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Reading Phys. Rev. Lett. 125, 252501 (2020)

Surface localization of the dinuetron in 11Li

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Two questions

The reaction and experiment set up?

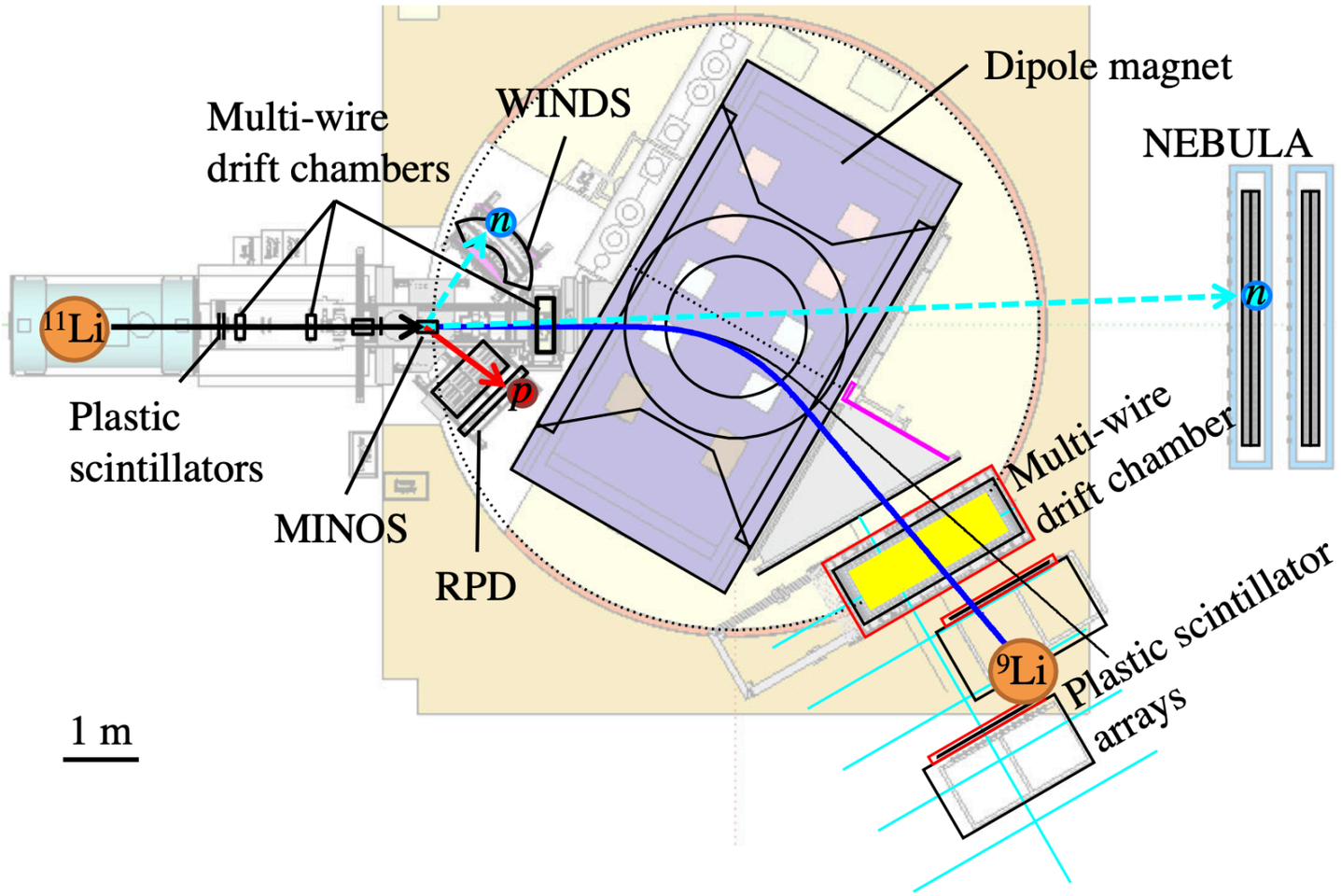
How can we detect the dinuetron correlation ?

The reaction and experiment setup

$$^{11}\mathrm{Li}(p, pn)^{10}\mathrm{Li}^* \rightarrow ^{9}\mathrm{Li} + n$$

2n, p and the heavy residue 9Li are detected, and their momenta are measured.

A complete detection of all particles in the final state.



How determine the correlation?

The correlation angle between the valence neutrons θ_{nf} is defined for momentum space in the so- called Y-type Jacobi coordinates[1].

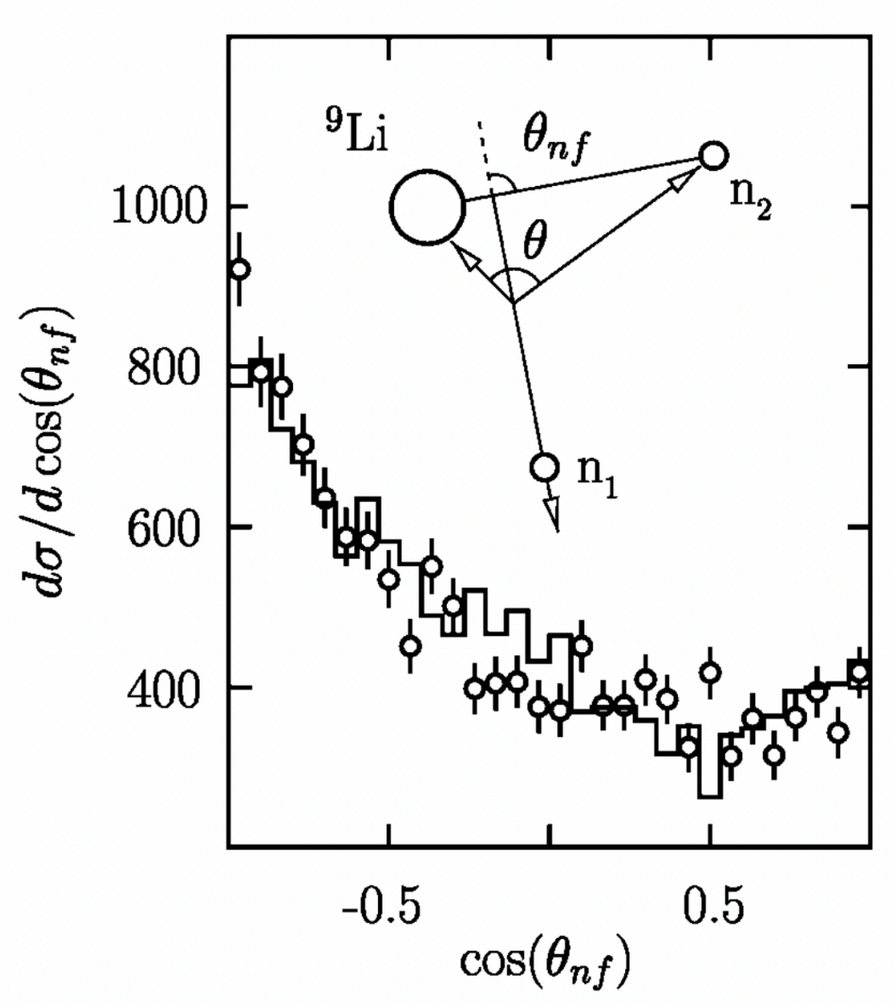
Define the missing momentum

$$\boldsymbol{k} := \boldsymbol{k}_{n1} = \boldsymbol{k}'_{n1} + \boldsymbol{k}'_{p} - \boldsymbol{k}_{p},$$

Define of the correlation angel[2]:

$$\cos\theta_{nf} = \frac{\boldsymbol{K}' \cdot \boldsymbol{k}}{|\boldsymbol{K}'||\boldsymbol{k}|},$$

$$\boldsymbol{K}' = \boldsymbol{k}'_{n2} - \boldsymbol{k}'_{f},$$



[1] D. Betounes, Differential Equations: Theory and Applications (Springer, New York, 2001).

[2] H. Simon et al., Phys. Rev. Lett. 83, 496 (1999).

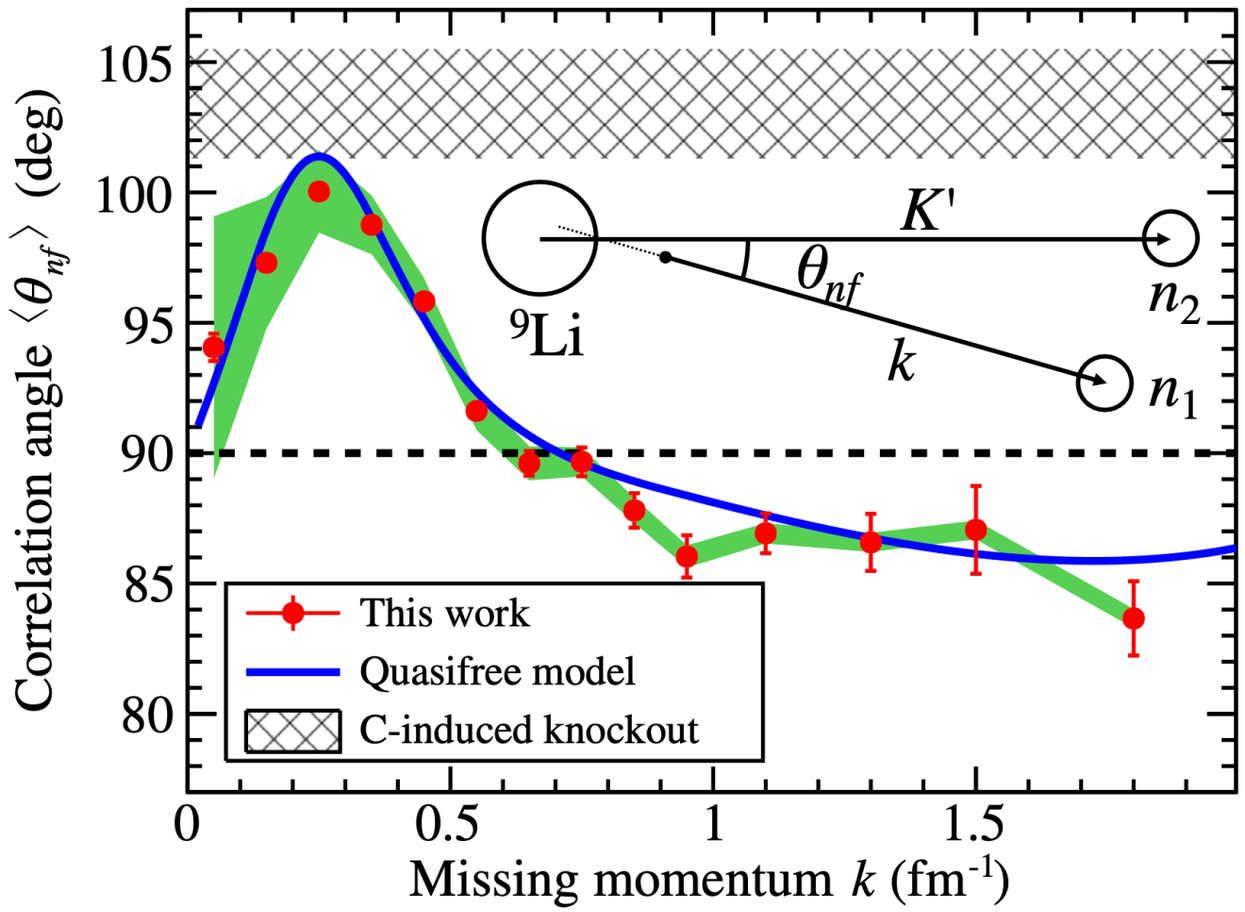
How determine the correlation?

The neutron spectator moves preferably in the direction of the participant neutron which indicates a n 2 n correlation[2].

Indication of correlation

$$\theta'_{nf} < 90°,$$

$$\cos\theta_{nf} = \frac{\boldsymbol{K}' \cdot \boldsymbol{k}}{|\boldsymbol{K}'||\boldsymbol{k}|} < 0.$$

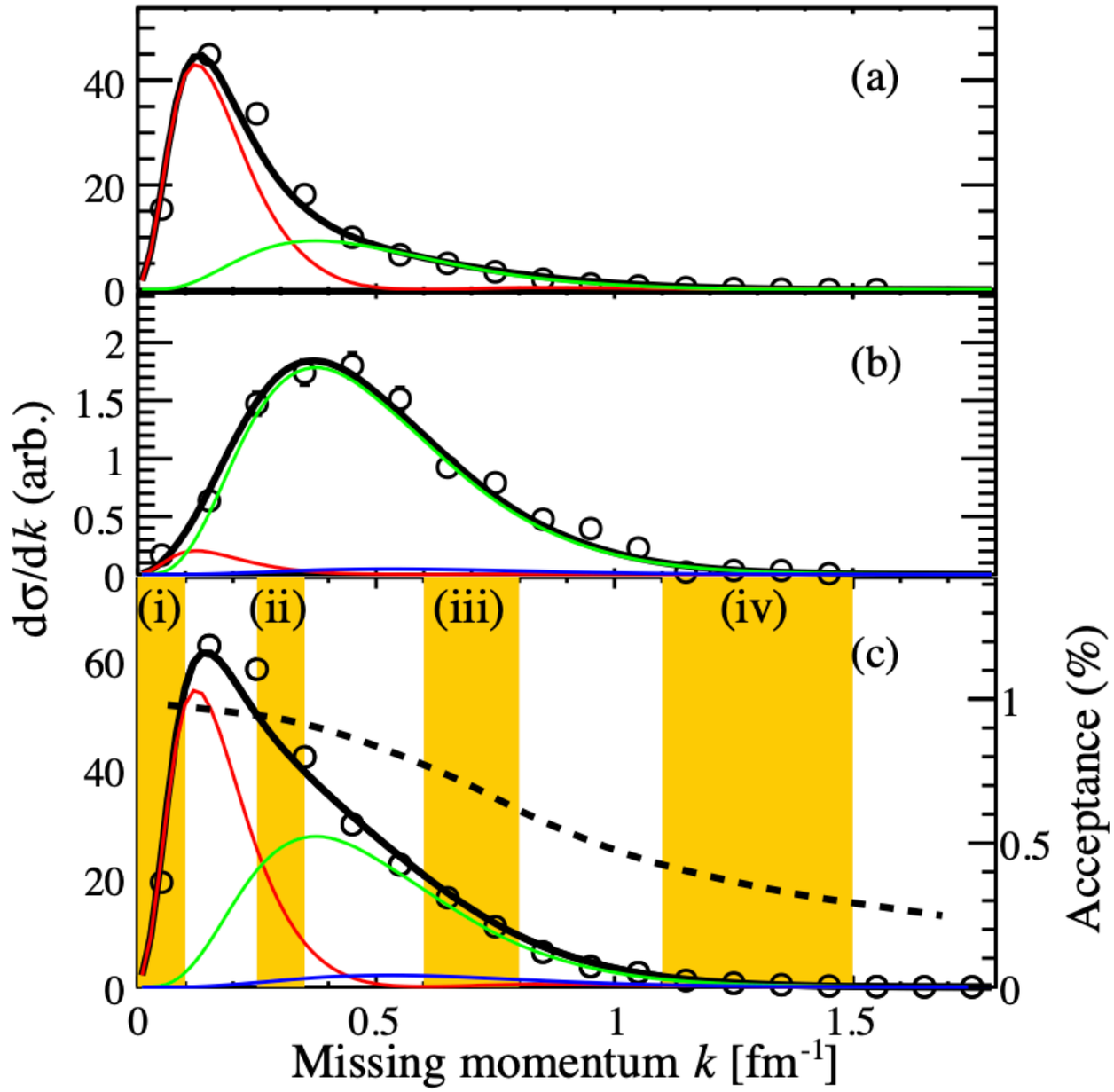


[2] H. Simon et al., Phys. Rev. Lett. 83, 496 (1999).

Different component of the cross section

The calculations according to the distorted-wave impulse approximation (DWIA) [3] can be fitted to the measured k distribution to determine each multipole component.

In different energy region, the fraction of each configuration varies.



[3] Y. Kikuchi, K. Ogata, Y. Kubota, M. Sasano, and T.Uesaka, Prog. Theor. Exp. Phys. 2016, 103D03 (2016).

Different component of the cross section

Comparison of different experiment and theoretical calculation

TABLE I. Comparison of the integrated fraction for each multipole in percentage (%) of experimental (Exp.) and theoretical (Theor.) studies.

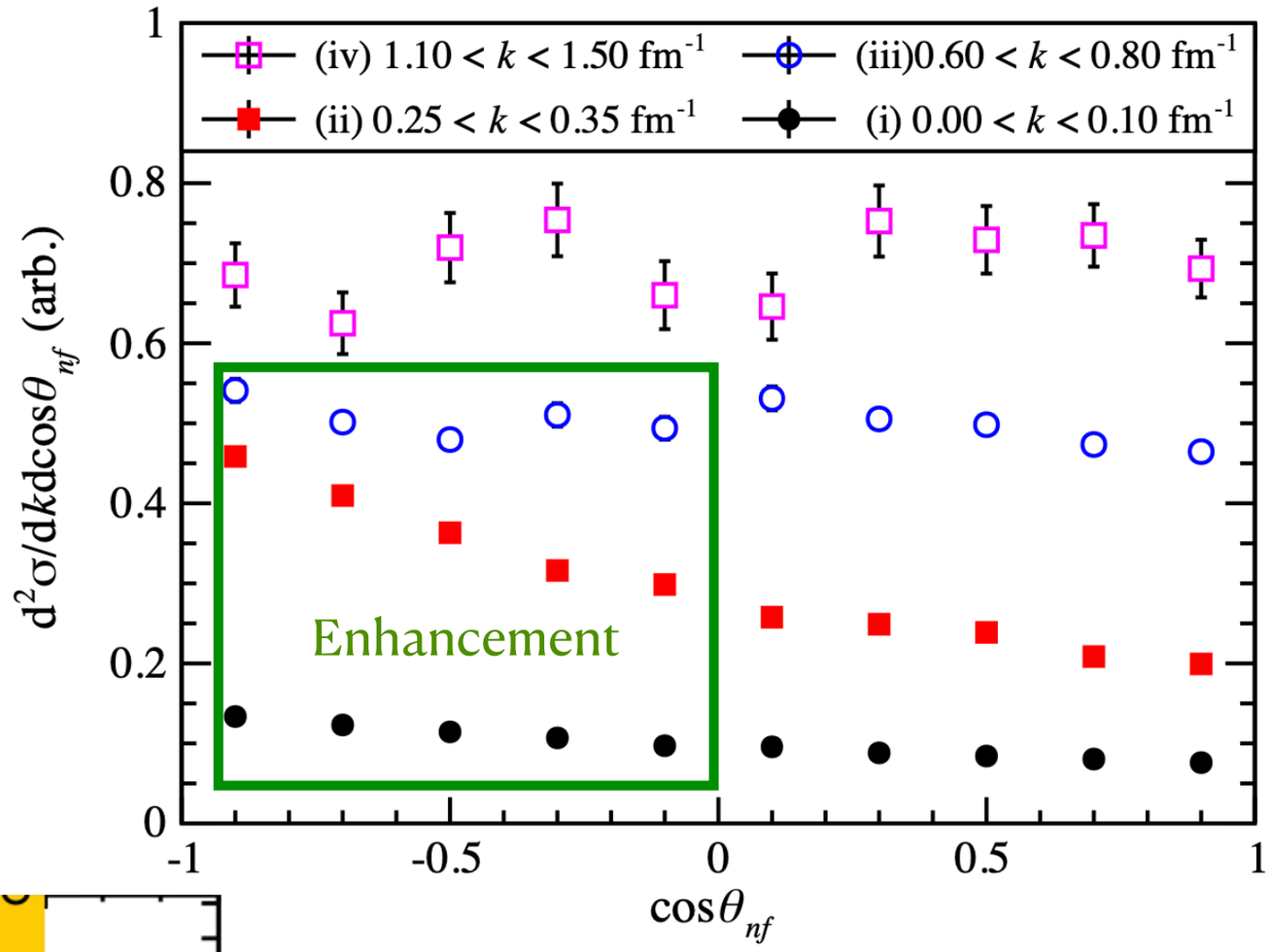
			$(1s_{1/2})^2$	$(0p_{3/2})^2$	$(0p_{1/2})^2$	$(0d_{5/2})^2$	$(0d_{3/2})^2$
Exp.	This work; quasifree (p, pn)		35 ± 4	59 ± 1		6 ± 4	
	C-induced knockout	[25]	45 ± 10	3–5	45 ± 10	10 ± 8	
	Detailed analysis of Ref. [25]	[27]	36.8	9.9	46.8		
	(p, pn)	[43]				11 ± 2	
	(p, d)	[44]	≥ 44		33 ± 12		
	(p, t)	[45]	31–45		51–64		
Theor.	Few body	[46]			59.1		
	Coupled channel	[19]	44.0	2.5	46.9	3.1	1.7
	Tensor-optimized shell model	[47] [a]	46.9	2.5	42.7	4.1	1.9
	Transfer to the continuum	[48]	67		31	1	

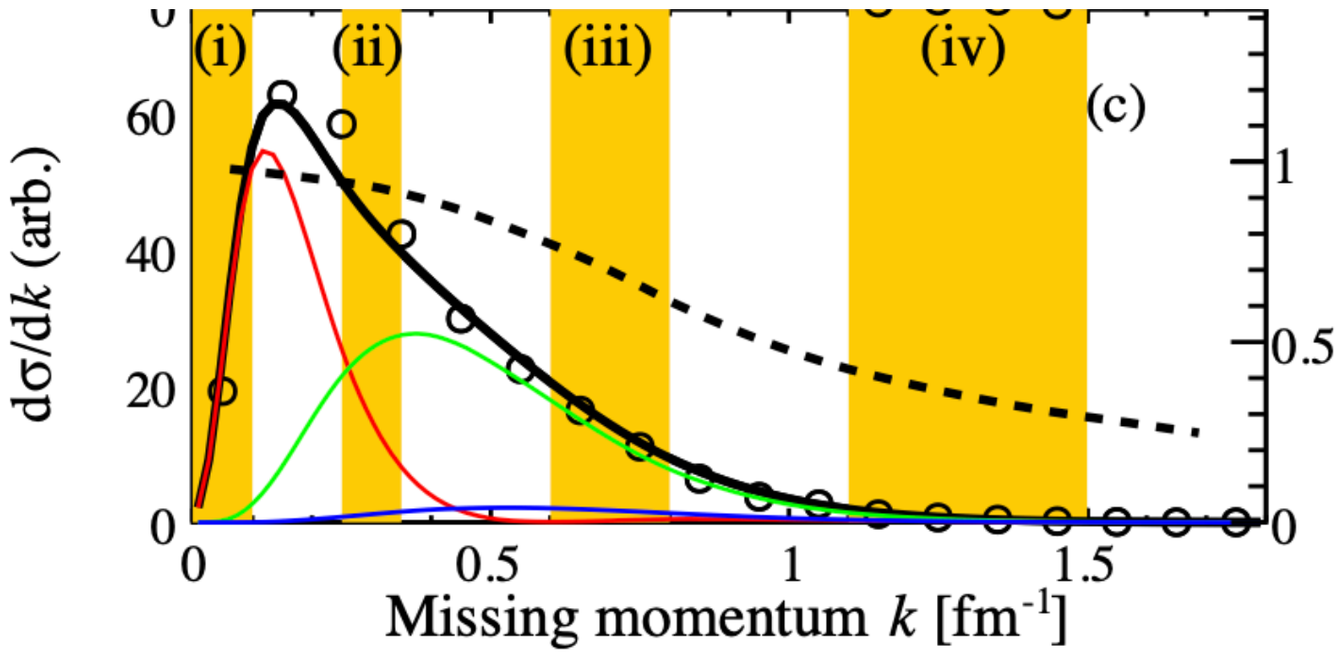
[a] 0.6% and 0.5% for $(f_{7/2})^2$ and $(f_{5/2})^2$, respectively.

Momentum dependence

Enhancement is strong when the states contributes similarly.

The trend is less prominent when only one state dominates.





Clear k dependence

And angle dependence

Momentum dependence

Take the average: $\langle\theta_{nf}\rangle(k) = \int \theta_{nf} P(\cos\theta_{nf}, k) d\cos\theta_{nf}$

"The correlation angle distribution has an asymmetric shape and a missing momentum k dependence, indicating that the dineutron correlation is localized radially on the ^{11}Li surface."