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Study of non-strange dibaryon resonances via coherent double neutral-pion photoproduction on the deuteron

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The search for non-strange dibaryon bound/resonance states has a long history.
A dibaryon state is of interest, which can be a molecule consisting of
two baryons or a spatially compact hexaquark object. The d*(2380) resonance
observed in the pn-collision reactions by the CELESIUS/WASA and WASA-at-COSY [1,2]
collaborations may be attributed to an isoscalar $\Delta\Delta$ quasi-bound state
$\mathcal{D}_{03}$, predicted by Dyson and Xuong [3]. The $\gamma d \to \pi^0\pi^0 d$
reaction has been experimentally investigated using energy-tagged bremsstrahlung photon beams at the Research Center for Electron Photon Science (ELPH), Tohoku University, Japan [4]. The γd center of mass energy $W_{\gamma d}$ is covered from 2.38 to 2.80 GeV.
All the final-state particles are detected with an electromagnetic calorimeter FOREST [5].
No clear resonance-like
behavior is observed in the excitation function near $W_{\gamma d} = 2.38$ GeV [6],
where the $d^*(2380)$ dibaryon resonance is expected to appear. The measured
excitation function is consistent with the existing theoretical calculation for
this reaction. At high incident energies, $\pi^0 d$ invariant-mass distributions
show a peak at approximately 2.15 GeV, which can be attributed to a $N\Delta$
quasi-bound state $\mathcal{D}_{12}$. We also discuss the properties of the peak
observed in the $\pi^0 d$ channel.

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Primary author: Dr ISHIKAWA, Takatsugu (Research Center for Electron Photon Science, Tohoku University)

Presenter: Dr ISHIKAWA, Takatsugu (Research Center for Electron Photon Science, Tohoku University)

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