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## VI–15 Magnetic Moments of $^3$H and $^3$He in the Quark Model

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We have investigated the magnetic moments of $^3$H and $^3$He by treating the nucleons N and nucleon resonances N* (1236 MeV) on the same footing. The ground state wave function of the trinucleon system is assumed to be

$$\psi_t = \mathcal{N}[\phi_s(N^3) + \sum_{\alpha=1}^{3} \phi_\alpha]$$

where $\phi_1 = \phi_D(N^3)$, $\phi_2 = \phi(N^2N^*)$ and $\phi_3 = \phi(NN^{*2})$ and $\mathcal{N}$ is the normalization constant. By the approximation used by Riska and Brown,[1] the $\phi'_\alpha$s are expressed as

$$\phi_\alpha \approx (1/\Delta E_\alpha) \sum_{i>j} V^{(\alpha)}(ij)\phi_s(N^3)$$

where the $\Delta E'_\alpha$s are the effective energy denominators and $V^{(\alpha)}(ij)$ is the transition potential between the S-state and the α-th states. $\Delta E_1$ is determined so as to give an 8% D-state probability. The quark model is used to determine potentials and magentic-moment operators. For processes involving N*, it is found that strong cancellations take place between effects from wave function renormalization (−0.083 n.m.) and cross terms (0.139 n.m.). Hence, even a sizable N* component does not shift the magnetic moments of $^3$H and $^3$He much from their Schmidt values. We also evaluated the two body exchange moments coming from so-called Born term, including the contribution from the transitions between the S-state and the α-th states. They are all additive with the same sign.

Numerical results are shown in the Table I.

### References

1) D. O. Riska and G. E. Brown: Phys. Letters **32B** (1970) 662.
2) M. Chemtob and M. Rho: Nuclear Phys. **A163** (1971) 1.

Table I.

| | | Isoscalar | Isovector |
|---|---|---|---|
| The unperturbed state | Schmidt | 0.440 | 2.353 |
| | Exchange current[2] | 0.009 | 0.193 |
| The D and the isobar states | (a) One body spin part | −0.067 | −0.067 |
| | (b) One body orbital part | 0.038 | 0.000 |
| | (c) pionic and pair-excitation current | 0.000 | 0.163 |
| Total of calculation | | 0.420 | 2.666 |
| Experiment | | 0.426 | 2.553 |

The processes specified in rows (a), (b) and (c) are illustrated in the figures.

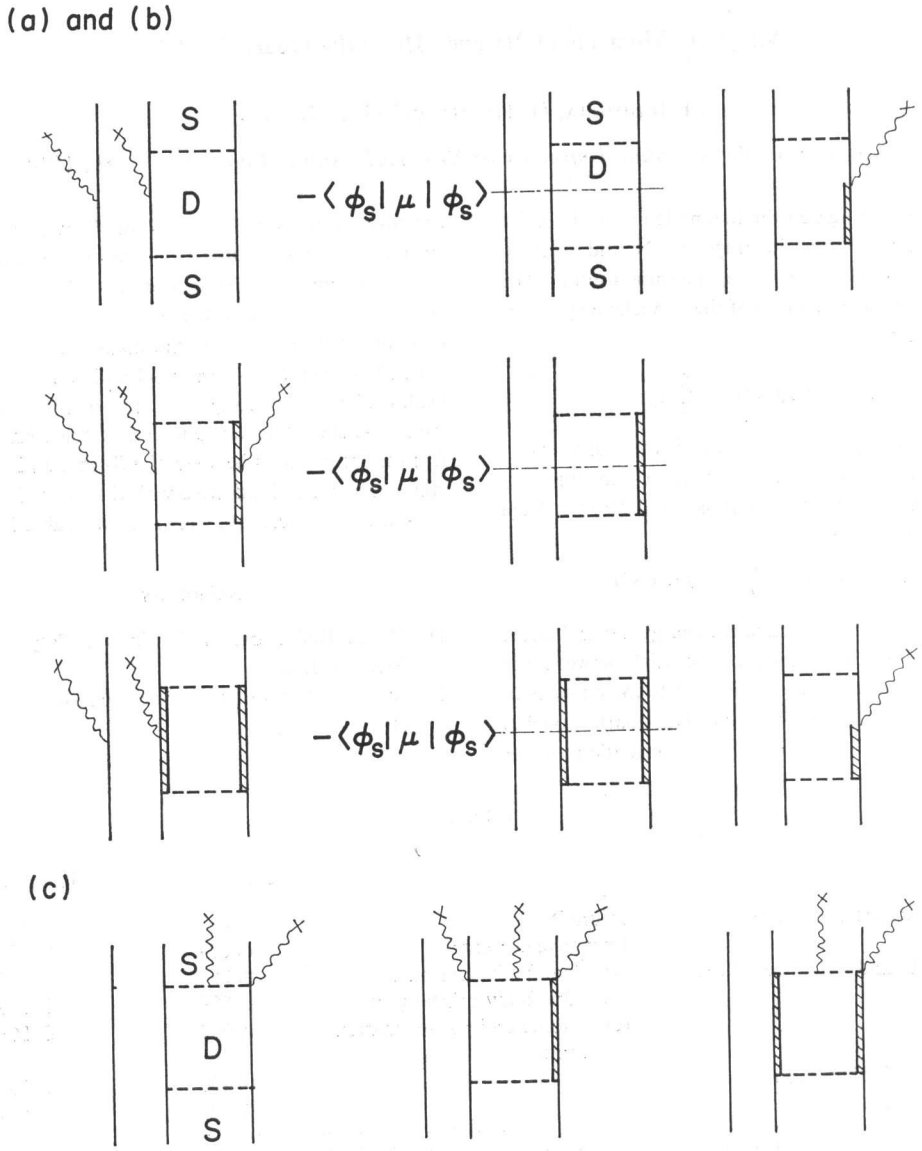
(a) and (b)
S
D
S
$-\langle \phi_s | \mu | \phi_s \rangle$
S
D
S
$-\langle \phi_s | \mu | \phi_s \rangle$
$-\langle \phi_s | \mu | \phi_s \rangle$
(c)
S
D
S

Fig. 1.