Spin 1 GPDs with tensor polarized deuteron DVCS

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References: Berger, Cano, Diehl, Pire, PRL87-142302(2001); S. Liuti, K. Kathuria (2014), Cosyn, Teryaev, Lorce...

As spin 1/2 case, vector and axial current decomposed into form factors, F.T. of matrix elements ⇒GPDs

$$V_{\lambda'\lambda} = -(\epsilon'^* \cdot \epsilon)H_1 + \frac{(\epsilon\cdot n)(\epsilon'^*\cdot P) + (\epsilon'^*\cdot n)(\epsilon\cdot P)}{P\cdot n}H_2 - \frac{(\epsilon\cdot P)(\epsilon'^*\cdot P)}{2M^2}H_3 + \frac{(\epsilon\cdot n)(\epsilon'^*\cdot P) - (\epsilon'^*\cdot n)(\epsilon\cdot P)}{P\cdot n}H_4 + \left\{4M^2\frac{(\epsilon\cdot n)(\epsilon'^*\cdot n)}{(P\cdot n)^2} + \frac{1}{3}(\epsilon'^*\cdot\epsilon)\right\}H_5,$$

$$A_{\lambda'\lambda} = -i\frac{\epsilon_{\mu\alpha\beta\gamma}n^\mu\epsilon'^{*\alpha}\epsilon^\beta P^\gamma}{P\cdot n}\tilde{H}_1 + i\frac{\epsilon_{\mu\alpha\beta\gamma}n^\mu\Delta^\alpha P^\beta}{P\cdot n}\frac{\epsilon^\gamma(\epsilon'^*\cdot P) + \epsilon'^{*\gamma}(\epsilon\cdot P)}{M^2}\tilde{H}_2 + i\frac{\epsilon_{\mu\alpha\beta\gamma}n^\mu\Delta^\alpha P^\beta}{P\cdot n}\frac{\epsilon^\gamma(\epsilon'^*\cdot P) - \epsilon'^{*\gamma}(\epsilon\cdot P)}{M^2}\tilde{H}_3 + i\frac{\epsilon_{\mu\alpha\beta\gamma}n^\mu\Delta^\alpha P^\beta}{P\cdot n}\frac{\epsilon^\gamma(\epsilon'^*\cdot n) + \epsilon'^{*\gamma}(\epsilon\cdot n)}{P\cdot n}\tilde{H}_4$$

9 real GPDs
factorization holds
almost same partity rules... no π pole

1st moment ⇒ GFFs "gravitational form factors"

(≡ matrix elements of EMT → source of gravitationnal interaction)

$$\int_{-1}^{1} dx\, H_i(x,\xi,t) = G_i(t) \qquad (i=1,2,3),$$

$$\int_{-1}^{1} dx\, \tilde{H}_i(x,\xi,t) = \tilde{G}_i(t) \qquad (i=1,2),$$

$$\int_{-1}^{1} dx\, H_4(x,\xi,t) = \int_{-1}^{1} dx\, \tilde{H}_3(x,\xi,t) = 0,$$

$$\int_{-1}^{1} dx\, H_5(x,\xi,t) = \int_{-1}^{1} dx\, \tilde{H}_4(x,\xi,t) = 0.$$

2d moment: spin density

momentum (7), angular mom. (8), quadrupole (9), b_1 sum rule (11)

direct access L^g (isospin symmetry)

$$\int dx x[H_1(x,\xi,t) - \frac{1}{3}H_5(x,\xi,t)] = \mathcal{G}_1(t) + \xi^2\mathcal{G}_3(t) \quad (7)$$

$$\int dx x H_2(x,\xi,t) = \mathcal{G}_5(t) \quad (8)$$

$$\int dx x H_3(x,\xi,t) = \mathcal{G}_2(t) + \xi^2\mathcal{G}_4(t) \quad (9)$$

$$\int dx x H_4(x,\xi,t) = \xi\mathcal{G}_6(t) \quad (10)$$

$$\int dx x H_5(x,\xi,t) = \mathcal{G}_7(t) \quad (11)$$

$$\frac{1}{2}\mathcal{G}_5^{q,g} = \frac{1}{2}\int dx\, xH_2(x,0,0) = J_z^{q,g}$$

forward limit Δ=0 (→q densities):

$$H_1(x,0,0) = \frac{q^1(x) + q^{-1}(x) + q^0(x)}{3}, \Rightarrow F_1(x)$$

$$H_5(x,0,0) = q^0(x) - \frac{q^1(x) + q^{-1}(x)}{2}, \Rightarrow b_1(x)$$

$$\tilde{H}_1(x,0,0) = q_\uparrow^1(x) - q_\uparrow^{-1}(x) \Rightarrow g_1(x)$$

H_5 sum rule: no tensor pol. of sea (d-wave component in deuteron)

$$0 = \int_{-1}^{1} dx\, H_5(x,0,0) \quad \rightarrow \int_0^1 b_1(x) = 0$$

$$= \int_0^1 dx\left[q^0(x) - \frac{q^1(x)+q^{-1}(x)}{2}\right] - \{q\to\bar{q}\}$$

Asymmetry: DVCS NPS-setup + tensor target, recoil detector?

- gluon spin OAM content
- nuclear target, quadrupole, b_1...

$$A_{UT} \approx -\frac{4\sqrt{D_0}}{\Sigma}\Im m\left[\mathcal{H}_1^*\mathcal{H}_5 + \left(\mathcal{H}_1^* + \frac{1}{6}\mathcal{H}_5^*\right)(\mathcal{H}_2 - \mathcal{H}_4)\right]$$