaneously, the lifetimes and production cross sections of ${}^{4}_{\Lambda}H$ and ${}^{3}_{\Lambda}H$ will be studied in the same experiment. The ${}^{4}_{\Lambda}H$ and ${}^{3}_{\Lambda}H$ measurement scan be used as “reference points” to confirm the production and decay of ${}^{6}_{\Lambda}H$**.**

The present HyperNIS spectrometer for search of ${}^{6}_{\Lambda}H$ hypernuclei with the ${}^{7}Li$ beam contains a carbontarget,beam monitors, three types of trigger counters, vacuum decay vessel of 55 cm length, the analyzing magnet of 0.6T, four blocks of proportional chamberswhich are the main tracking detectors, RPC TOF stations, SciHe (Scintillation counter to confirm registration of He nuclei). The dedicated and very selective trigger on two body hypernucleidecays with negative pion was the key point of this approach. In the future two detector systems will be added to the spectrometer: a high resolution scintillating fiber detector will provide more sophisticated tracking capabilities and four Čerenkov counters with a quartz radiator will enhance the selectivity of the trigger.

Background events suppression is expected at the 10^4 level according to MC simulation and experimental tests. It would be interesting if the data will be taking with heavy ion beams (C, Ar) at Nuclotron with ${}^{6}_{\Lambda}H$ trigger cuts to provide an experimental evaluation of the number of fake ${}^{6}_{\Lambda}H$ hypernuclei events which may be used for a systematic error evaluation in the hypernuclei production with ${}^{7}Li$ beam. Naturally, more detailed MC simulation of systematic errors is necessary.

The study of properties of the lightest hypernuclei is actual, has high significance and the Nuclotron beam is suitable place to investigate these tasks. There is a strong group that includes more than 25 scientists and engineers to provide the present and future (up to 2023) of JINR activity in this important domain of the home JINR science. A ratio of the project financial request and its scientific program is quite reasonable.

I recommend to approvethis project for realization at JINR with the first priority.

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