EMC and SRC in EFT

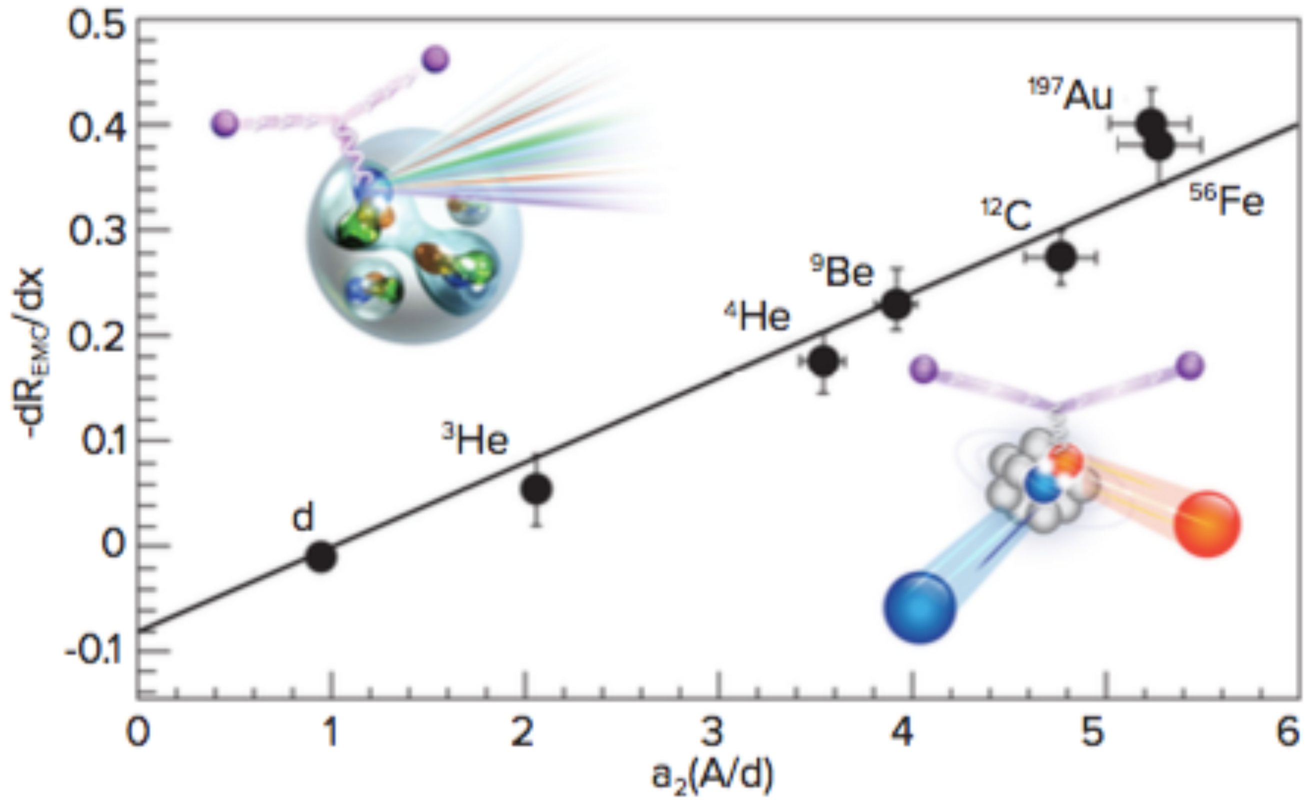
Jiunn-Wei Chen

National Taiwan U.

w/ William Detmold, Joel E. Lynn, Achim Schwenk, 1607.03065

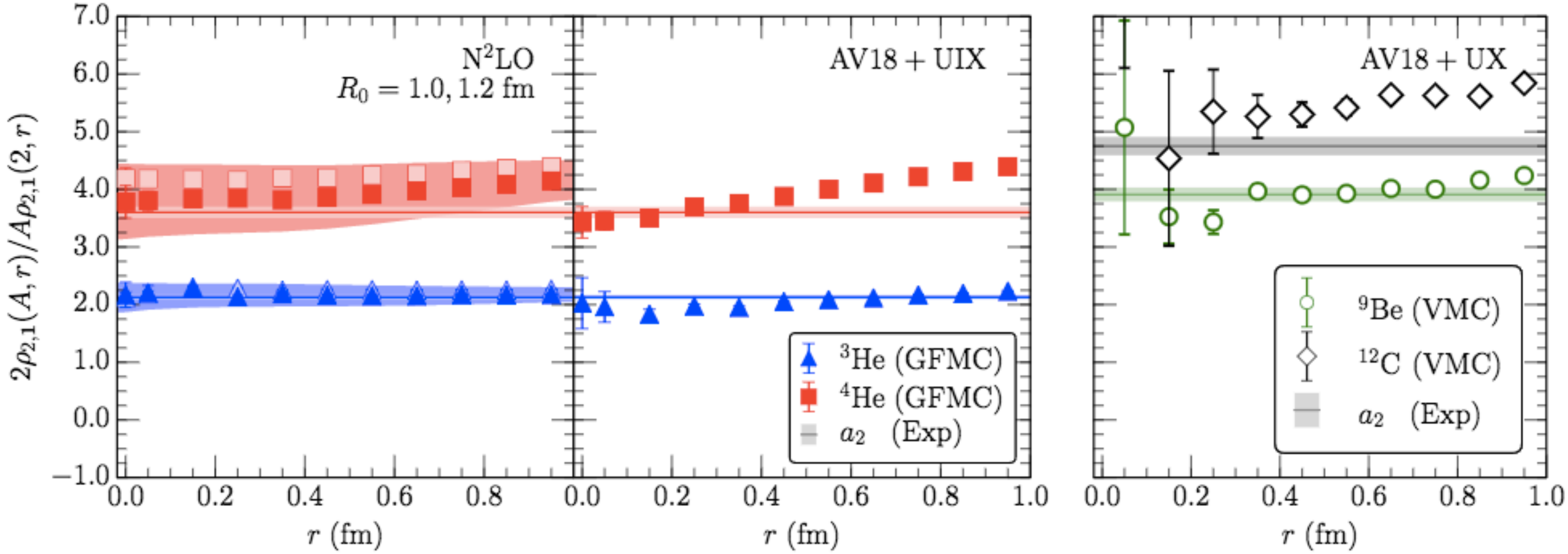
w/ William Detmold, hep-ph/0412119,

Claims(or fantasy?) of EFT from Will and Joel's talks…



- EMC-SRC linear relation reproduced
- Some a_2 reproduced ab initioly
- Remaining problem: EMC slope from LQCD (only need deuteron)

a_2: scheme and scale independent



Key Results

Factorization implies symmetries!

$$q_A(x,Q)/A = q_N(x,Q) + g_2(A,\Lambda)\tilde{q}_2(x,Q,\Lambda),$$

$$\sigma_A/A = \sigma_N + g_2(A,\Lambda)\sigma_2(\Lambda),$$

$$g_2(A,\Lambda) = \frac{1}{A}\langle A|\left(N^\dagger N\right)^2|A\rangle_\Lambda,$$

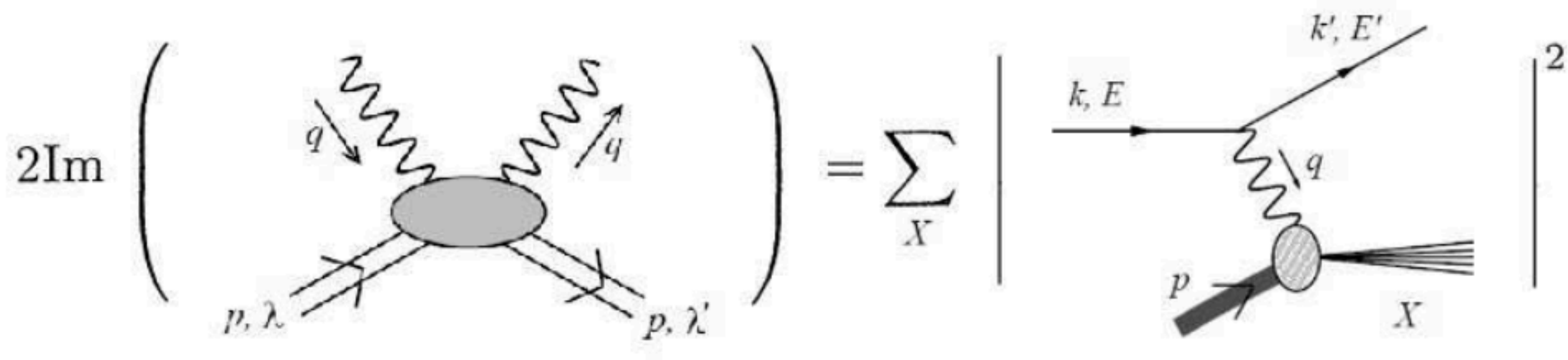
$$a_2(A, x>1) = \frac{g_2(A,\Lambda)}{g_2(2,\Lambda)}.$$

Indept of scheme & scale!

How do we get them?

Limitation of EFT

- Describes physics below momentum cut-off (~500 MeV in ChEFT)
- Why useful for DIS & QE at several GeV? (a) optical theorem (inclusive processes) (b) OPE (Wilson coeff. PQCD (Q), ME of local op. LQCD (Λ,P)) $Q \gg \Lambda \gg P$
- Twist exp. Λ/Q; chiral exp. $\epsilon \sim P/\Lambda \sim 0.2 - 0.3$



Twist-2 operator matching (isoscalar) - standard procedure in ChPT

$$\mathcal{O}^{\mu_0\cdots\mu_n} = \bar{q}\gamma^{(\mu_0}iD^{\mu_1}\cdots iD^{\mu_n)}q,$$

$$\langle A;p|\mathcal{O}^{\mu_0\cdots\mu_n}|A;p\rangle = \langle x^n\rangle_A(Q)\,p^{(\mu_0}\ldots p^{\mu_n)}$$

$$\langle x^n\rangle_A(Q) = \int_{-A}^{A} x^n q_A(x,Q)dx,$$

$$\mathcal{O}^{\mu_0\ldots\mu_n} \to \langle x^n\rangle_N M^n v^{(\mu_0}\cdots v^{\mu_n)} N^\dagger N\left[1+\alpha_n N^\dagger N\right] + \langle x^n\rangle_\pi \pi^\alpha i\partial^{(\mu_0}\cdots i\partial^{\mu_n)}\pi^\alpha + \ldots,$$

From moments to PDF (solution unique?)

LQCD EFT

$$\langle x^n \rangle_A(Q) = \langle x^n \rangle_N(Q) \Big[A + \alpha_n(\Lambda, Q) \langle A | (N^\dagger N)^2 | A \rangle_\Lambda \Big],$$

Factorization!

$$q_A(x, Q)/A = q_N(x, Q) + g_2(A, \Lambda) \tilde{q}_2(x, Q, \Lambda),$$

When does factorization breakdown?

From DIS (twist-2) to QE (all twists)

$$O^{\mu\nu}(y) = iT\{J^\mu(y)J^\nu(0)\}$$
$$= \sum_{t=2}^{\infty}\sum_{k=0}^{\infty}(C^t_{1,k}g^{\mu\nu}O_t^{\mu_1\mu_2\cdots\mu_{2k}} + C^t_{2,k}O_t^{\mu\nu\mu_1\mu_2\cdots\mu_{2k}})y_{\mu_1}y_{\mu_2}\cdots y_{\mu_{2k}},$$

$$W^{\mu\nu} = \int d^4x e^{iqy}\langle P|O^{\mu\nu}(y)|P\rangle$$
$$= -(g^{\mu\nu} + \frac{q^\mu q^\nu}{q^2})W_1 + (P^\mu - \frac{P\cdot q}{q^2}q^\mu)(P^\nu - \frac{P\cdot q}{q^2}q^\nu)W_2$$
$$\to -g^{\mu\nu}W_1 + P^\mu P^\nu W_2,$$

Factorization!

$$\sigma_A/A = \sigma_N + g_2(A,\Lambda)\sigma_2(\Lambda).$$

(x, E, Q^2 dependence in σ suppressed)

Outlook

- Factorization: implies symmetries; Incalculable parts cancel in the ratio; seen in inclusive processes. Exist in semi-inclusive knock out processes as well?
- Application: ν-A scattering for long baseline exp. (Measurements from three unpol. targets (e.g. p, d, C) gives predictions to all isoscalar targets.