Nucleon Structure with Domain Wall Valence Quarks and Improved Staggered Sea Quarks

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http://talks.drubryantrenner.org/lhpc_11-13-04.pdf

What are generalized form factors?

Definition of Generalized Form Factors

- unpolarized twist two operators

$$O_q^{\mu_1 \cdots \mu_n} = \overline{q} i D^{(\mu_1} \ldots i D^{\mu_{n-1}} \gamma^{\mu_n)}$$

- off-forward matrix elements of the twist two operators

$$\langle P', S' | O_q^{\mu_1 \cdots \mu_n} | P, S \rangle = \overline{U}(P', S') [\sum_{\substack{i=0 \\ \text{even}}}^{n-1} A_{ni}^q(t) K_{ni}^A(P', P)$$

$$+ \sum_{\substack{i=0 \\ \text{even}}}^{n-1} B_{ni}^q(t) K_{ni}^B(P', P) + \delta_{\text{even}}^n C_n^q(t) K_n^C(P', P)] U(P, S)$$

Basic Properties of Generalized Form Factors

- moments of parton distributions - $\langle P|O_q^{\mu_1\cdots\mu_n}|P\rangle$

$$A_{n0}^q(0) = \int_{-1}^{1} dx\; x^{n-1}\, q(x)$$

- ordinary form factors - $\mathcal{O}_q^\mu = \bar{q}\gamma^\mu q$

$$A_{10}^q(t) = F_1^q(t) \quad \text{and} \quad B_{10}^q(t) = F_2^q(t)$$

- quark angular momenta [1]

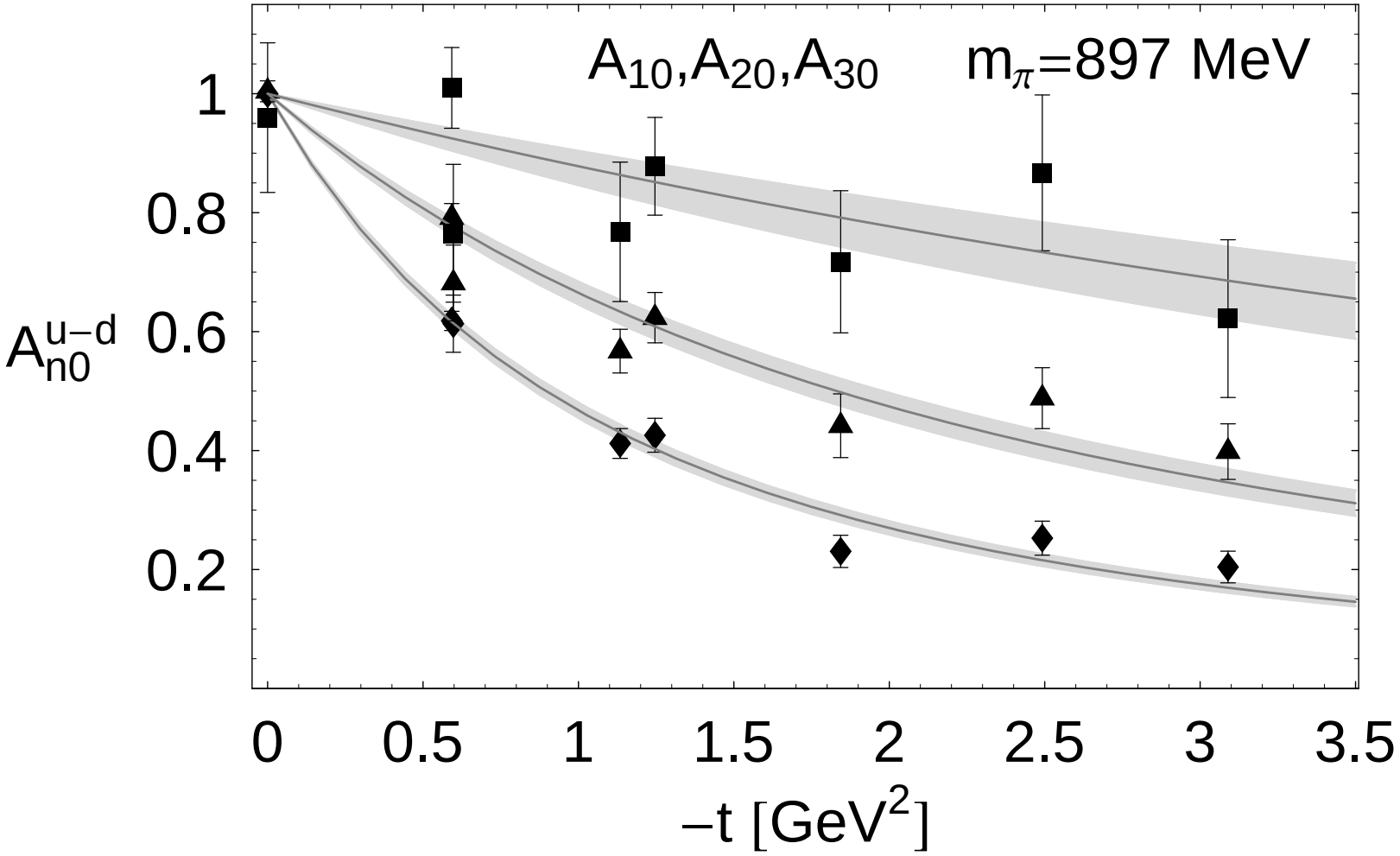
- transverse quark distributions [2]

$$\int_{-1}^{1} dx\; x^{n-1}\, q(x,\vec{b}_\perp) \;=\; \int \frac{d^2\Delta_\perp}{(2\pi)^2} e^{-i\vec{b}_\perp\cdot\vec{\Delta}_\perp} A_{n0}^q(-\vec{\Delta}_\perp^{\,2})$$

[1] X. D. Ji hep-ph/9603249
[2] M. Burkardt hep-ph/0005108

Some examples with heavy-*ish* quarks.

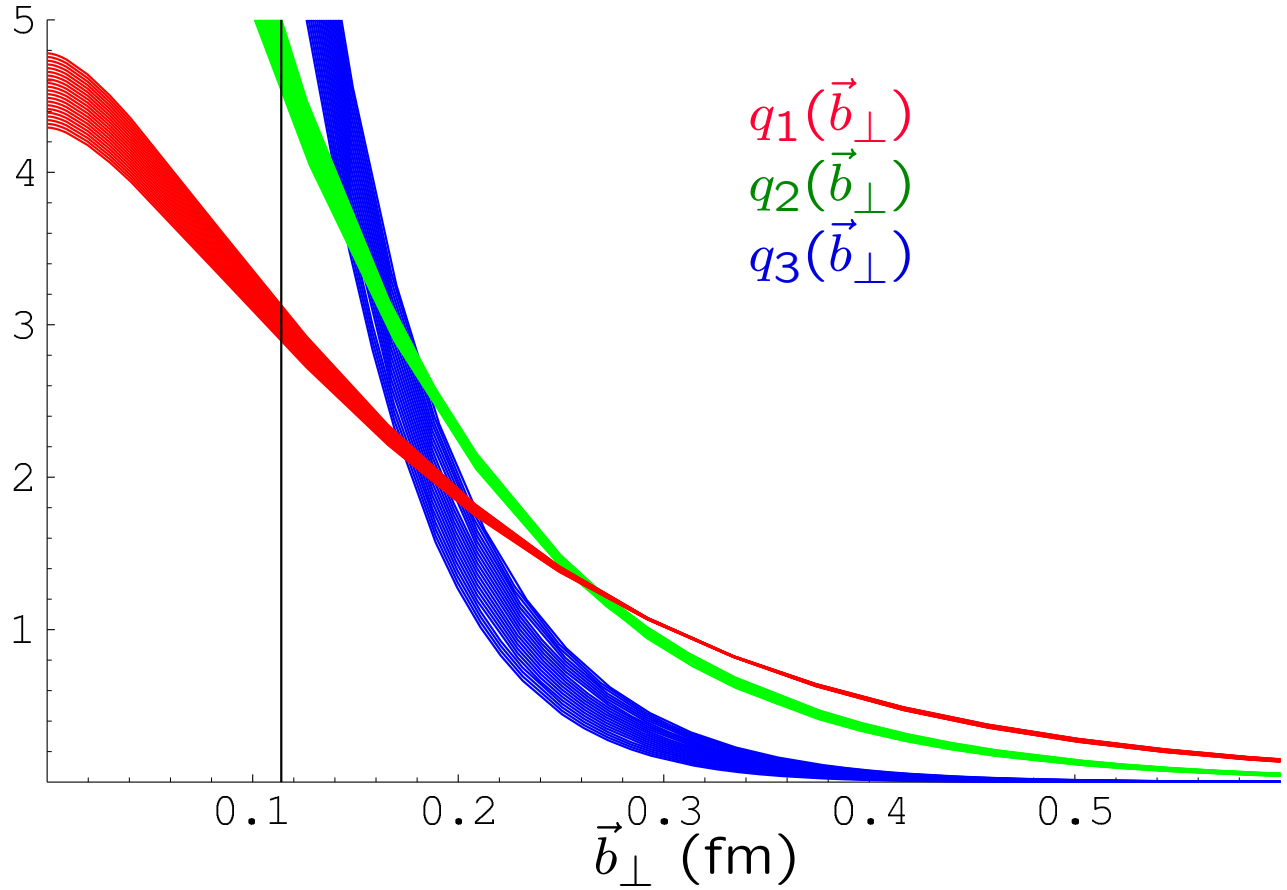
Generalized Form Factors: t Behavior



Transverse Quark Distributions: $\vec{b}_\perp$ Behavior

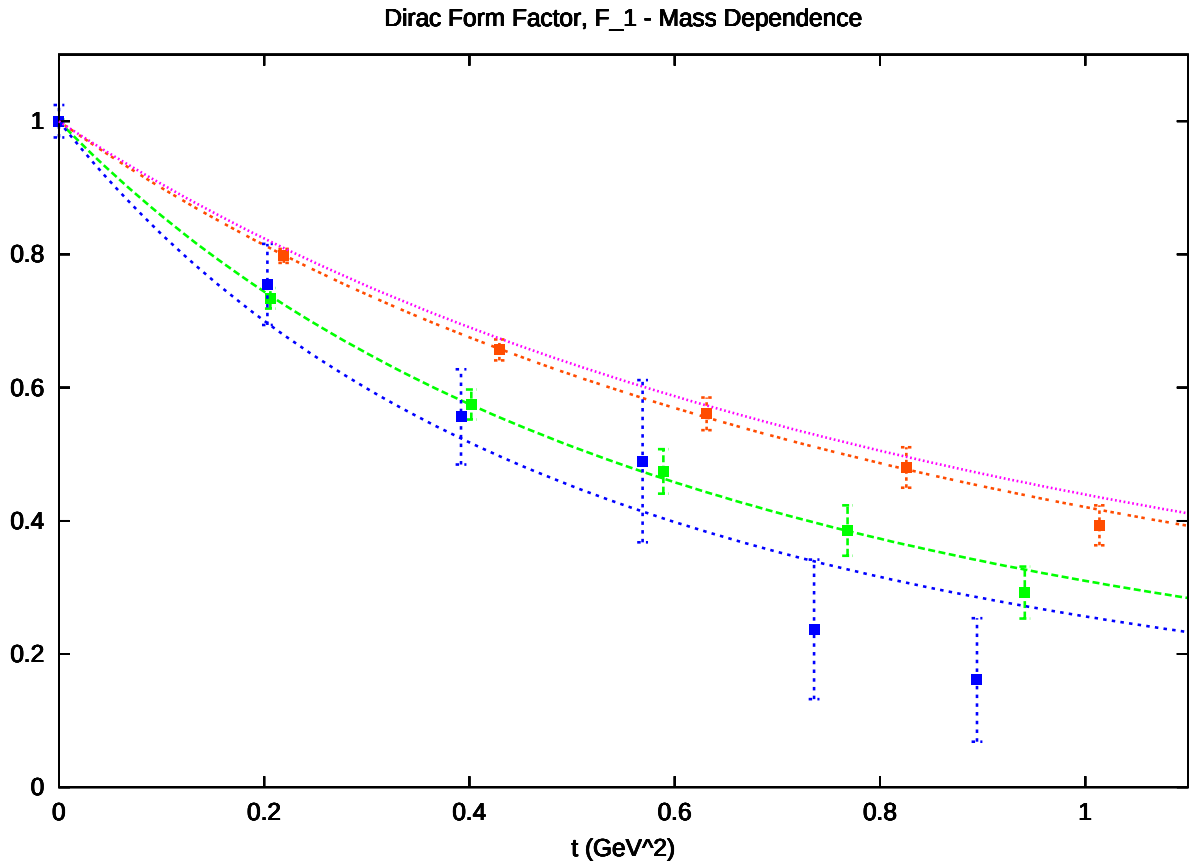
$$q_1(\vec{b}_\perp) = \int_{-1}^{1} dx\; q(x,\vec{b}_\perp) = \int \frac{d^2\Delta_\perp}{(2\pi)^2} e^{-i\vec{b}_\perp\cdot\vec{\Delta}_\perp} A^q_{10}(-\vec{\Delta}^2_\perp)$$

$$q_2(\vec{b}_\perp) = \int_{-1}^{1} dx\; x\, q(x,\vec{b}_\perp) = \int \frac{d^2\Delta_\perp}{(2\pi)^2} e^{-i\vec{b}_\perp\cdot\vec{\Delta}_\perp} A^q_{20}(-\vec{\Delta}^2_\perp)$$

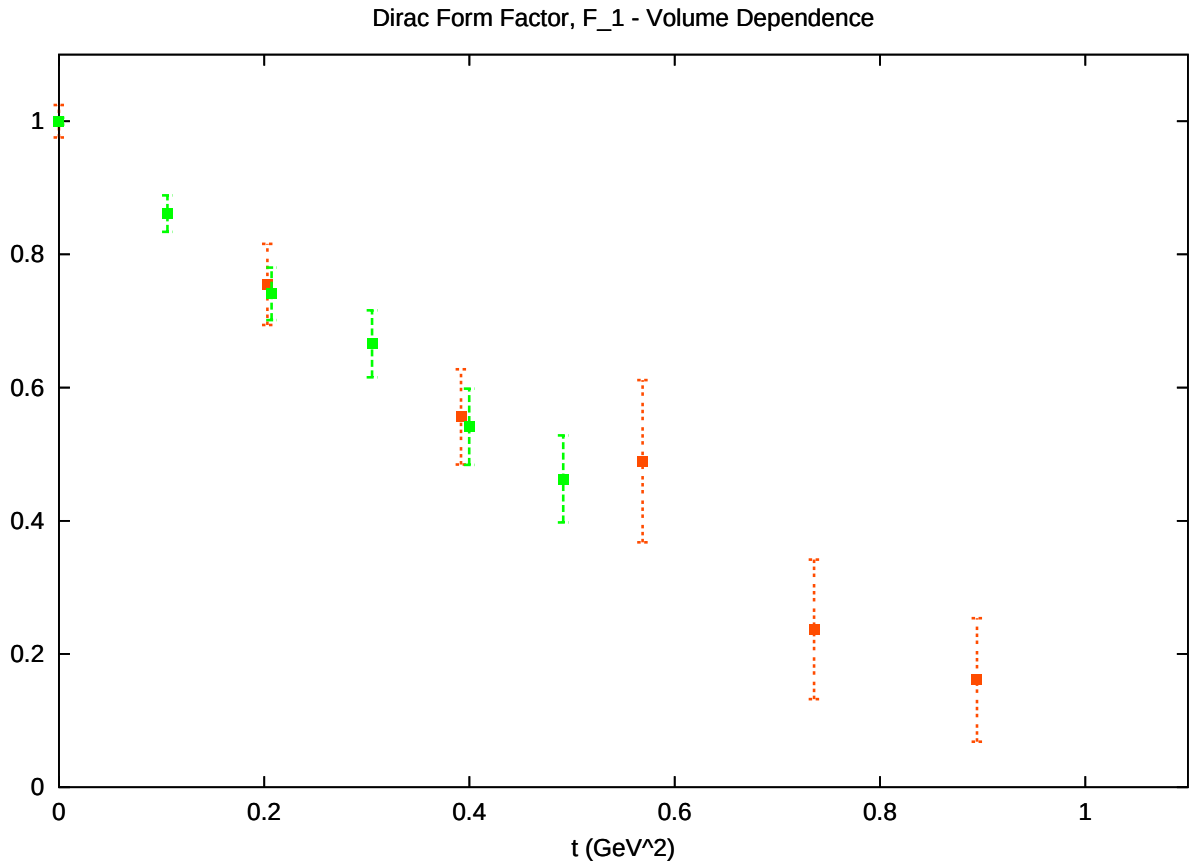


Some examples with light-*ish* quarks.

F_1 Form Factor - Mass Dependence

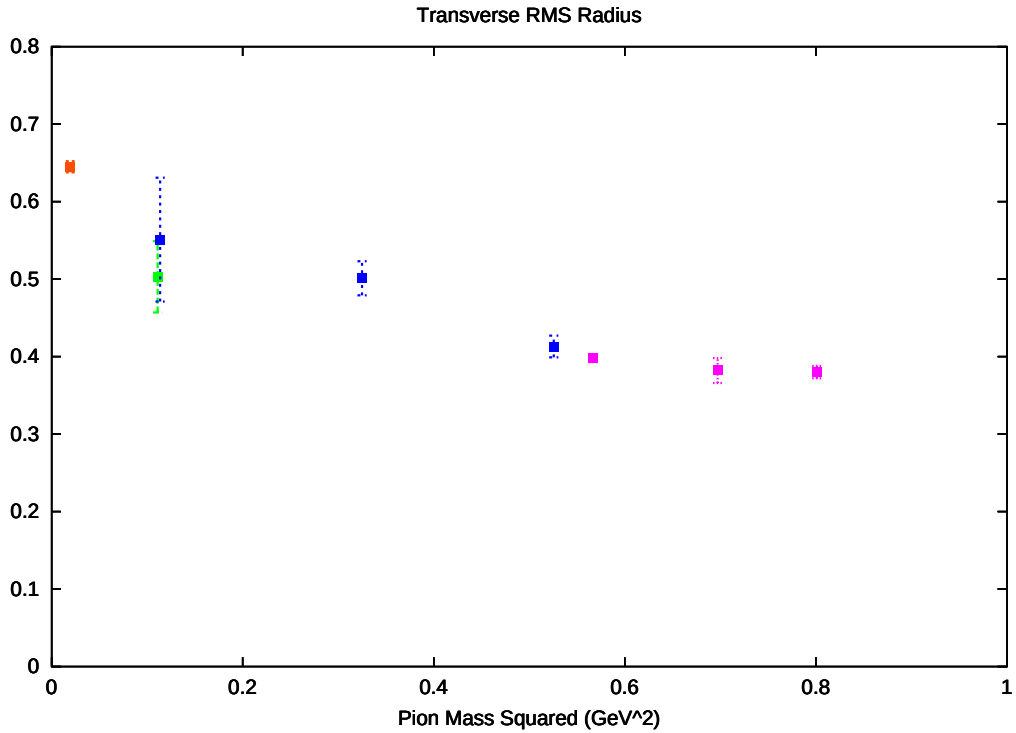


F_1 Form Factor - Volume Dependence



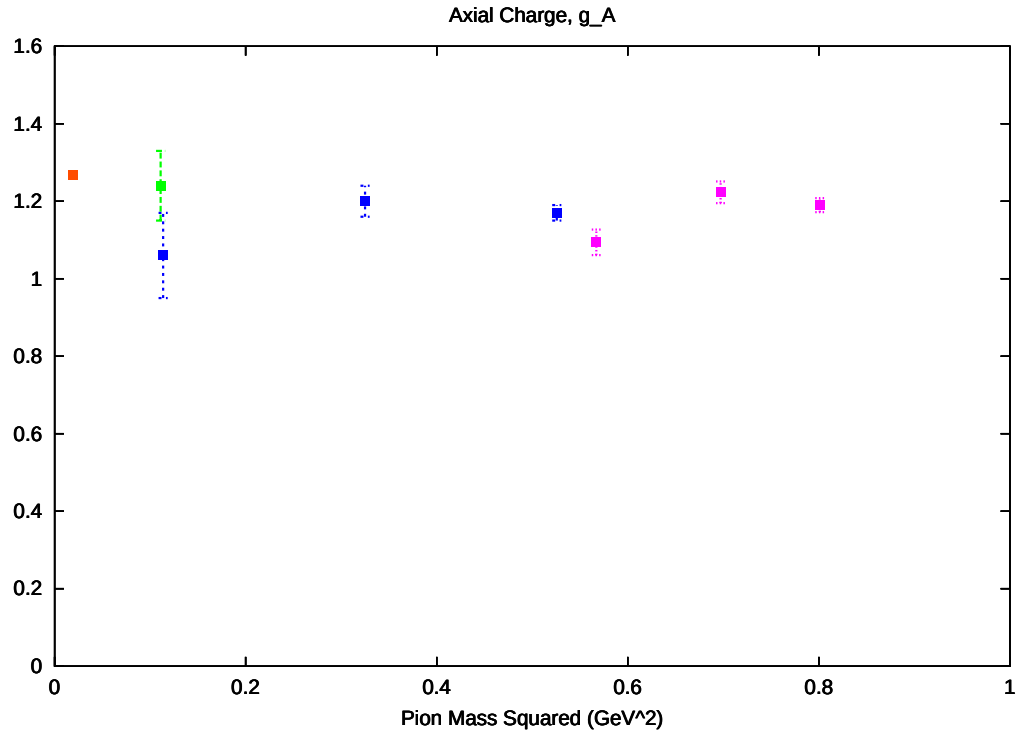
Transverse RMS Radius $\sqrt{r_\perp^2}$

m_π^{DWF}	L/a	Z_V	$\sqrt{r_\perp^2}$ (fm)
725	20	1.153(2)	0.413(14)
570	20	1.132(3)	0.501(22)
337	20	1.117(27)	0.551(80)
333	28	1.108(7)	0.503(46)



Axial Charge g_A

m_π^{DWF}	L/a	Z_A	Z_V	g_A
725	20	1.1282( )	1.153(2)	1.17(2)
570	20	1.1066(6)	1.132(3)	1.20(4)
337	20	1.0852(8)	1.117(27)	1.06(11)
333	28	1.0838(1)	1.108(7)	1.24(9)



Where are we and where are we going?

Status

- production status web page

http://pierre.mit.edu/~LHPC/private/calculations/nucleon_matrix_elements/