Search for super-narrow dibaryon resonances by the $pd \to ppX$ and $pd \to pdX$ reactions

A. Tamii,[a] H. Kuboki,[b] H. Sakai,[b] K. Yako,[b] M. Hatano,[b] Y. Maeda,[b] T. Saito,[b] M. Sasano,[b] K. Hatanaka,[a] Y. Sakemi,[a] J. Kamiya,[a] Y. Shimizu,[a] K. Fujita,[a] T. Uesaka,[c] K. Sekiguchi,[d] K. Sagara,[e] T. Wakasa,[e] S. Nozoe,[e] T. Kudoh,[e] S. Shimomoto,[e] M. Shiota,[e] L.V. Fil'kov,[f] V.L. Kashevarov,[f] E.S. Konobeevski,[g] M.V. Mordovskoy,[g] and S.I. Potashov[g]

[a]*Research Center for Nuclear Physics, Osaka University, Ibaraki, Osaka 567-0047, Japan*
[b]*Department of Physics, University of Tokyo, Bunkyo, Tokyo 113-0033, Japan*
[c]*Center for Nuclear Study, University of Tokyo, Bunkyo, Tokyo 113-0033, Japan*
[d]*The Institute of Physical and Chemical Research, Wako, Saitama 351-0198, Japan*
[e]Department of Physics, Kyushu University, Fukuoka 812-8581, Japan
[f]Lebedev Physical Institute, Moscow, Russia
[g]Institute for Nuclear Research, Moscow, Russia

One of the interesting predictions of the Quantum Chromo-Dynamics (QCD) is the possibility of the existence of six-quark states, *i.e.* dibaryons. Much work has been devoted to the search for dibaryons [1] as well as theoretical predictions of their masses and quantum numbers. Among many predicted dibaryons, those which have a vary narrow decay width are of particular interest. If a dibaryon has a symmetric wave function in terms of nucleons and has a mass smaller than two nucleons plus a pion, the dibarion cannot decay into NN nor into $NN\pi$ system. Consequently the dibaryon must decay through electromagnetic process emitting a gamma ray and has a very narrow decay width of less than 1 keV. Such dibaryons are called super-narrow dibaryons.

Recently Fil'kov *et al.* have performed $pd \to ppX$ measurements at E_p=306 MeV at Institute for Nuclear Research (INR) and have found three narrow peaks at 1904, 1926, and 1942 MeV [2, 3]. Since the observed widths of the resonances are equivalent to the experimental mass resolution of 3 MeV, the resonances are considered as candidates for the super-narrow dibaryons.

At Research Center for Nuclear Physics (RCNP), Tamii *et al* have performed $pd \to ppX$ measurement in the same kinematical condition as the experiment at INR. By using magnetic spectrometer they could obtain a good mass resolution of 1 MeV and very low background condition. They have, however, found no signature of narrow resonances. The upper limits of the dibaryon production cross section have been determined as 1–2 μb/sr in the mass region of 1897–1911 MeV. The studied mass region has been limited at around 1904 MeV due to the available beam time.

In order to further study all the three candidates, we have measured $pd \to ppX$ reaction over a larger mass range of 1898–1953 MeV. In this experiment, we used a liquid deuterium target system [5] instead of deuterated polyethylene (CD_2) target for reducing background events from carbon and for obtaining a better sensitivity to the dibaryon production reactions.

The experiment was performed at the Research Center for Nuclear Physics, Osaka University. A polarized proton beam at an energy of 295 MeV has been used. We used the liquid deuterium target system which has aramide foil windows with a thickness of 4 μm for sealing the target from the vacuum. The diameter of the window was 10 mm (16 mm) for the entrance (exit) window. Before the end of the experiment, the window foils have been replaced by a thicker one with a thickness of 12.5 μm because the thinner foil had not

sufficient tolerance for the operation of more than ~3 days. The thickness of the liquid deuterium target has been monitored by a luminosity monitor system which detected elastically scattered protons and deuterons in coincidence by using two plastic scintillators [6].

Other details of the setup were the same as the previous experiment [4] except that the magnetic field of the GR and LAS spectrometers and the angular setting of the LAS spectrometer were changed depending on the mass region of the searched dibaryon.

The data analysis is in progress. Some histograms of very preliminary analysis are shown in Fig. 1 and 2. The background from the target cell has not been subtracted yet. Detailed analysis of the full data and carefull statistical treatments are required.

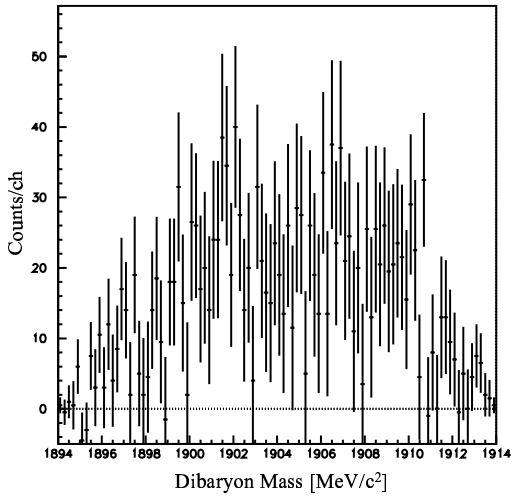

Figure 1: A very preliminary result of the dibaryon search around 1904 MeV. The background from the target cell has not been subtracted yet. 10 counts of data roughly correspond to 0.06μb/sr.

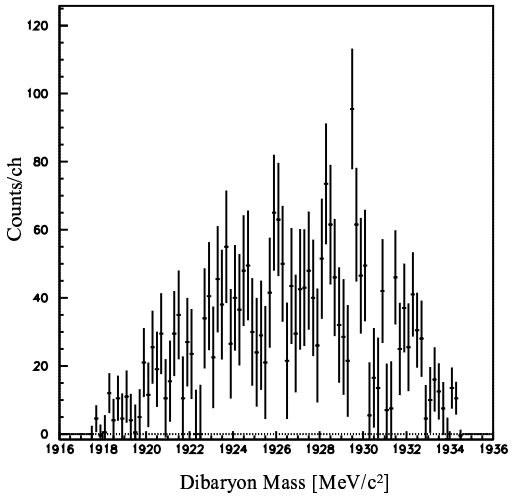

Figure 2: A very preliminary result of the dibaryon search around 1926 MeV. The background from the target cell has not been subtracted yet. 10 counts of data roughly correspond to 0.13μb/sr.

References

[1] For example, see a review in B. Tatischeff *et al.*, Phys. Rev. C **59**, 1878 (1999).
[2] L.V. Fil'kov *et al.*, Phys. Rev. C **61** (2000) 044004.
[3] L.V. Fil'kov *et al.*, Euro. Phys. J. A **12** (2001) 369.
[4] A. Tamii, *et al.*, Phys. Rev. C **65** (2002) 047001;
A. Tamii, *et al.*, PCNP Annual Report 2001, pp. 31.
[5] K. Sagara *et al.*, RCNP Annual Report 1995, pp. 158.
[6] H. Kuboki *et al.*, in this RCNP Annual Report 2002.