Argonne NATIONAL LABORATORY

Inclusive studies of 3N-SRCs

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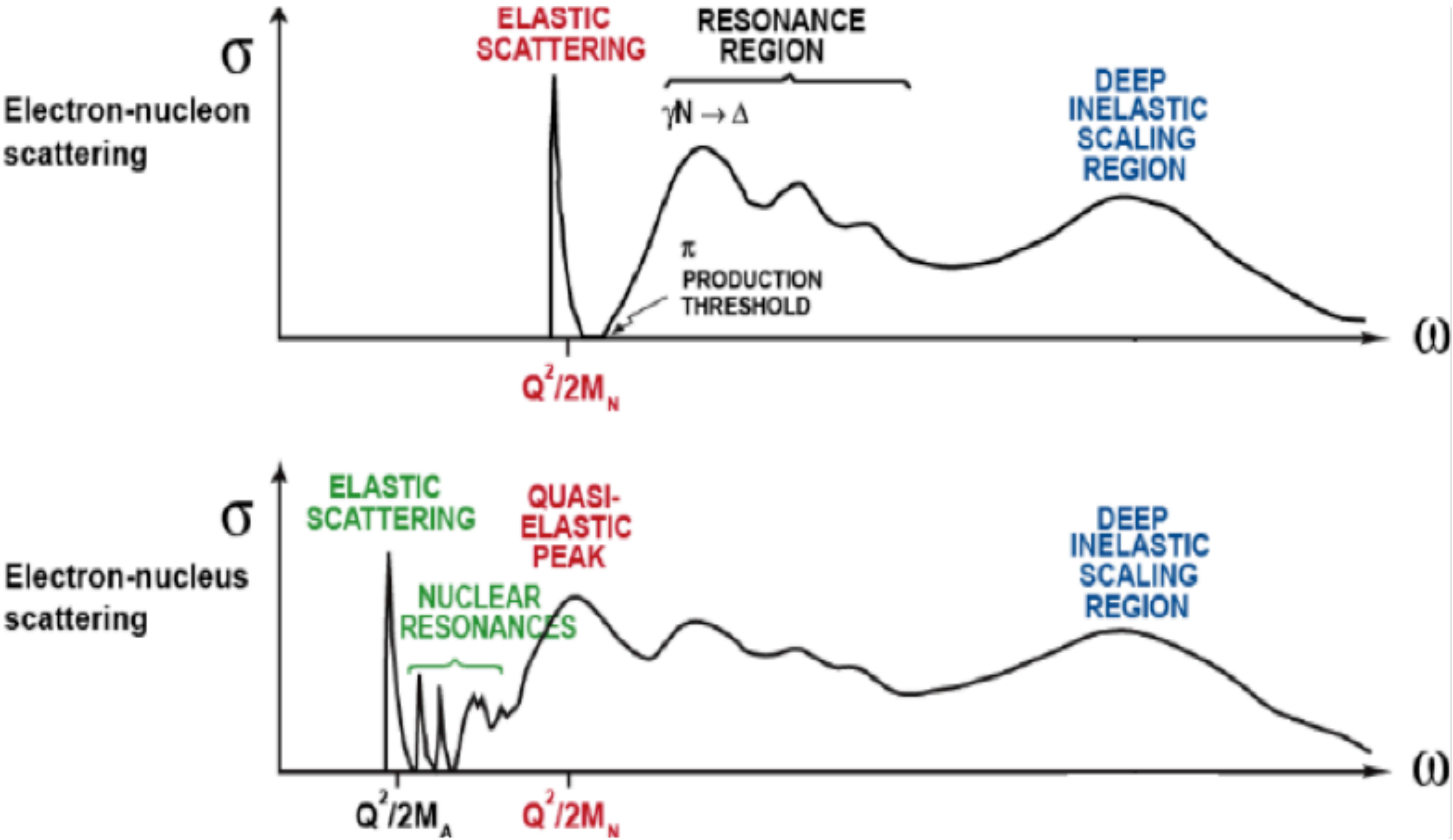
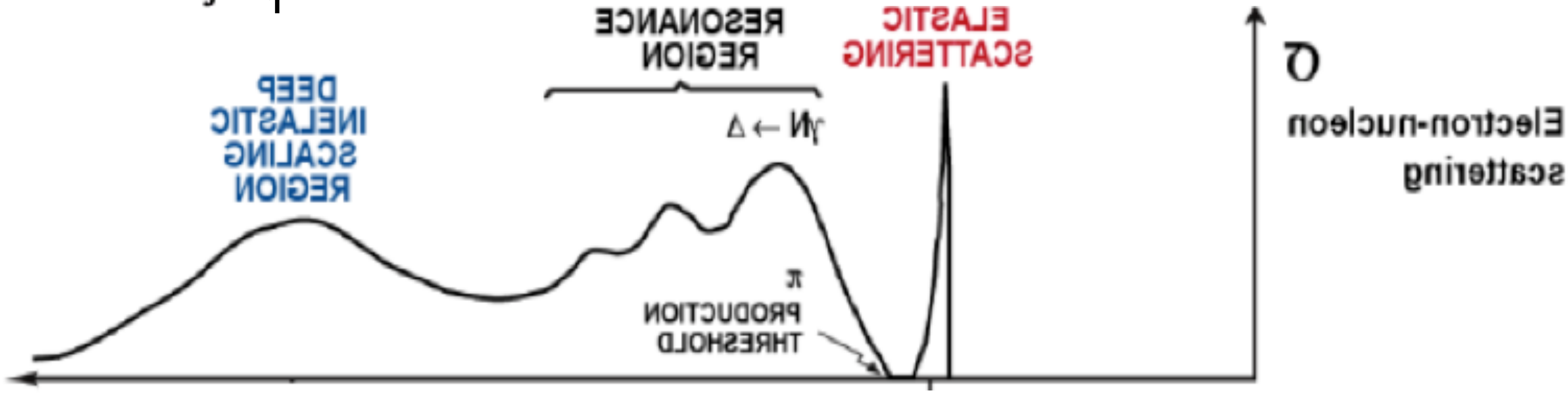
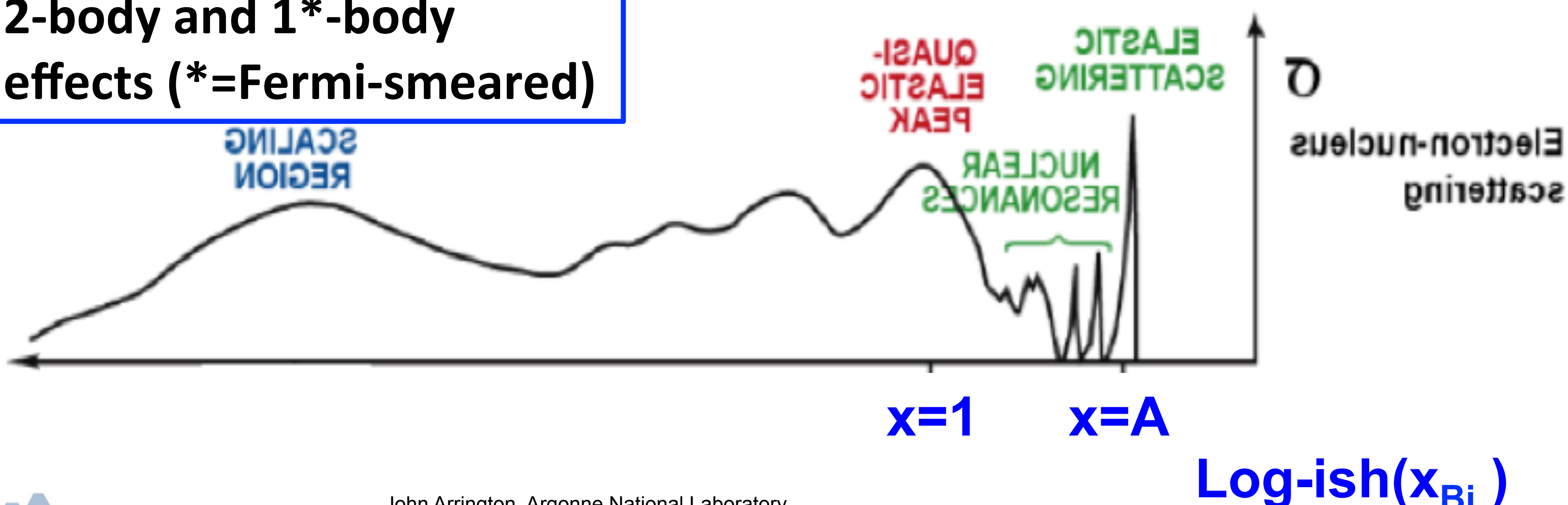

σ
Electron-nucleon scattering
ELASTIC SCATTERING
RESONANCE REGION
γN → Δ
π PRODUCTION THRESHOLD
DEEP INELASTIC SCALING REGION
ω
Q²/2M_N
σ
Electron-nucleus scattering
ELASTIC SCATTERING
QUASI-ELASTIC PEAK
NUCLEAR RESONANCES
DEEP INELASTIC SCALING REGION
ω
Q²/2M_A
Q²/2M_N

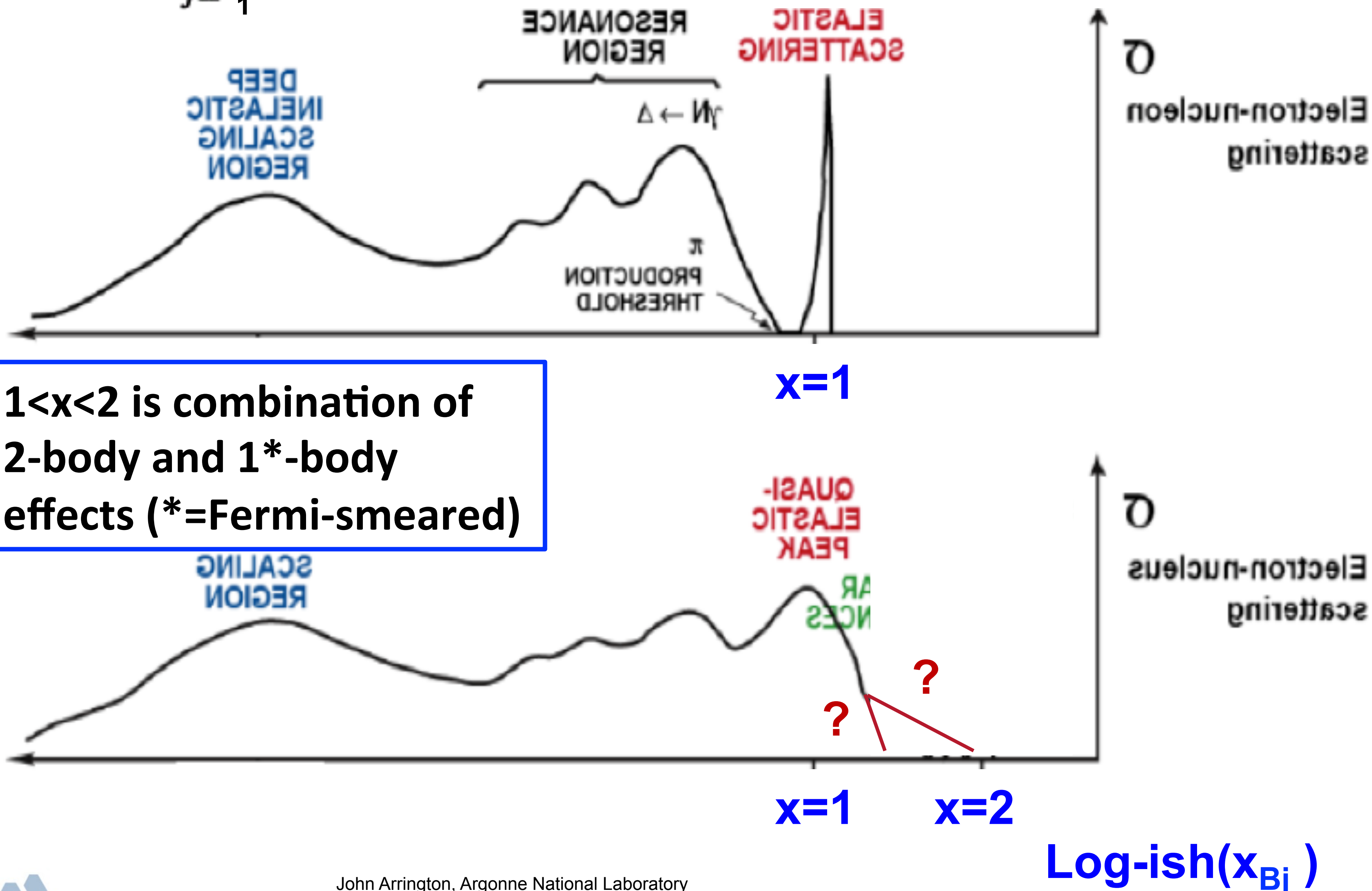
$$\sigma(x,Q^2) = \sum_{j=1}^{A} A\frac{1}{j}a_j(A)\sigma_j(x,Q^2)$$



1<x<2 is combination of 2-body and 1*-body effects (*=Fermi-smeared)

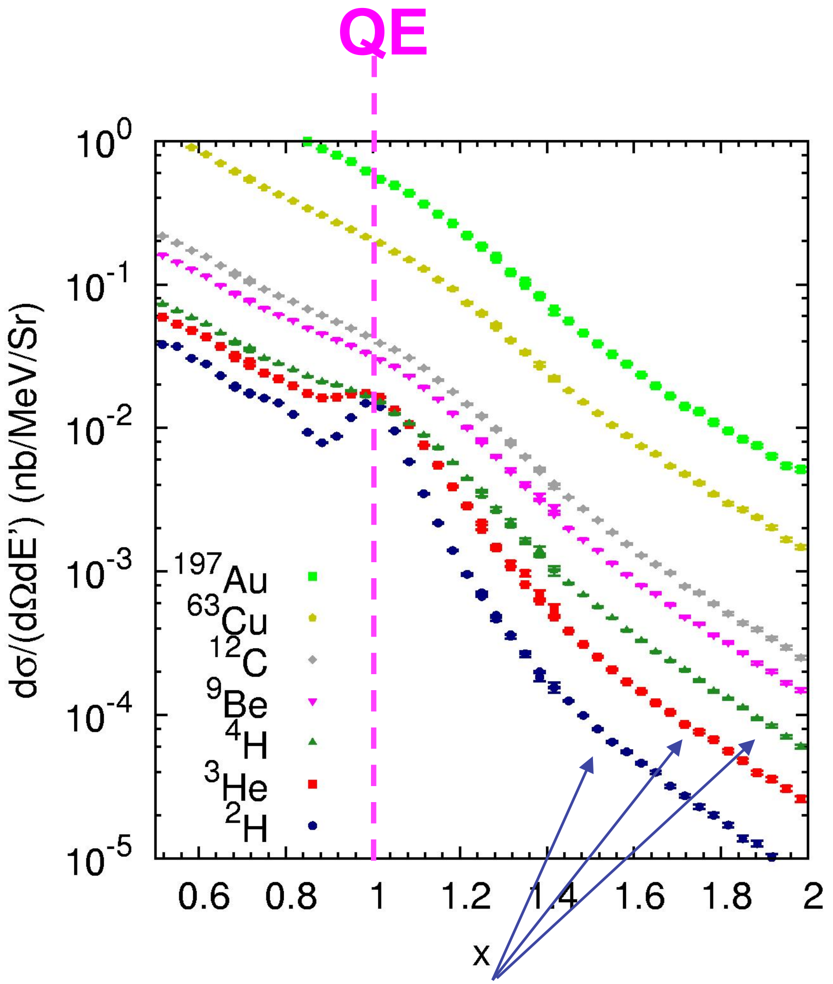


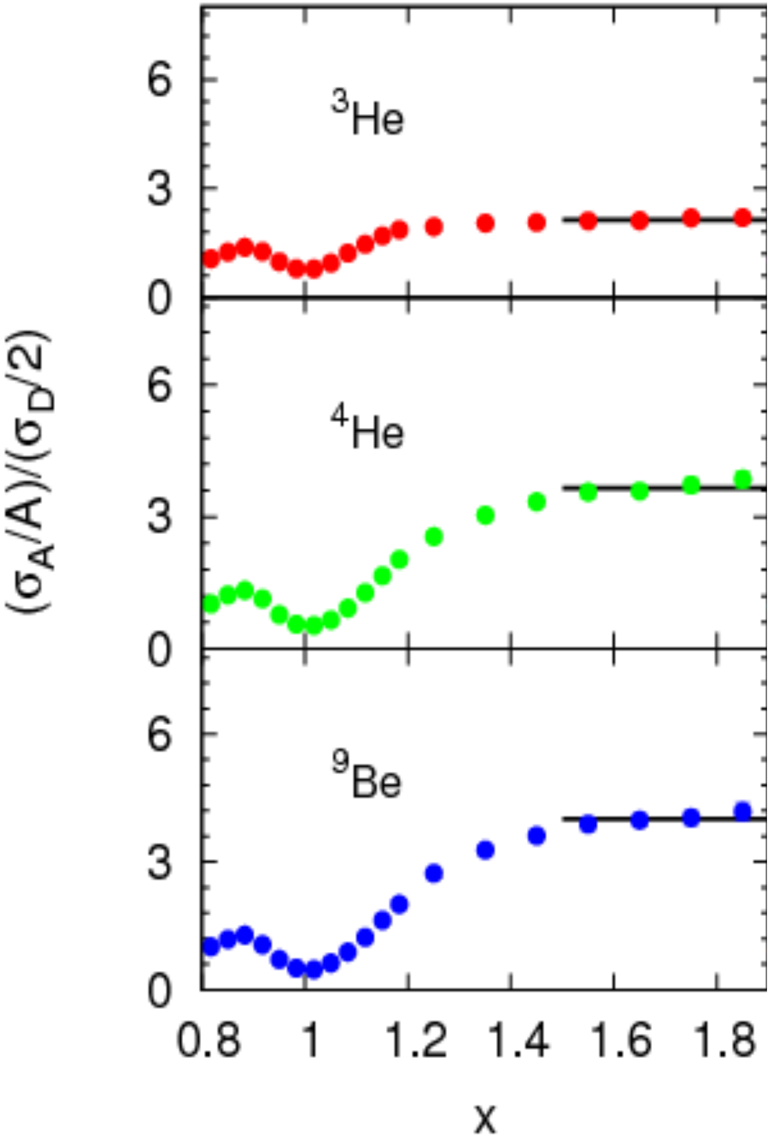
$$\sigma(x, Q^2) = \sum_{j=1}^{A} A \frac{1}{j} a_j(A) \sigma_j(x, Q^2)$$



1<x<2 is combination of 2-body and 1*-body effects (*=Fermi-smeared)

If two-body physics (SRCs) dominate beyond some value of x; $\sigma_A \sim \sigma_2$ independent of x, Q^2

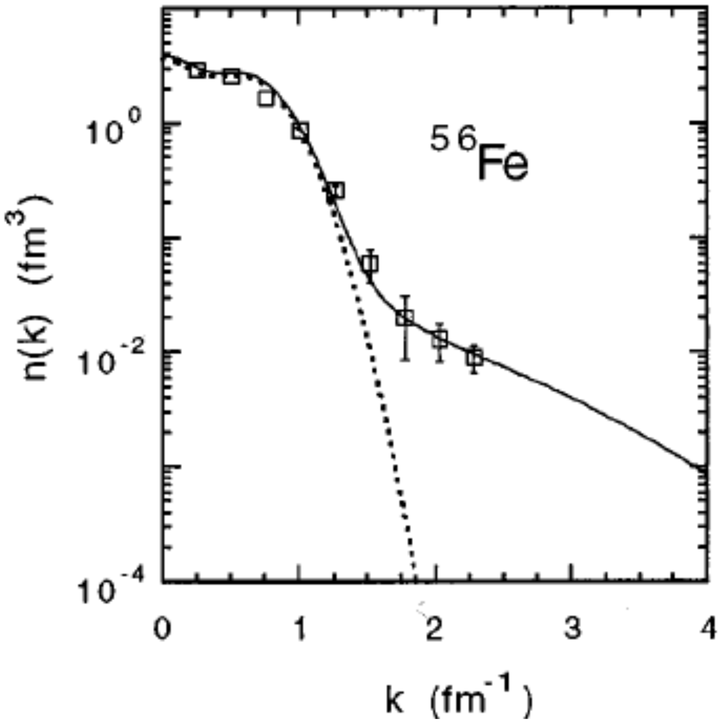


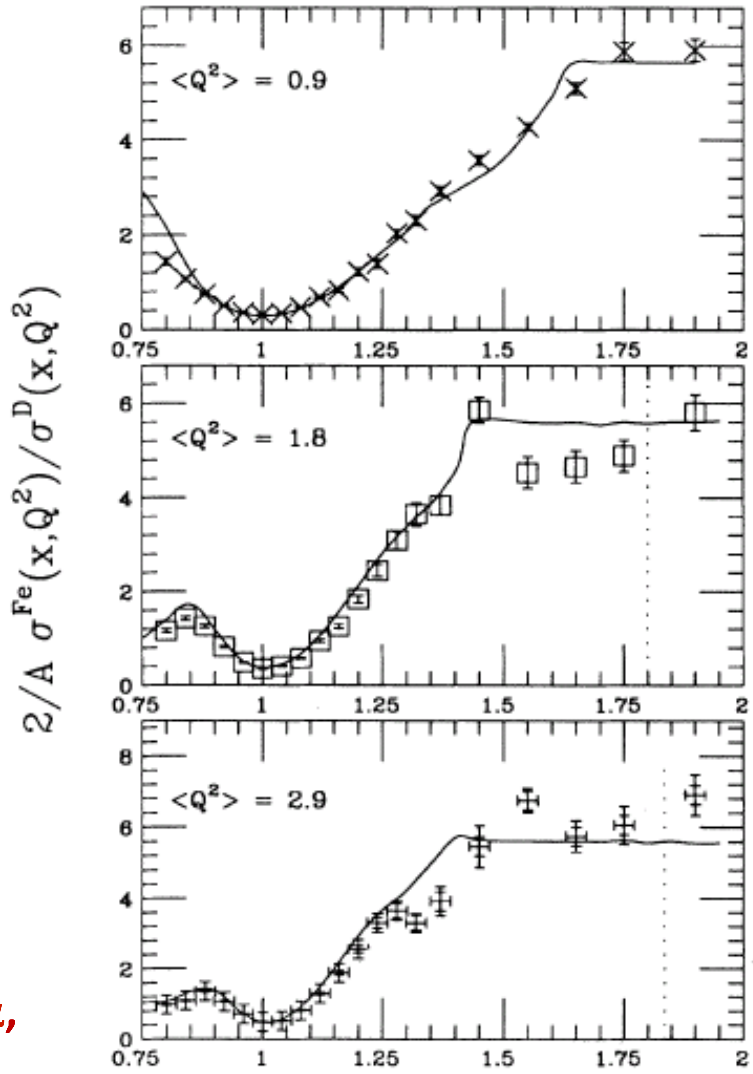


High momentum tails should yield constant ratio if SRC-dominated

N. Fomin, et al., PRL 108 (2012) 092052

2N plateaus if (1) negligible 1-body contributions





Onset of scaling can be estimated simply from Fermi momentum.

1*-body contributions disappear earlier in x as Q^2 increases. Low Q^2 –> very limited scaling region.

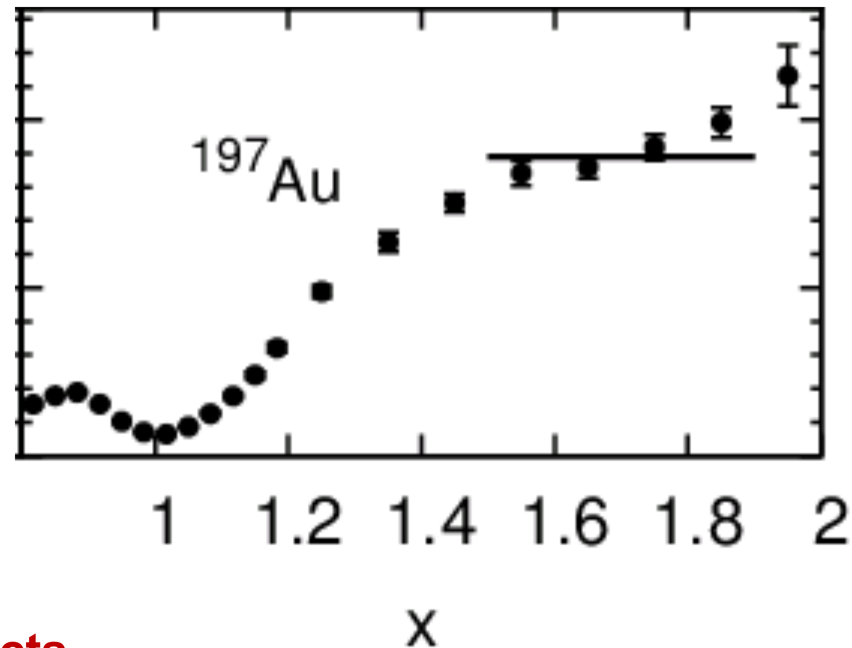
Note: largely Q^2 independent as function of light code α, but α can't be reconstructed in inclusive scattering for A>2

2N plateaus if (1) negligible 1-body contributions (2) existence of identical 2N-SRCs in A and ^{2}H

Cross section for deuteron goes to zero as x → kinematic limit (x≈2)

Even if SRC is internally identical to deuteron, motion of SRC in nucleus will extend strength to x>2

A/D → ∞ as you approach x=2



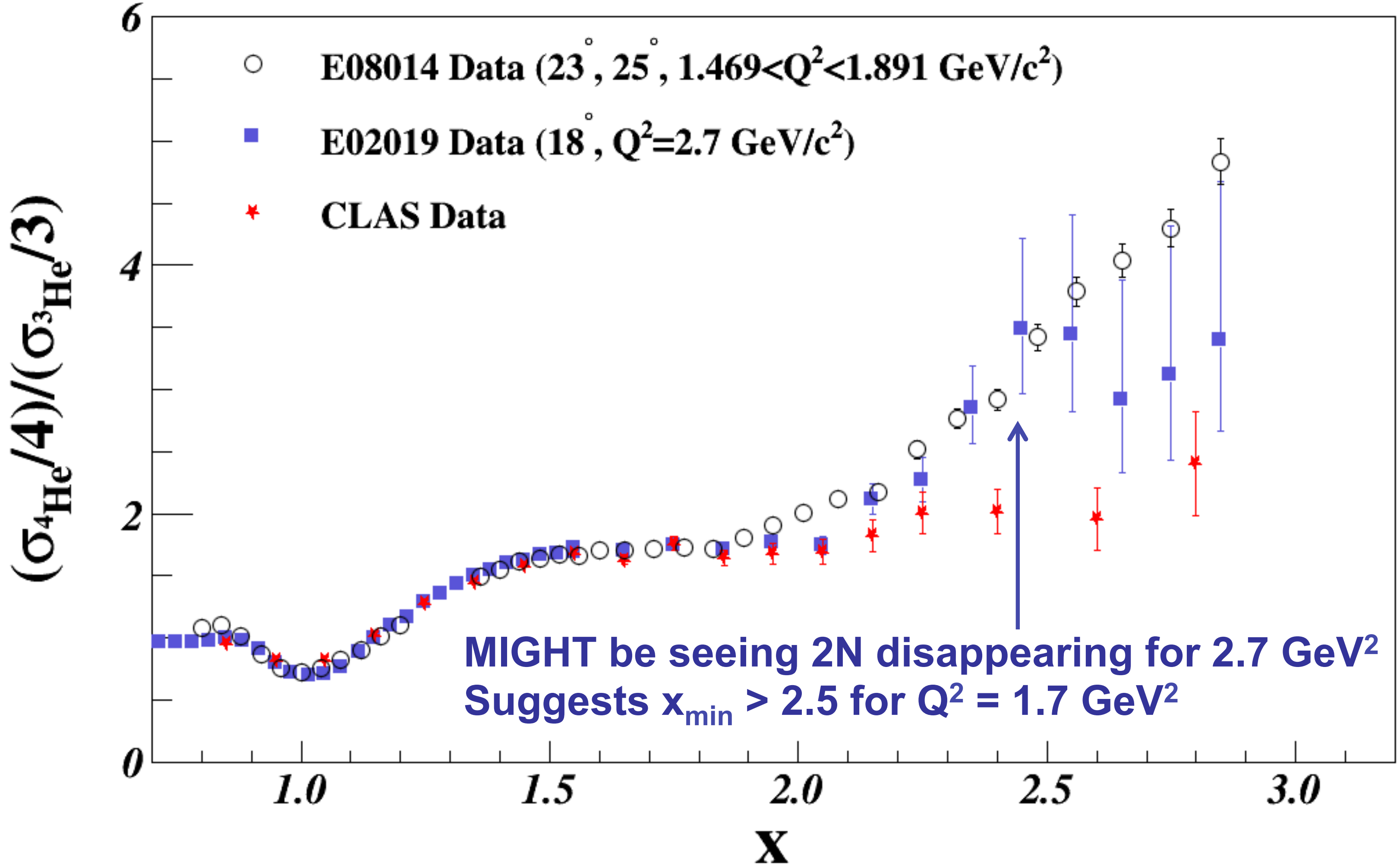
Good news: this effect is relatively
Small below x=1.8-1.9

Plateau for (x_{min}≈1.5) < x < (x_{max}≈1.9)

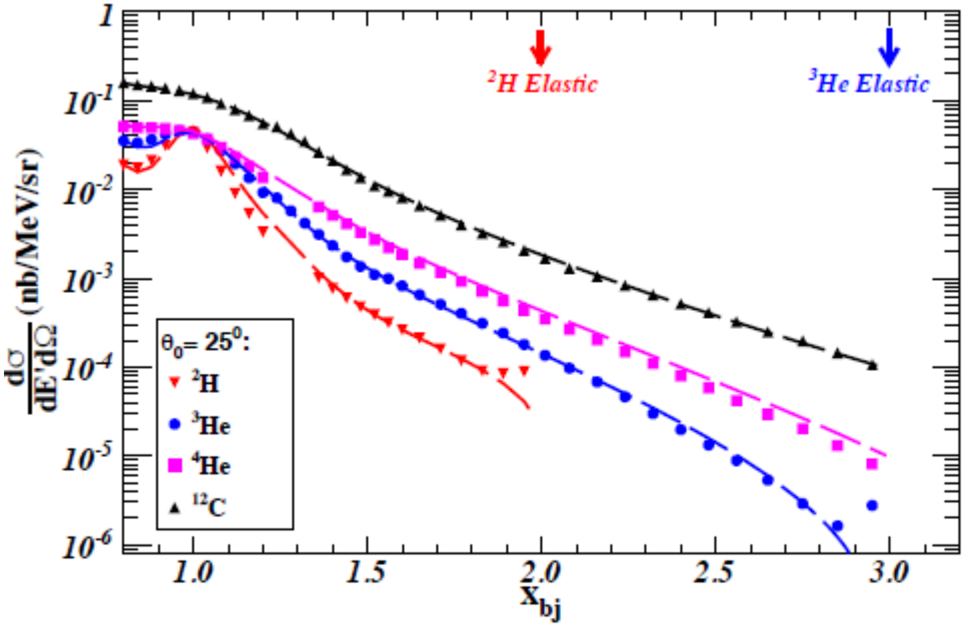
3N SRCs in A/^{3}He ratios??

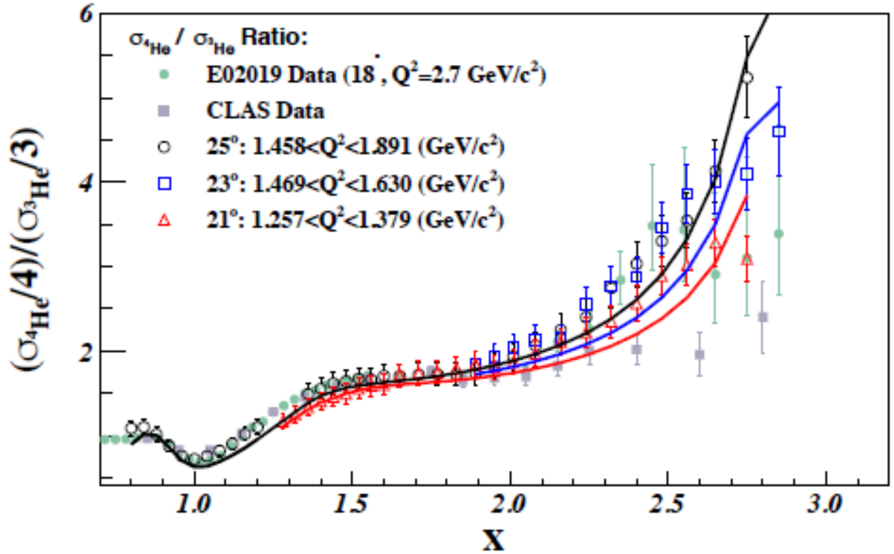
x > x_{min} (>2) and high Q^2 for 2N to die out
x < x_{max} (<3) to avoid ^{3}He “smearing” effects

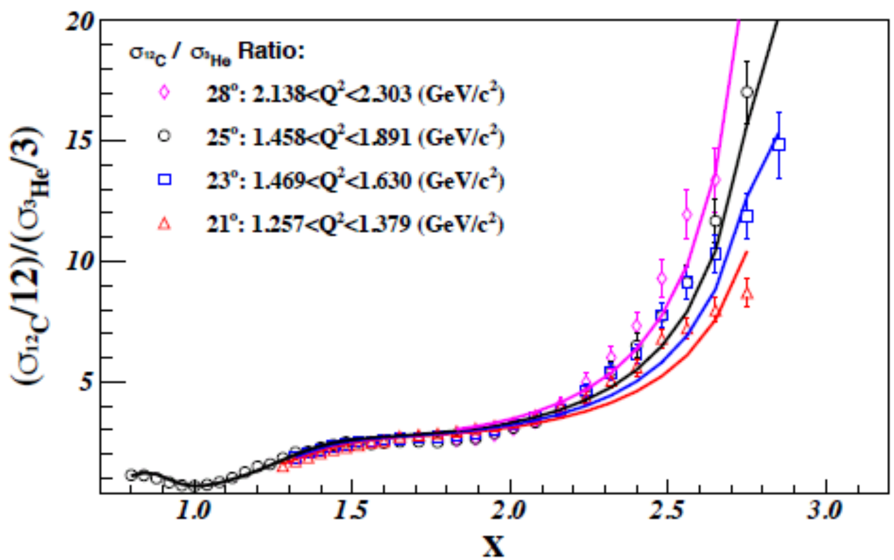
Not obvious that such a region exists, until CLAS showed scaling in A/^{3}He


E08014 Data (23°, 25°, 1.469<Q²<1.891 GeV/c²)
E02019 Data (18°, Q²=2.7 GeV/c²)
CLAS Data
(σ4He/4)/(σ3He/3)
x
0
2
4
6
1.0
1.5
2.0
2.5
3.0
MIGHT be seeing 2N disappearing for 2.7 GeV²
Suggests xmin > 2.5 for Q² = 1.7 GeV²

x_{min} > 2.5; what about x_{max}?







Deuteron: smeared SRC similar to 2H (A/2H is ~flat) until x>1.8

3He: cross section of stationary 3N-SRC begins to fall off closer to x=2.6. Sets in EARLIER at high Q^2

For 2N-SRCs, we could predict where 1*-body contributions vanish
For 3N-SRCs, not clear where 2*-body contributions vanish
Expect x_{min} to decrease as Q^2 increases, making scaling start at smaller x
→ Higher Q^2 expands lower bound of possible scaling region

Difference between stationary 2N-SRC and moving 2N-SRC makes A/^{2}H diverge as x→2, but effect small until x=1.8-1.9.

Difference between stationary 3N-SRC and moving 3N-SRC makes A/^{3}He diverge as x→3, appears to impact potential plateau at x~2.6 or so.

At higher Q^2, this effect starts at smaller x
→ Higher Q^2 decreases upper bound of possible scaling region

Not clear what Q^2 is optimal (data to be taken at Q^2 ~ 2, 3, 4 GeV^2)

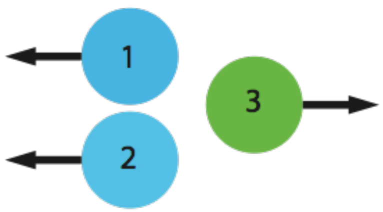
Is there any Q^2 with significant separation of x_{min} (2N contributions negligible) and x_{max} (small impact of 3N motion)?

Need better modeling of 2N-SRC and 3N-SRC motion
A/^{4}He comparisons better for x→3 region

Note: looking for 3N-SRCs at larger x doesn't necessarily mean looking for larger initial nucleon momenta.

Struck nucleon in green, assume k=600 MeV/c

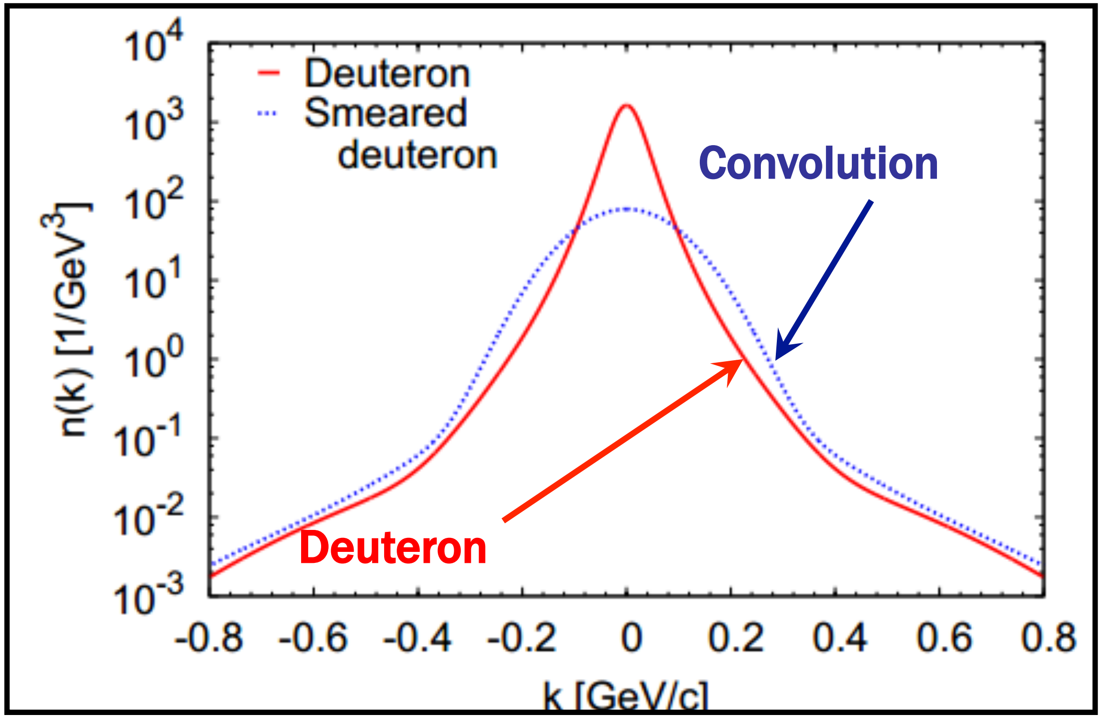
2N-SRC: Kinetic energy of recoil nucleon is ~180 MeV



3N-SRC (linear): KE of recoil nucleons is ~45 MeV each

Since inclusive scattering cross section is integral over spectral function rather than momentum distribution, the kinematics for the 2N- and 3N-SRCs are different (less energy transfer required)

Backups



Deuteron
Smeared deuteron
Convolution
Deuteron
n(k) [1/GeV^3]
k [GeV/c]