Composition of low-lying $J^P = \frac{3}{2}^{\pm}$ Δ - baryons

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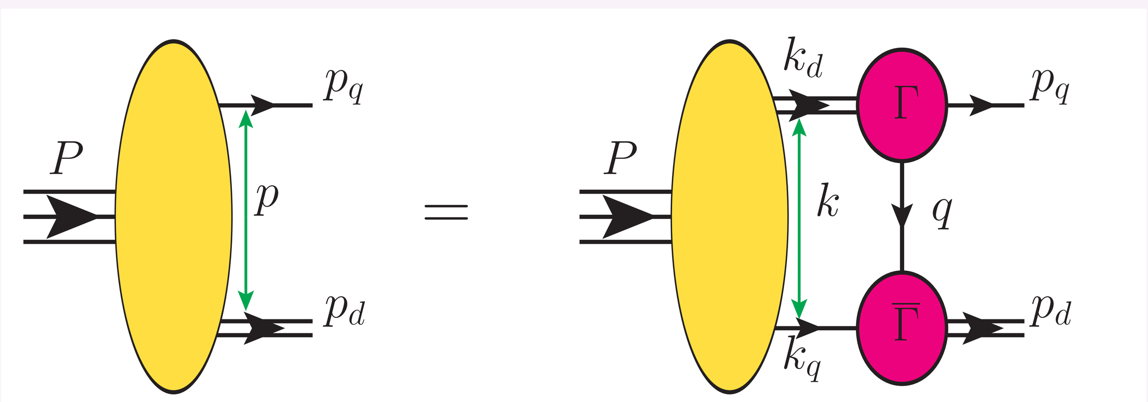
Starting Points

- The baryons and their parity partners are essential for us to understand the dynamical chiral symmetry breaking of QCD, a corollary of the emergent hadron mass.
- The excited baryon states can reveal more details about the QCD interactions.
- The quark model has been used extensively to explore the $J^P = \frac{3}{2}^{\pm}$ Δ.
- Quark model is a non-relativistic picture of hadrons with effective potential interactions. It does not connect QCD tightly.
- We can solve the such baryons in a Poincaré-covariant quark diquark Faddeev equation approach. This continuum Schwinger function method connects the QCD tightly.
- What are the similarities and differences about the structure of $J^P = \frac{3}{2}^{\pm}$ Δ baryons in this two approaches.

Method

The quark-diquark Faddeev equation



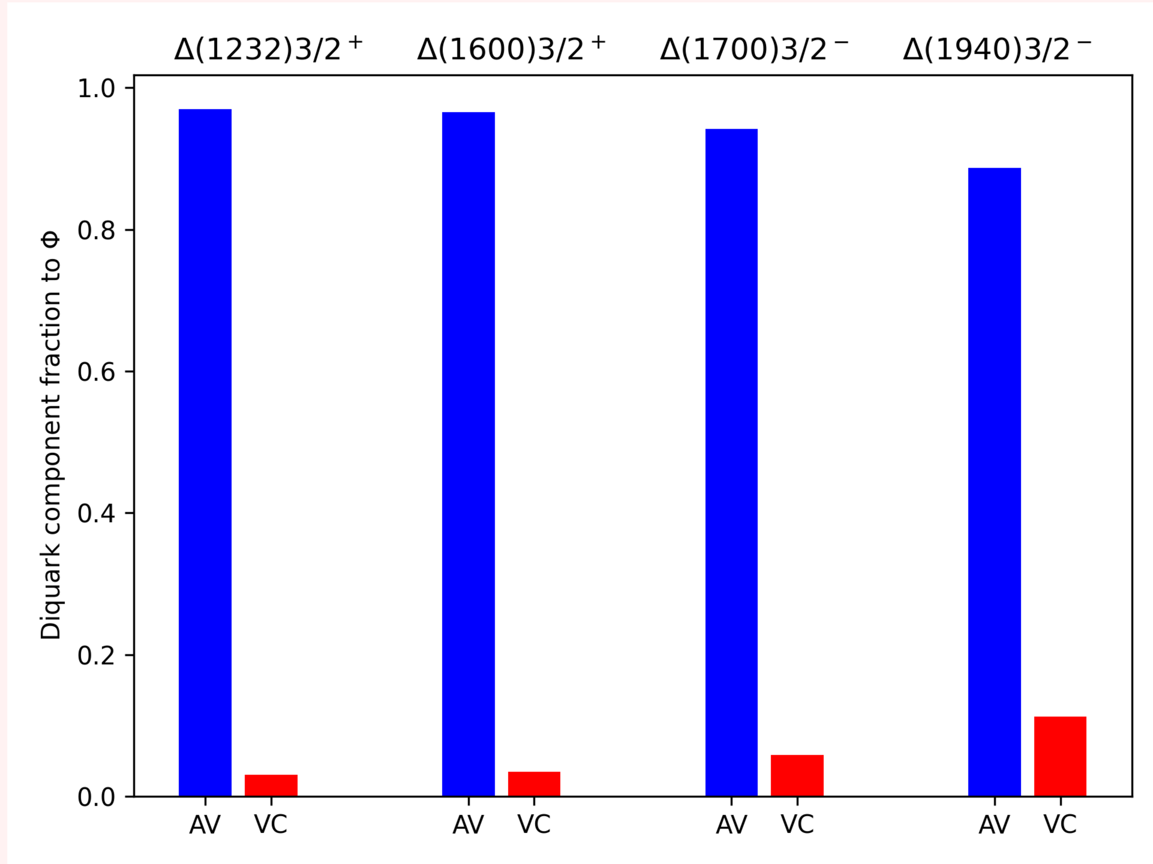
References

[1] L. Liu, C. Chen, Y. Lu, C. D. Roberts **and** J. Segovia. Composition of low-lying $J = \frac{3}{2}^{\pm}$ Δ-baryons. *Phys. Rev. D*, 105(11):114047, 2022.

[2] Y. Lu, C. Chen, Z.-F. Cui, C. D. Roberts, S. M. Schmidt, J. Segovia **and** H.-S. Zong. Transition form factors: $\gamma^* + p \to \Delta(1232)$, $\Delta(1600)$. *Phys. Rev. D*, 100(3):034001, 2019.

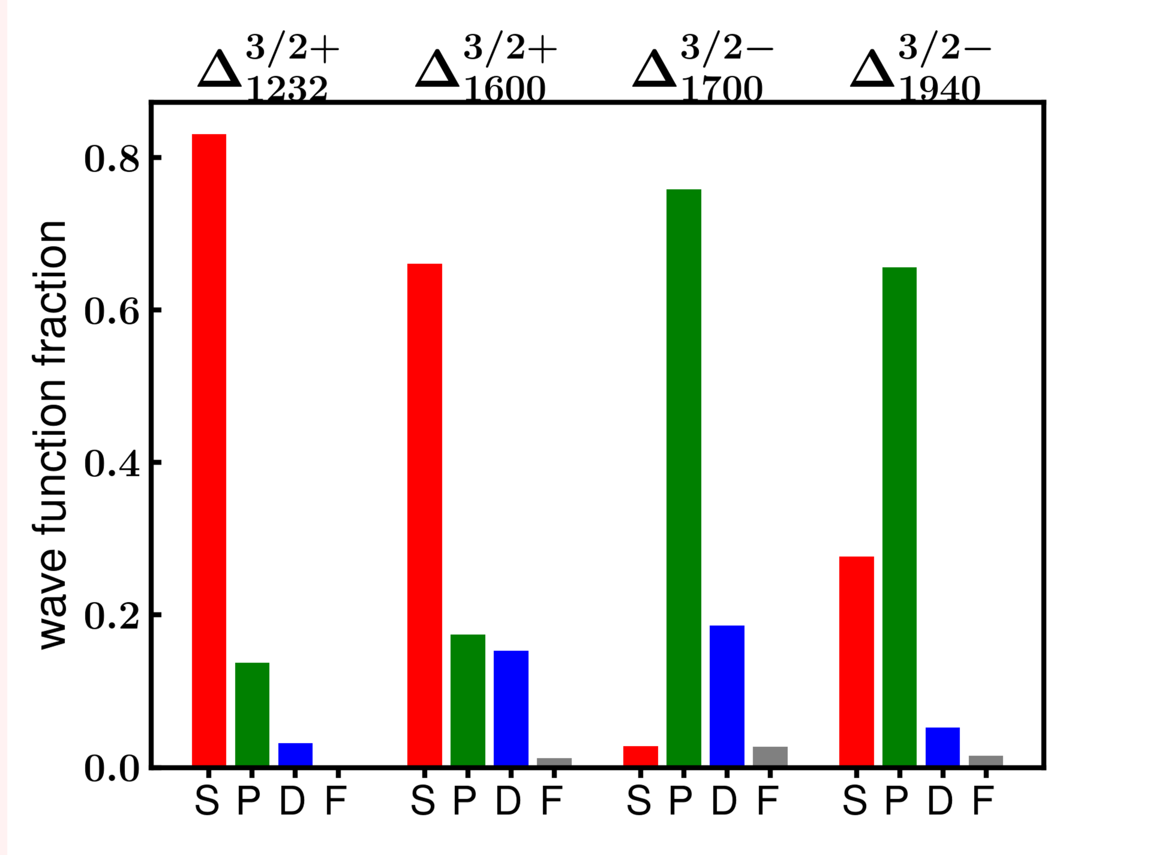
Results

Diquark fractions of Faddeev amplitudes.



The 1^+ diquark dominates $J^P = \frac{3}{2}^{\pm}$ Δ.

L fractions of Faddeev wave functions.



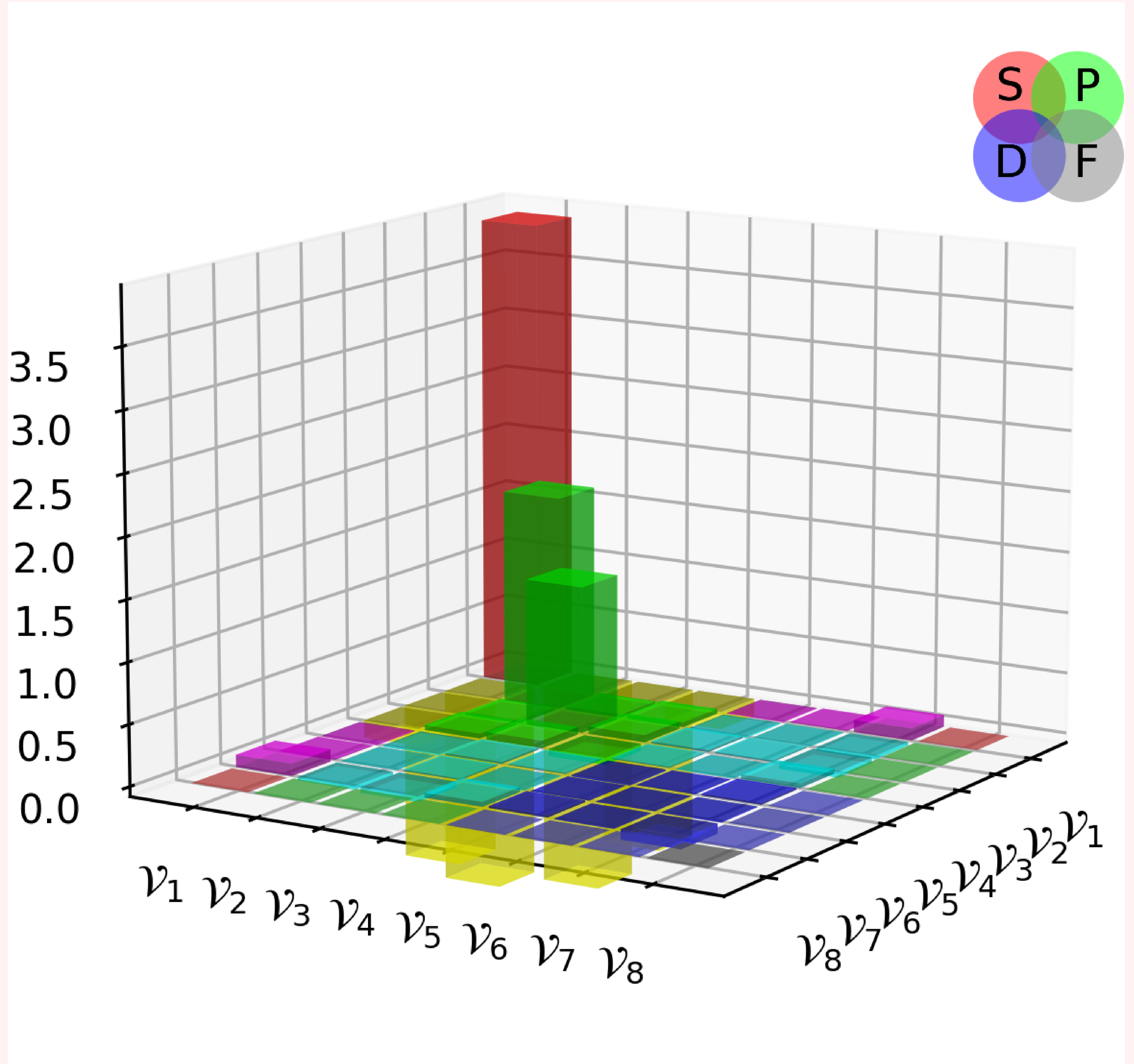
$\Delta(1232)\frac{3}{2}^+$, $\Delta(1600)\frac{3}{2}^+$: S wave dominated.
$\Delta(1700)\frac{3}{2}^-$, $\Delta(1940)\frac{3}{2}^-$: P wave dominated.

Outlook

These predictions can be tested in the resonance electroexcitation experiments, e.g., JLab 12 GeV program, which may shed light on the nature of emergent hadron mass.

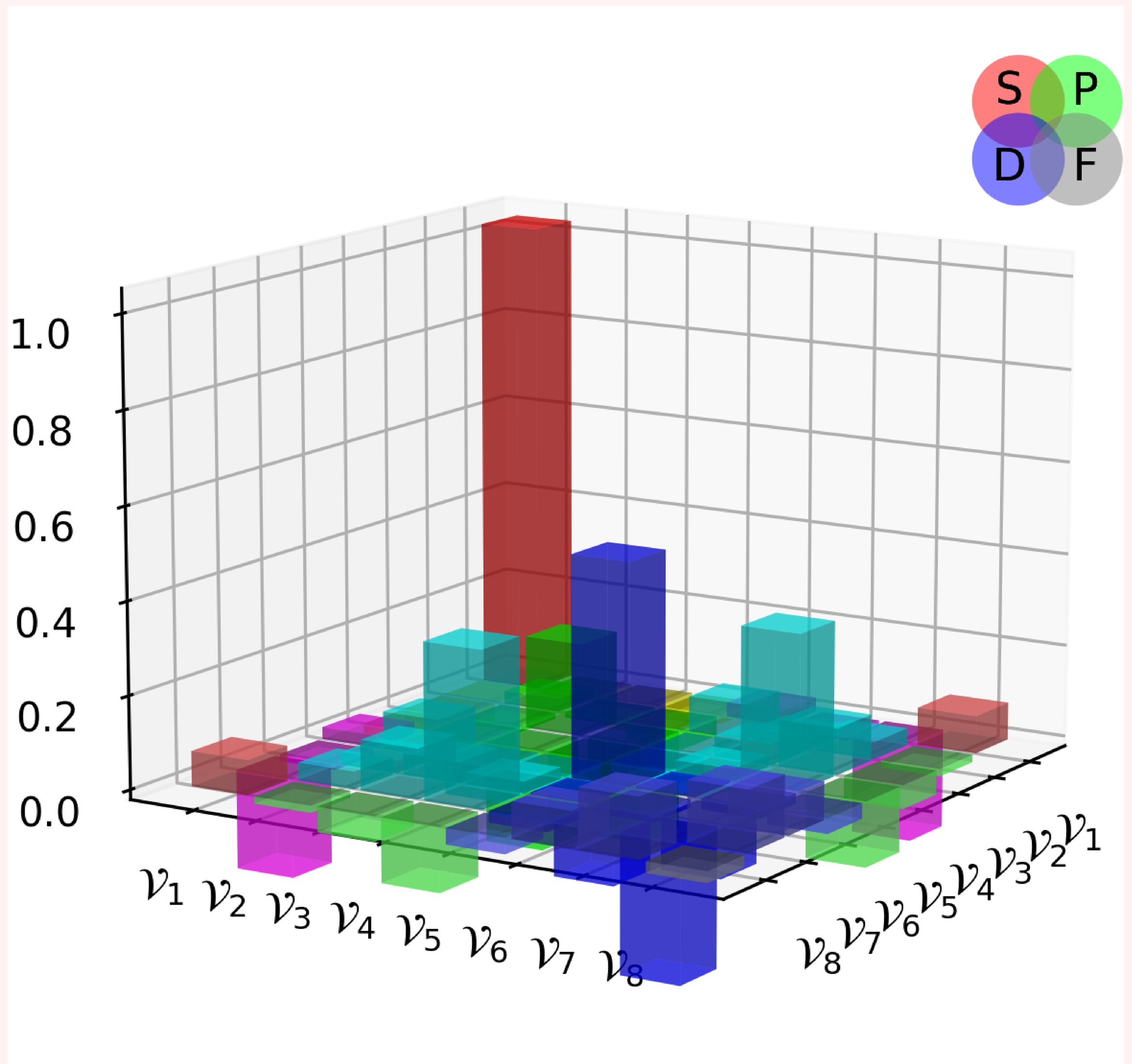
Results

L decomposition of $G_{E_0}(0)$ of $\Delta(1232)\frac{3}{2}^+$



S wave dominated.

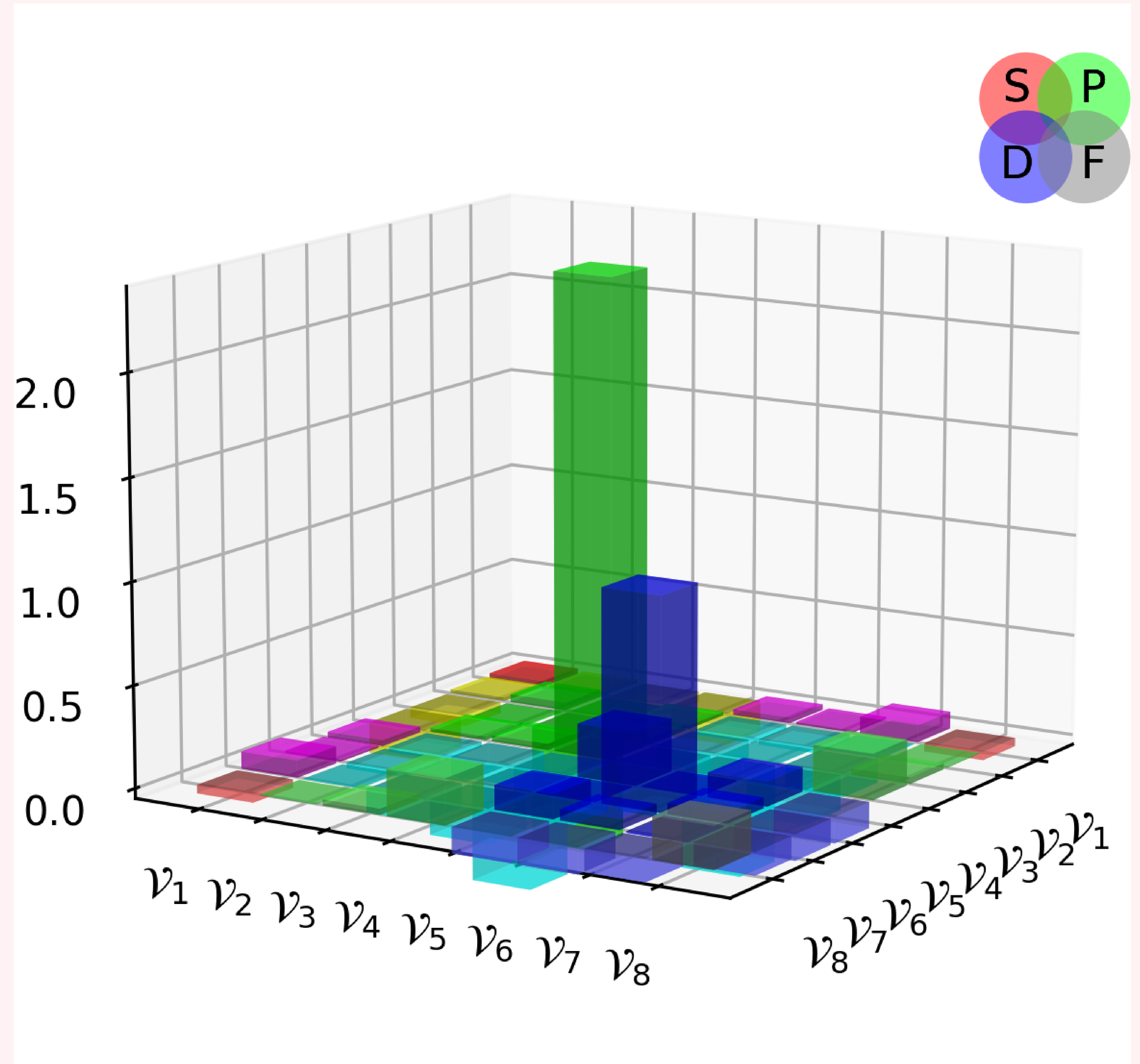
L decomposition of $G_{E_0}(0)$ of $\Delta(1600)\frac{3}{2}^+$



S wave dominated.

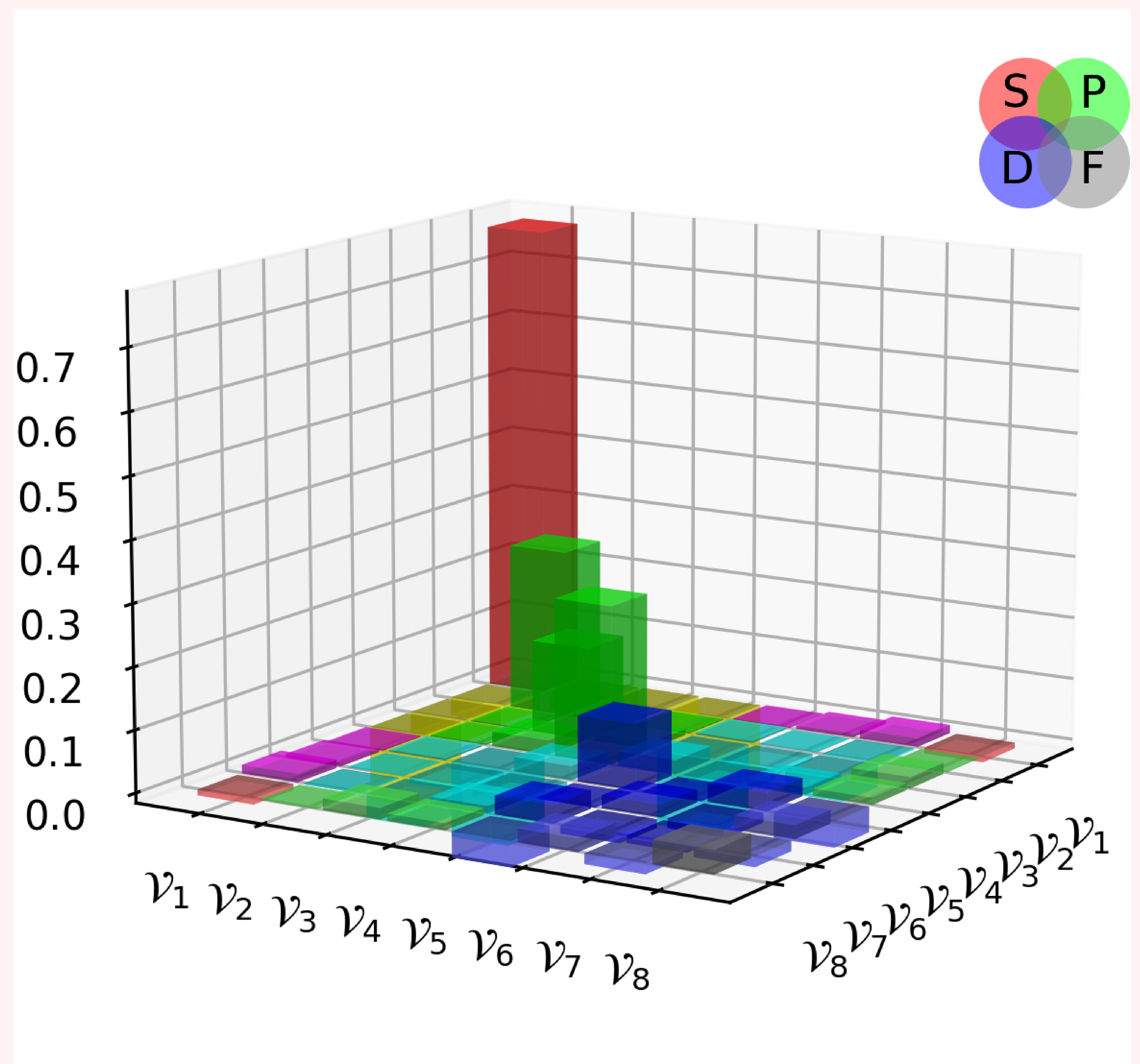
Results

L decomposition of $G_{E_0}(0)$ of $\Delta(1700)\frac{3}{2}^-$



P wave dominated.

L decomposition of $G_{E_0}(0)$ of $\Delta(1940)\frac{3}{2}^-$



S wave dominated.