Coherent scattering off lightest nuclei: Objectives

what

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theorists planning to be involved in the study:
Perugia group, V. Guzey, MS

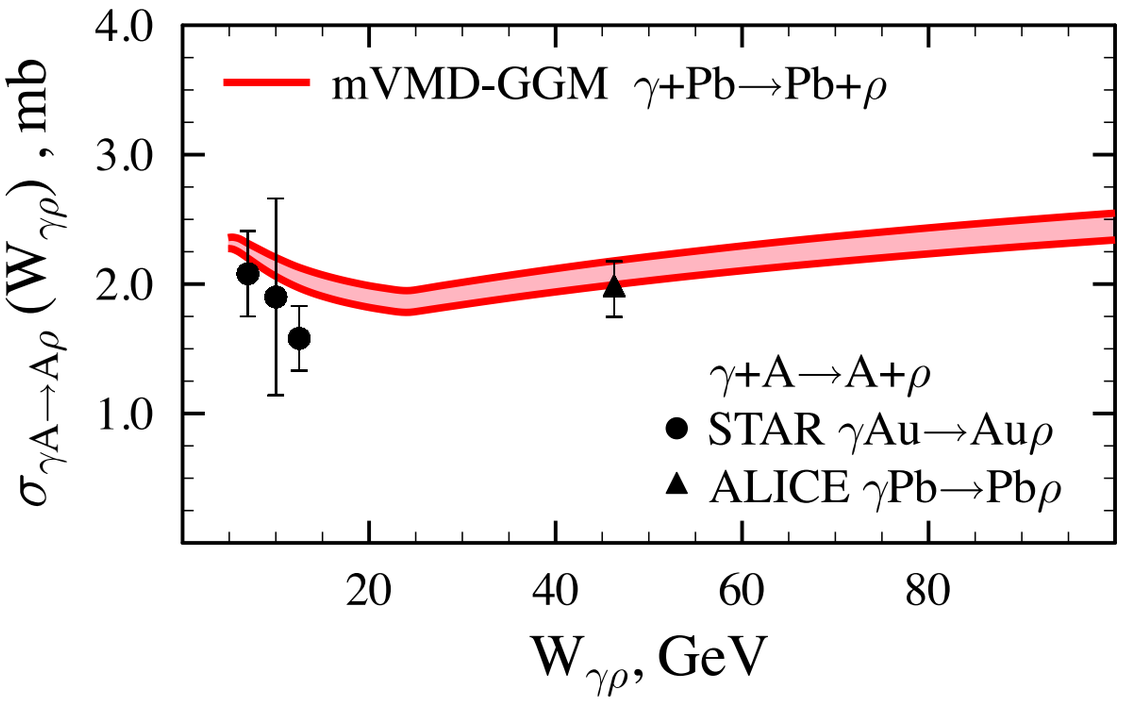
Study of Dynamics of interaction of small and large configurations is one of EIC objectives

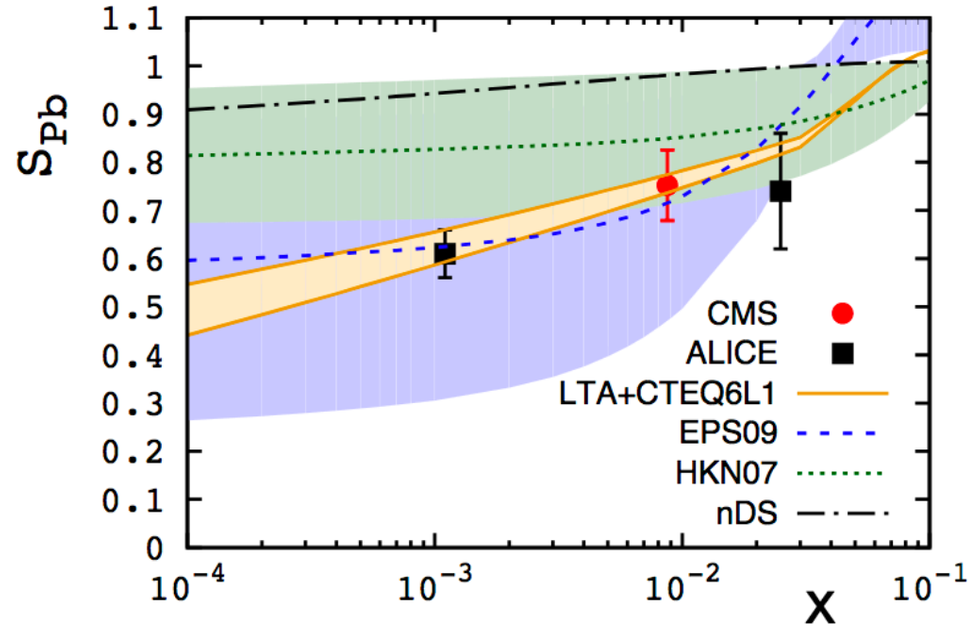
- **in reactions γ+ Pb/Au→ρ (J/ψ) +Pb/Au large screening effects: 7 (3)**

we explained/predicted these suppressions

Gribov - Glauber model with cross section fluctuations

$$S_{Pb} = \left[\frac{\sigma(\gamma A \to J/\psi + A)}{\sigma_{imp.approx.}(\gamma A \to J/\psi + A)}\right]^{1/2} = \frac{g_A(x,Q^2)}{g_N(x,Q^2)}$$





Reactions provide information about color fluctuations of the projectile in soft regime and LT gluon shadowing in hard regime

EIC/LHC: challenge to measure coherent scattering away from t=0 for A~200

Hence information only about interaction with ~ 2 —4 nucleons in average

- **Solution: use the lightest nuclei especially ^{4}He (also ^{3}He ?) to study coherent effects for interaction with exactly 2 nucleons in the range of momentum transfer t=0 ÷ 0.5 GeV^2**

Advantages:

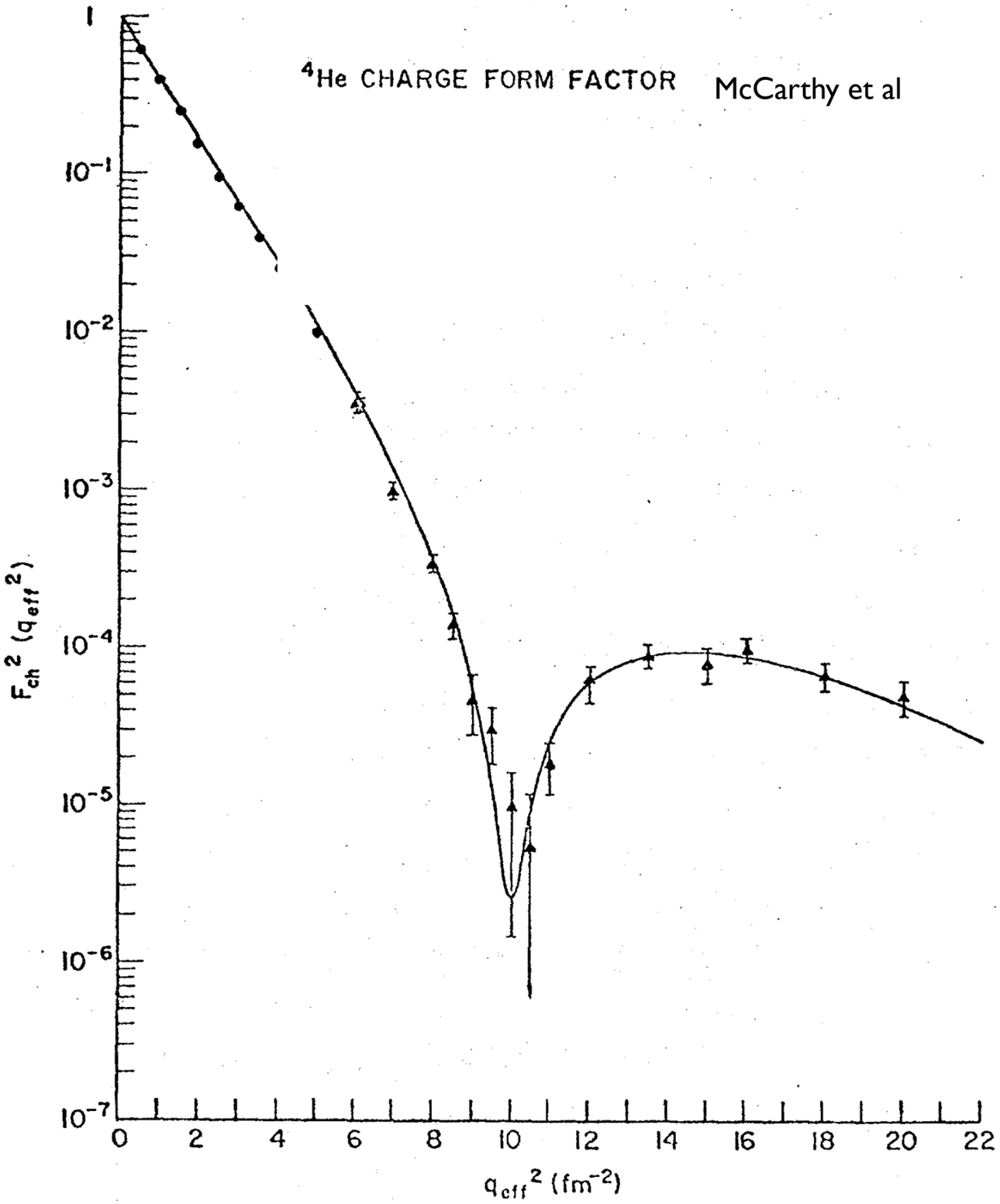
S(4He)=0 - one amplitude

no low-lying excitations (below break up threshold) - easy to select coherent events

significant probability of interactions with two nucleons

well known wave function.

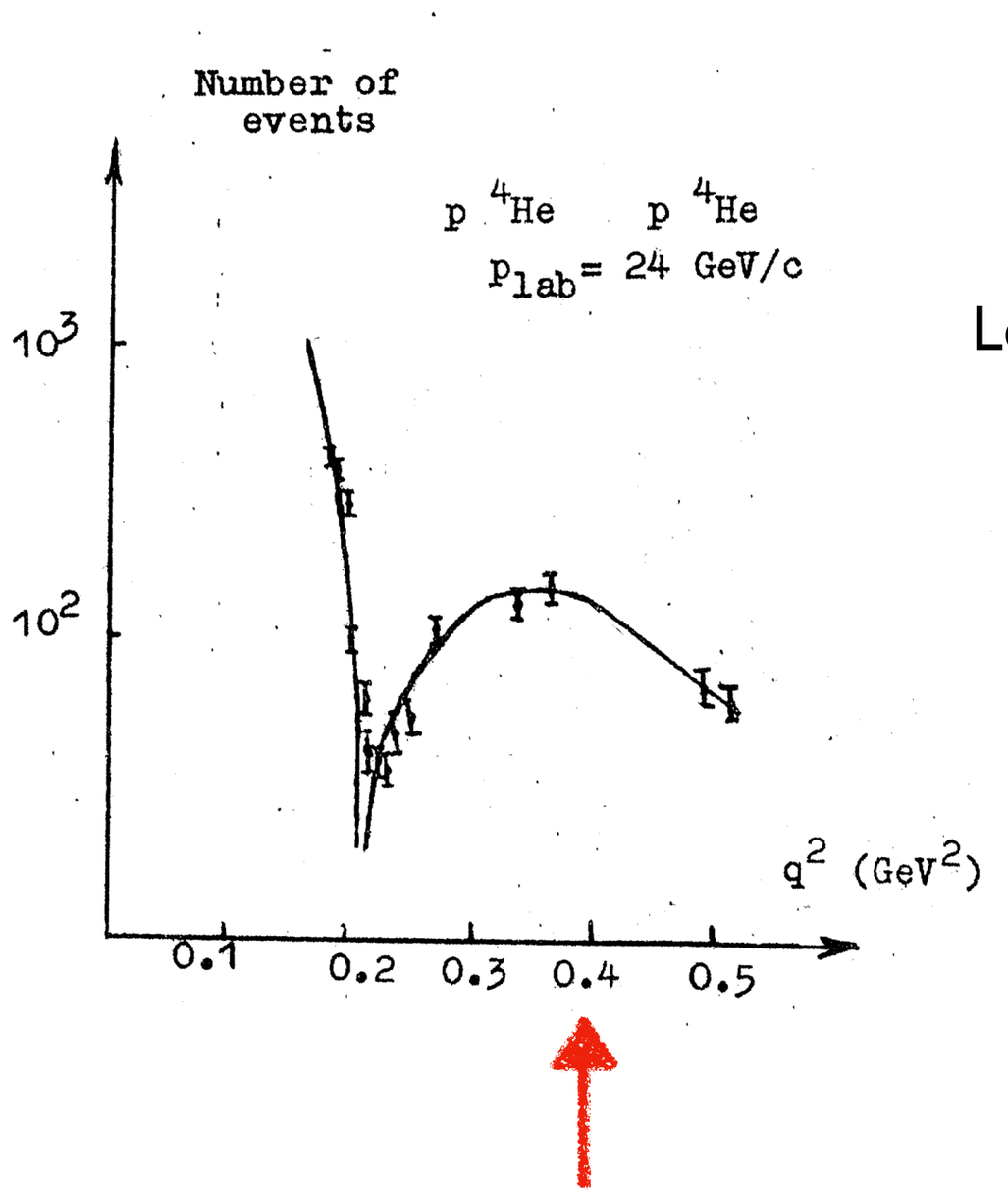
Form factor goes through zero: $F_e(Q^2=0.4\ GeV^2)=0$



e.m. form factor goes through 0 at -t ~ 0.4 GeV^2

⇒ *strong sensitivity to double scattering starting at -t ~0.4 GeV^2*

Glauber model works well for energies where Gribov shadowing is still small.

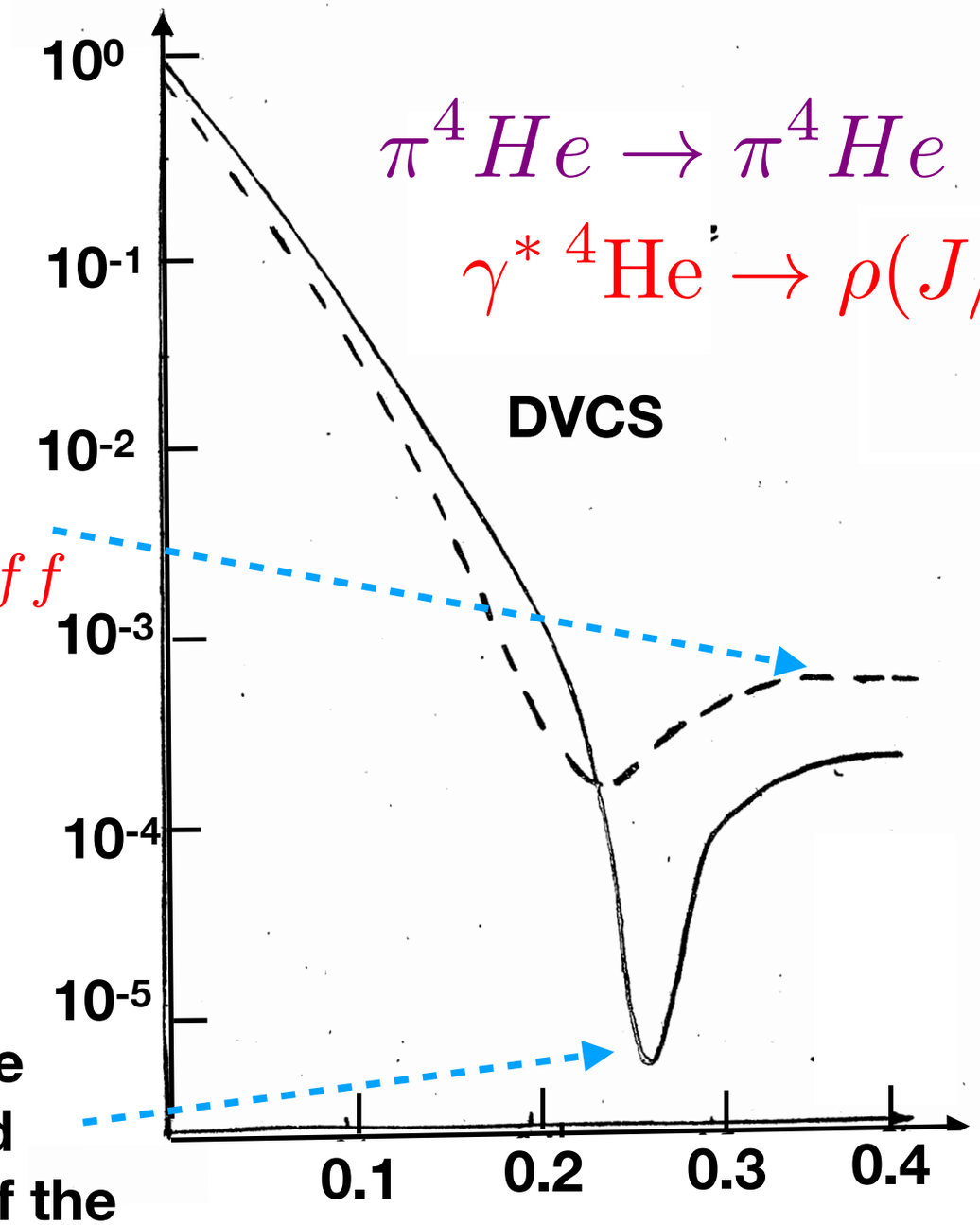


Levin & MS 1975

no contribution of impulse approximation term

Strong sensitivity of the cross section to the strength of double scattering

$$\frac{d\sigma}{dt}/\frac{d\sigma}{dt}(t=0)$$



$$\pi^4He \to \pi^4He$$

$$\gamma^{*\,4}\mathrm{He} \to \rho(J/\psi, M_X) +^4 He$$

$$\frac{d\sigma}{dt} \propto \sigma_{eff}^4$$

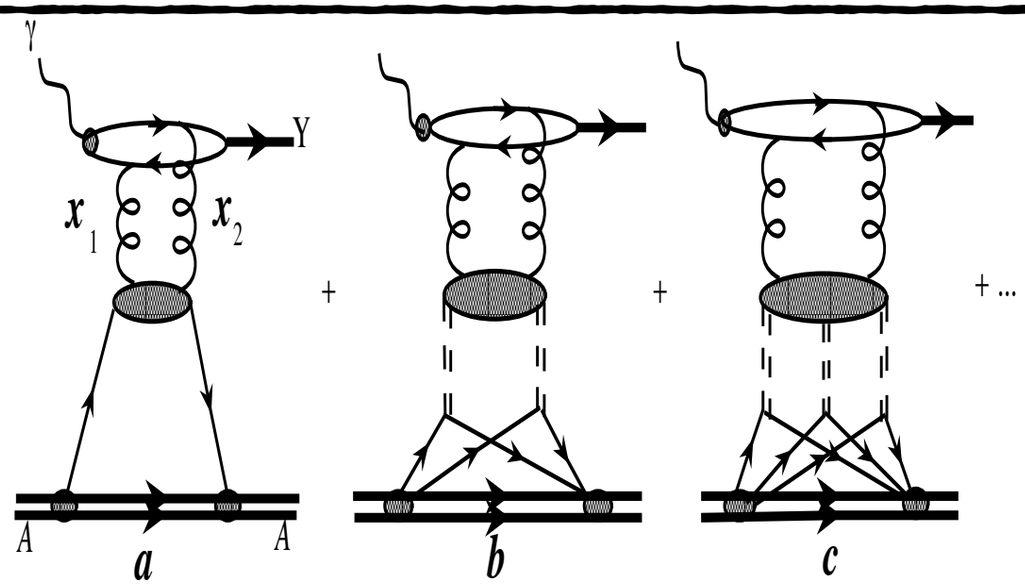
$$\sigma_{eff} = 30mb$$

$$\sigma_{eff} = 25mb$$

Likely to be dominated by real part of the amplitude

Cross section for scattering off 4He at -t=0.4±0.05 GeV²
is only 5 times smaller than for the same t for scattering off hydrogen

Counting rates are sufficient study transition from soft regime to LT



For finite t - probe new quantities nondiagonal diffractive pdfs

High energy quarkonium production in the LT theory

R(t)= $\frac{d\sigma}{dt}/\frac{d\sigma}{dt}(t=0)$

Examples:

$R_{\gamma^*\to\rho}(Q^2, t=0.4)$ **study how R drops with increase of Q**

$R_{\gamma^*\to J/\psi}(Q^2, t=0.4) \approx R_{\gamma^*\to J/\psi}(Q^2, t=0.4)$ **for Q²> 10 GeV²**

A nice plot for Yellow report: R(t) for Q^2= 0 & 10 for J/ψ and ρ

Requirements for detector for e^{4}He collisions

(similar requirements for e^{3}He)

vector meson production

-t range: up to 0.5 GeV^2

Good resolution in t for -t ~ 10^{-2} GeV^2

inelastic diffraction

additional requirement: resolution in diffractive mass

measurement of M_X in e^{4}He requires a very good resolution in $x_{/P}$