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

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One of the interesting predictions of the QCD is the possibility of the existence of six-quark states, *i.e.* dibaryons. A lot of experimental works have been devoted to the dibaryon search. Among many predicted dibaryons, super-narrow dibaryons are of particular interest. If a dibaryon has a symmetric wave function in terms of two nucleons (NN) and a mass less than two nucleons and a pion (π), it cannot decay into NN nor $NN\pi$ due to the Pauli principle and energy conservation law, respectively. Such dibaryons, called super-narrow dibaryons, must decay by emitting a gamma ray through an electromagnetic process, and are considered to have a very narrow decay width of less than 1 keV.

Recently a group at Moscow Meson Factory has found three super-narrow dibaryon candidates in (p,p') missing mass spectra of the ^{2}H$(p,p'X)$ reaction at E_p=300 MeV [1]. They used two arm spectrometers made of plastic and BGO scintillators. The observed widths of the resonances were consistent with the experimental mass resolution (∼3 MeV).

In order to draw decisive conclusion on the existence of a narrow peak at 1905 MeV, we have performed an experiment at the Research Center of Nuclear Physics, Osaka University [2]. We employed a proton beam with an energy of 295 MeV accelerated by the AVF and ring cyclotrons. The beam intensity was 15–20 nA. A deuterated polyethylene (CD_2) target with a thickness of 44 mg/cm^2 was placed in a scattering chamber. The momenta of scattered protons were analyzed using the high resolution magnetic spectrometer Grand Raiden (GR) placed at 70°. The produced dibaryons are considered to decay immediately into d+γ or p+n+γ. The large acceptance spectrometer (LAS) was placed at 34.9° to detect either a proton or a deuteron from the dibaryon decay for the purpose of reducing background events which came mostly from quasi-free scattering. The energy ranges of detected protons and deuterons were 74–130 and 112–198 MeV, respectively. Data were taken also with a 30 mg/cm^2 carbon target for subtracting background events from carbon in the CD_2 target. A good mass resolution (0.95 MeV) and background-free condition have been achieved.

Missing mass spectra were obtained as shown in Fig. 1 for (a) d+γ and (b) p+n+γ decay channels. The data are plotted by the solid circles with statistical error bars. No significant peak has been observed throughout the measured mass range for each decay channel. The solid curve in Fig. 1 (b) shows the expected dibaryon spectrum on the assumption of a 8 μb/sr cross section [1] at 1905 MeV and a 100% branching ratio for the p+n+γ channel. A resonance with a cross section of as much as 8μb/sr is clearly not observed.

The upper limits of the dibaryon production cross section have been determined as shown in Fig. 2. The open square with the error bars shows the data of Ref. 1. It can be seen from the figure that the dibaryon production cross section in a mass region of 1897–1911 MeV is less than 2 μb/sr at the 90% confidence level.

The details of the results were reported in Ref. 2.

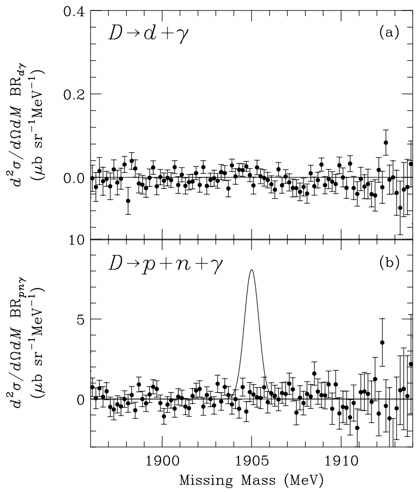

Figure 1: Results of the dibaryon production cross section multiplied by the branching ratio as a function of missing mass for (a) $d+\gamma$ and (b) $p+n+\gamma$ decay channels with statistical error bars. The solid curve in (b) represents the expected yield according to the data of Ref. 1.

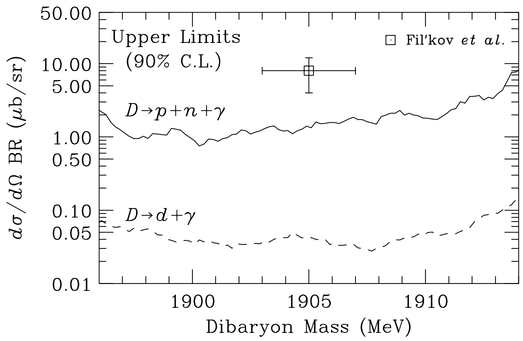

Figure 2: Upper limits of the dibaryon production cross section multiplied by the branching ratio at the 90% confidence level for $d+\gamma$ (dashed curve) and $p+n+\gamma$ (solid curve) decay channels. The result of Ref. 1 is plotted by the open square.

References

[1] L.V. Fil'kov *et al.*, Phys. Rev. C **61** (2000) 044004.
[2] A. Tamii, *et al.*, Phys. Rev. C **65** (2002) 047001.