Experimental search for the kaonic nuclear state, K^-pp with FOPI

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Recently a possible existence of exotic nuclear systems involving antikaon, $\bar{K}$ (K^- or $\bar{K^0}$), as a constituent has been widely discussed. Such kaonic system is first mentioned by Wycech in 1986, and the present stream of activity arises from the calculation by Akaishi and Yamazaki in late 90s [1]. They were stimulated by the new KpX experiment at KEK which solved so-called "kaonic hydrogen puzzle", constructed phenomenologically a $\bar{K}$N interaction whose $I = 0$ channel turned out to be strongly attractive. Using this interaction they predicted that antikaon plays glue-like role to bind nucleons (K^-pp, K^-ppp, ...) and density higher than normal nuclear density.

An existence of such kaonic states has been examined by many experiments, some are dedicated experiments, some are reanalysis of existing data, and indeed some indications have been obtained. However they lack for either enough statistical significance or/and unique interpretation, and moreover the indicated masses do not agree each other.

Theoretical understanding is in a way similar. Obtained binding energies and widths vary. Even so all major calculations predict that such bound state is at least shallowly formed [2].

The S349 experiment at the Gesellschaft für Schwerionenforschung (GSI) in Darmstadt, Germany investigates the reaction $p+p \rightarrow K^+ + X(X = K^-pp)$ at 3.1 GeV incident proton energy employing the FOPI detector [3]. The FOPI detector which is capable of tracking particles with $\sim 4\pi$ solid angle at high rate allows to perform an exclusive measurement. The signature of the K^-pp can be evaluated with a combined invariant-mass analysis of the decay particles $K^-pp \rightarrow \Lambda + p \rightarrow (p + \pi^-) + p$ and missing mass analysis of the K^+. The reaction is presumably cleaner to interpret.

The data taking was successfully completed in July-August 2009 and the data is currently being analyzed. In the talk, the overview of the S349 program also in a relation with the recently published DISTO data analysis [4] which employs the same reaction as FOPI but somewhat lower beam energy, and the present status of the data analysis will be presented.

[1] Y. Akaishi and T. Yamazaki, Phys. Rev. C 65 (2002) 044005.

[2] see for example A. Doté, T. Hyodo and W. Weise, Phys. Rev. C 79 (2009) 014003.

[3] K. Suzuki *et al.*, Nucl. Phys. A 827 (2009) 312.

[4] T. Yamazaki *et al.*, Phys. Rev. Lett. 104 (2010) 132502.

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