

A Three-Body Effect on the Double Polarized ${}^3\vec{\text{He}}(\vec{d},p){}^4\text{He}$ Reaction near the Threshold

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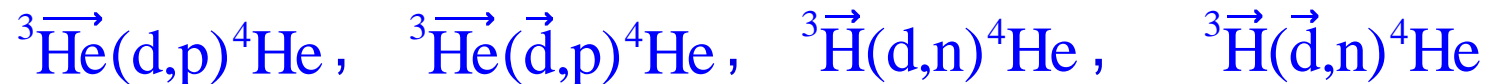
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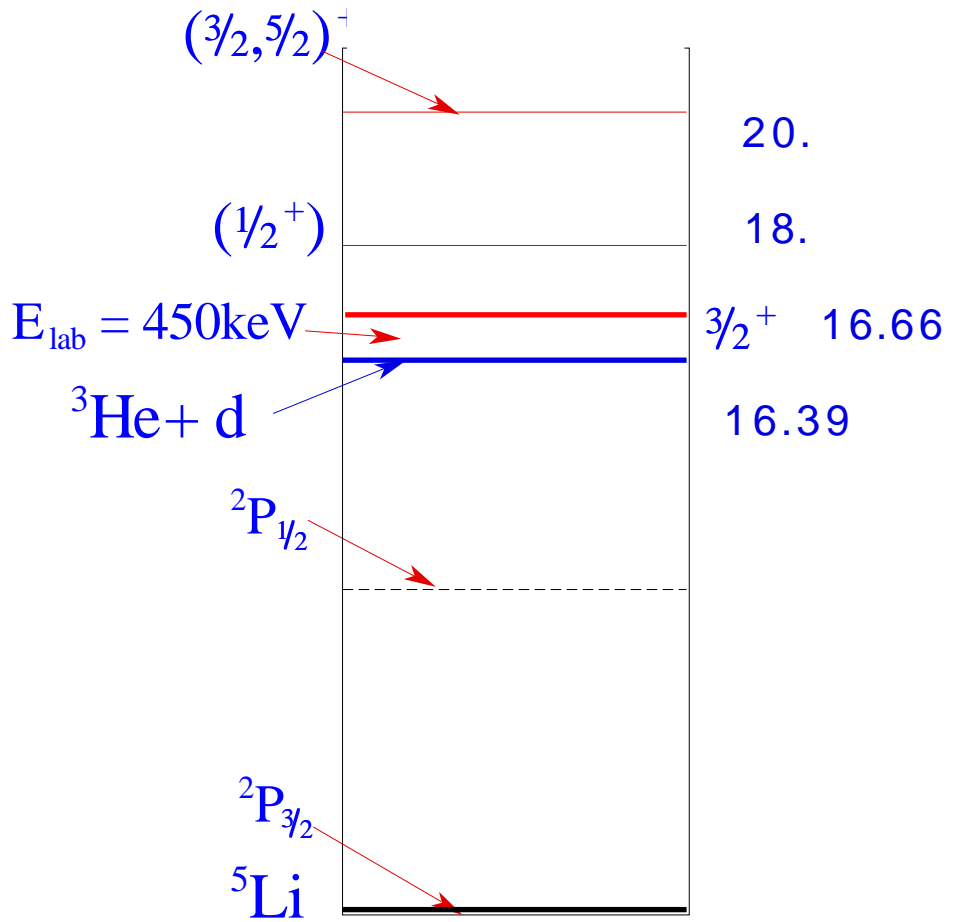
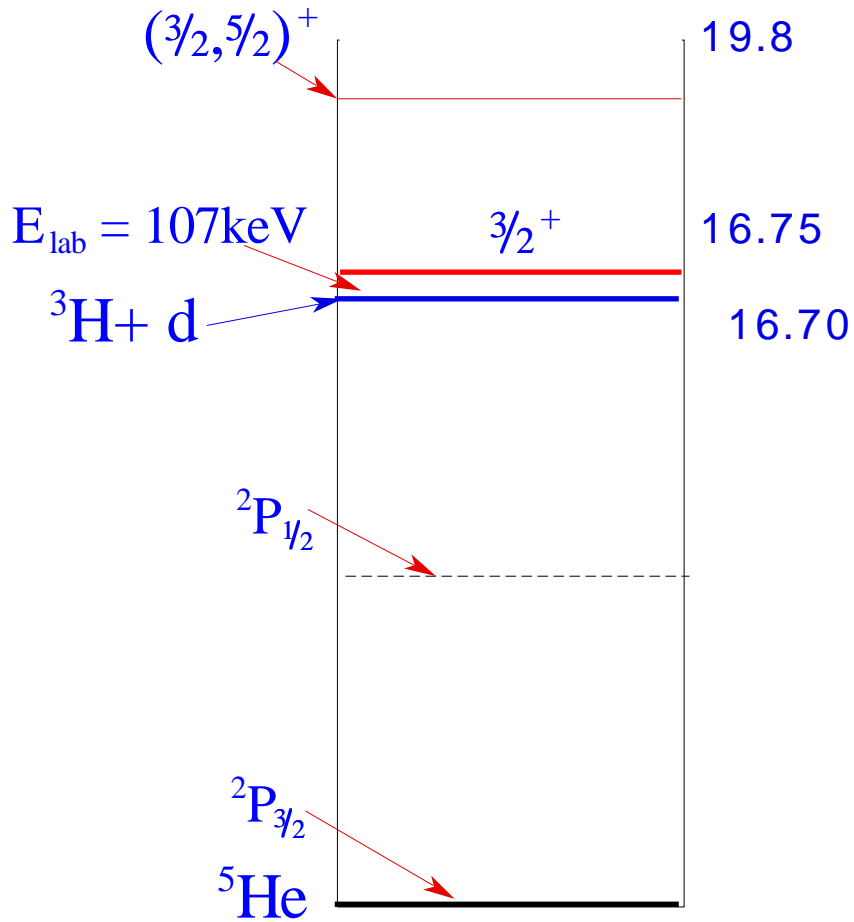
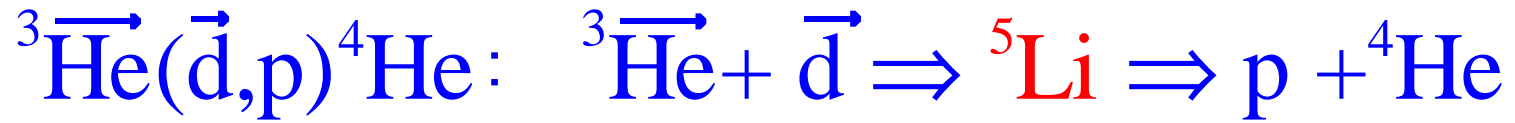
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I. Motivation:

- 1) The nearest resonance region above the $^3\text{H-d}$, and $^3\text{He-d}$ thresholds are very interesting subjects not only for the application problem but also in the primordial nucleosynthesis.
- 2) Improvements of **polarization technique** can supply new experiments.





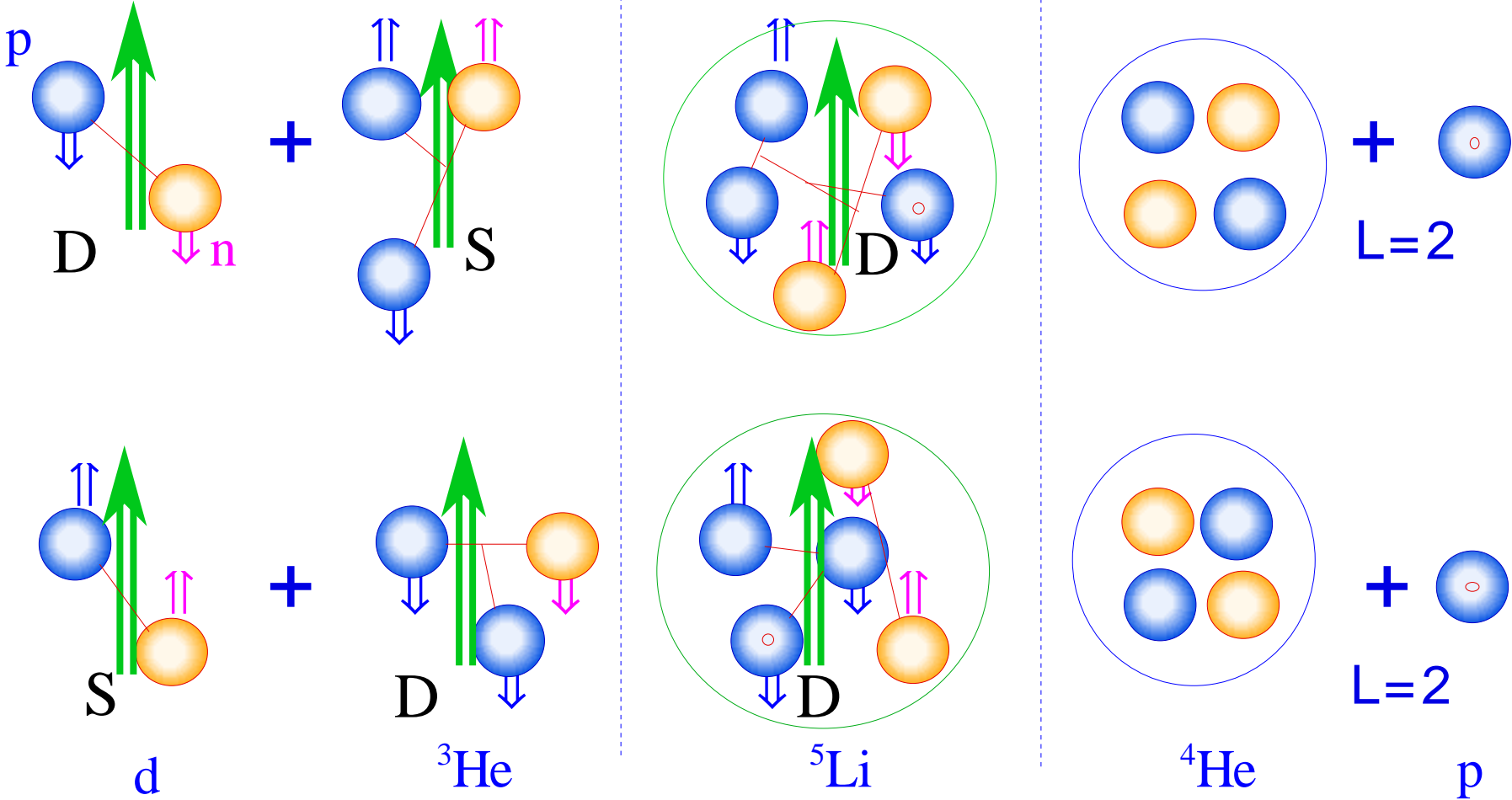
3) Two-Body Assumption:

$$\left(\frac{d\sigma}{d\Omega}\right)^{\text{unpol}} = \frac{1}{(2S_d + 1)(2S_h + 1)} \sum_{S=1/2, 3/2} (2S + 1) \left(\frac{d\sigma}{d\Omega}\right)^{(S)} = \frac{4}{6} \left(\frac{d\sigma}{d\Omega}\right)^{\left(\frac{3}{2}\right)}$$

$$\left(\frac{d\sigma}{d\Omega}\right)^{\text{pol}} = \left(\frac{d\sigma}{d\Omega}\right)^{\left(\frac{3}{2}\right)} ; \text{ assume } \left(\frac{d\sigma}{d\Omega}\right)^{\left(\frac{1}{2}\right)} = 0 \text{ at } \frac{3}{2}^+ \text{ resonance region.}$$

$$\therefore \frac{\left(\frac{d\sigma}{d\Omega}\right)^{\text{pol}}}{\left(\frac{d\sigma}{d\Omega}\right)^{\text{unpol}}} = 1.5$$

Where the polarization effects come from?



II. Three-Body Faddeev Calculation

3-body Faddeev calculation for n - p - ${}^3\text{He}$ system is on practical use for a realistic cluster-cluster interaction.

a) NN-interaction:

AV14 NN potential for the 1S_0 , 3S_1 , 3D_1 , 1P_1 , 3P_0 , 3P_1 , 3P_2 , 3F_2 , 1D_2 , and 3D_2 partial waves is available.

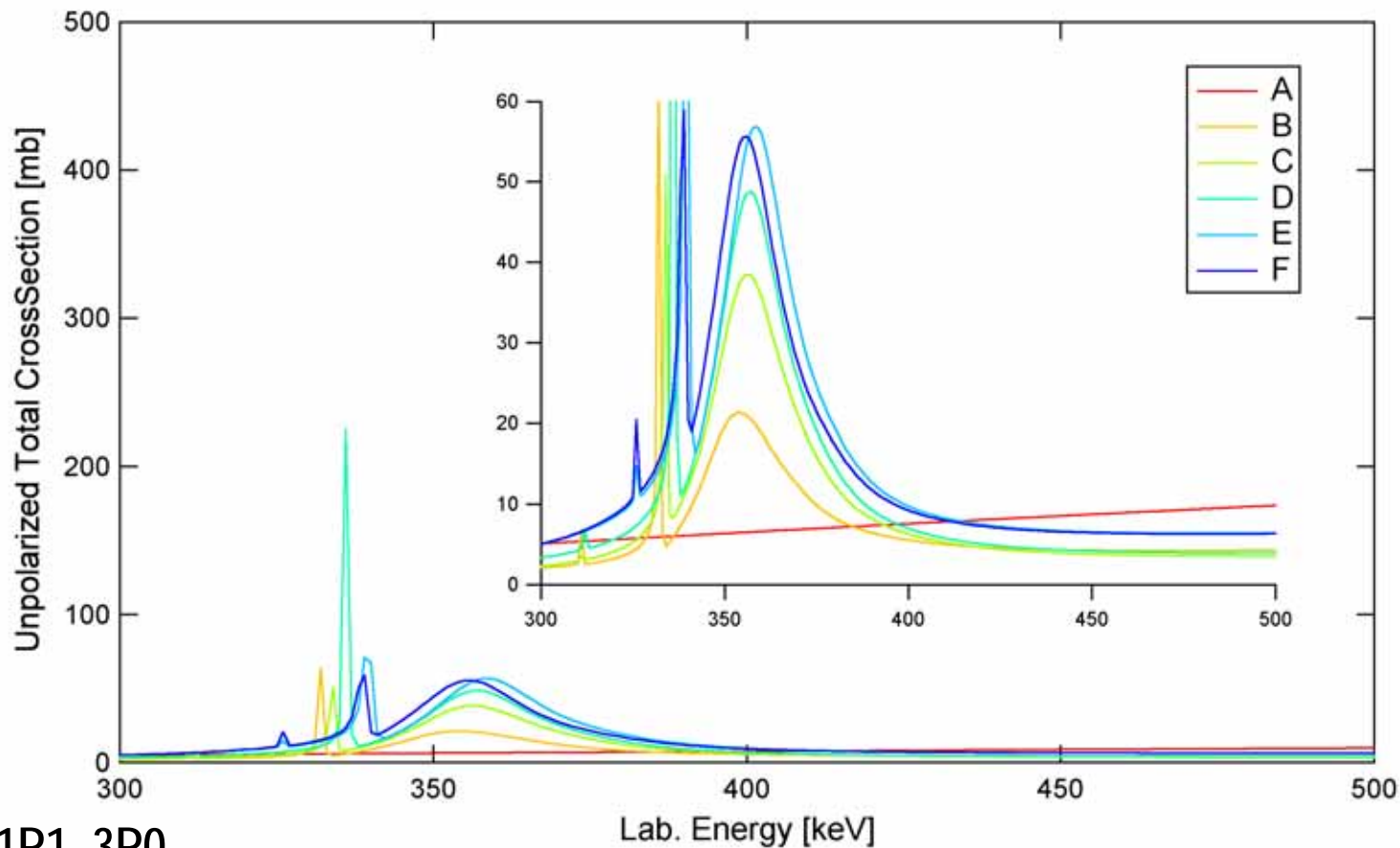
b) Cluster-cluster interactions:

Sophisticated p - ${}^3\text{He}$, and n - ${}^3\text{He}$ potentials are supplied.

S_0 , 3S_1 , 1P_1 , 3P_0 , 3P_1 , 3P_2 , 3D_1 , (next candidates 1D_2 , 3D_2 , 3F_2)

III. Results

Un-polarized Total Cross Section

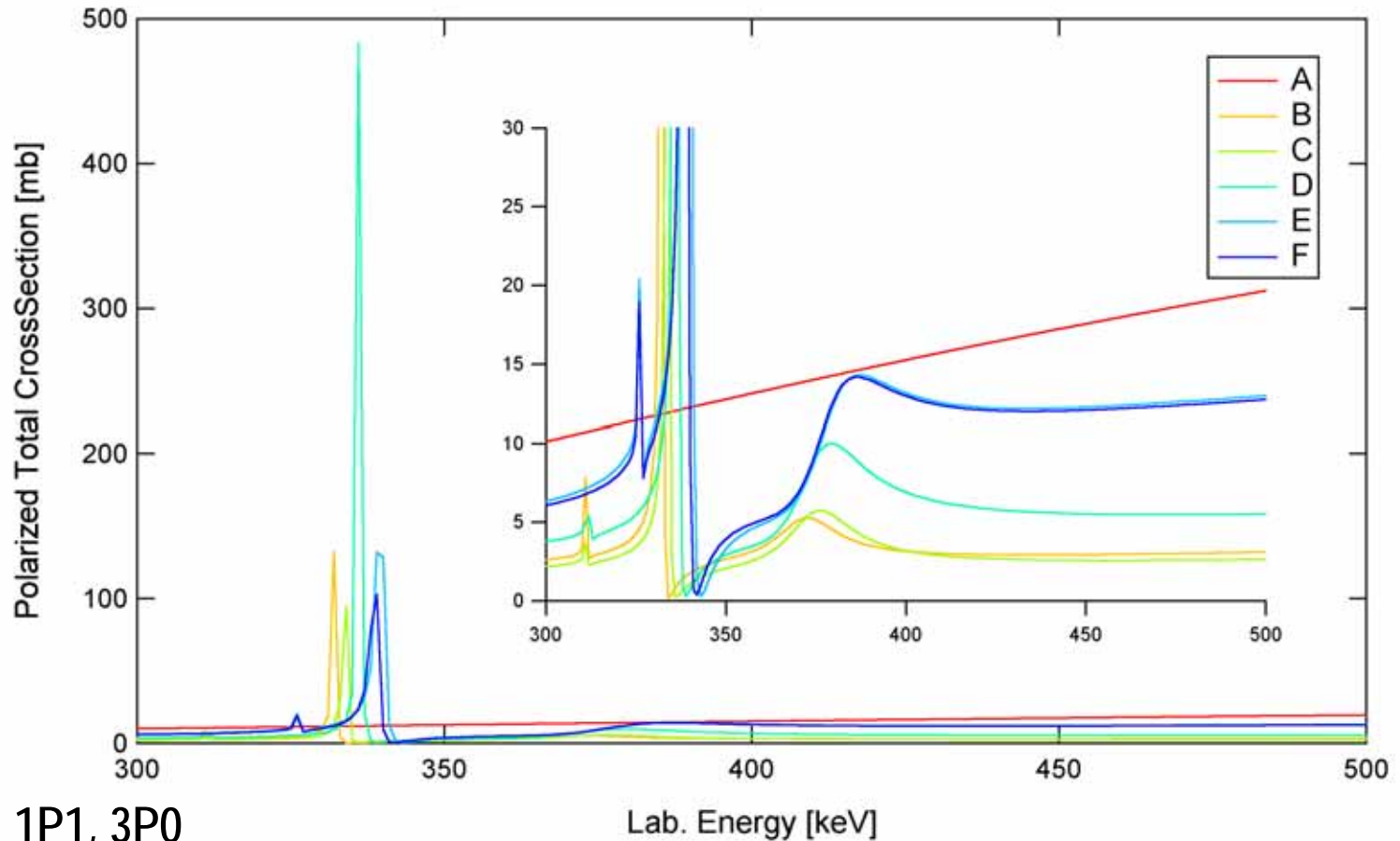


$N-^3\text{He}$ states

- A) 1S0
- B) 1S0, 3S1
- C) 1S0, 3S1, 1P1, 3P0
- D) 1S0, 3S1, 1P1, 3P0, 3P1
- E) 1S0, 3S1, 1P1, 3P0, 3P1, 3P2
- F) 1S0, 3S1, 1P1, 3P0, 3P1, 3P2, 3D1

All results include the N-N state, 1S0, 3S1-3D1, 1P1, 3P0, 3P1, 3P2-3F2, 1D2, and 3D2.

Polarized Total Cross Section

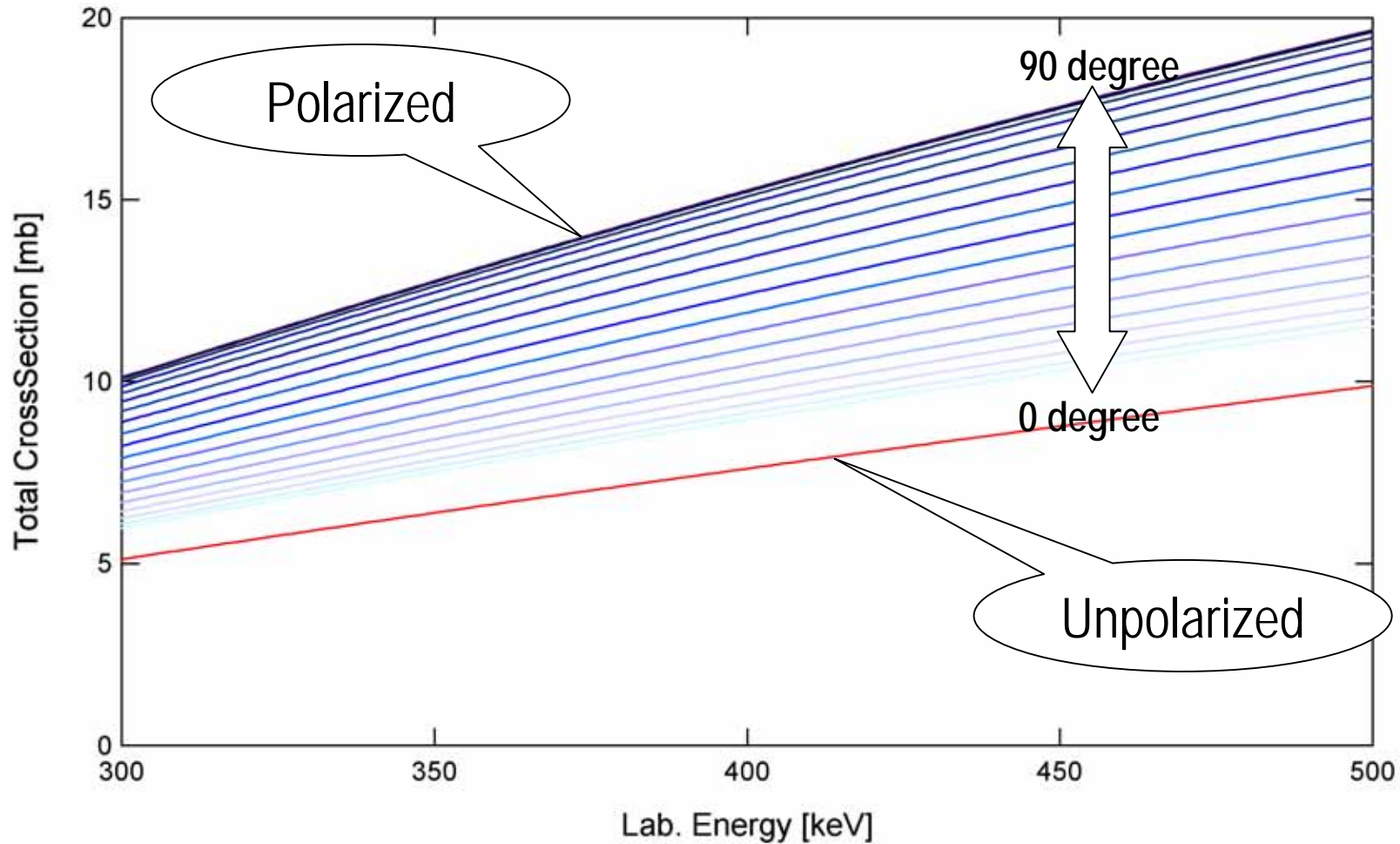


N-³He states

- A) 1S0
- B) 1S0, 3S1
- C) 1S0, 3S1, 1P1, 3P0
- D) 1S0, 3S1, 1P1, 3P0, 3P1
- E) 1S0, 3S1, 1P1, 3P0, 3P1, 3P2
- F) 1S0, 3S1, 1P1, 3P0, 3P1, 3P2, 3D1

All results include the N-N states, 1S0, 3S1-3D1, 1P1, 3P0, 3P1, 3P2-3F2, 1D2, and 3D2.

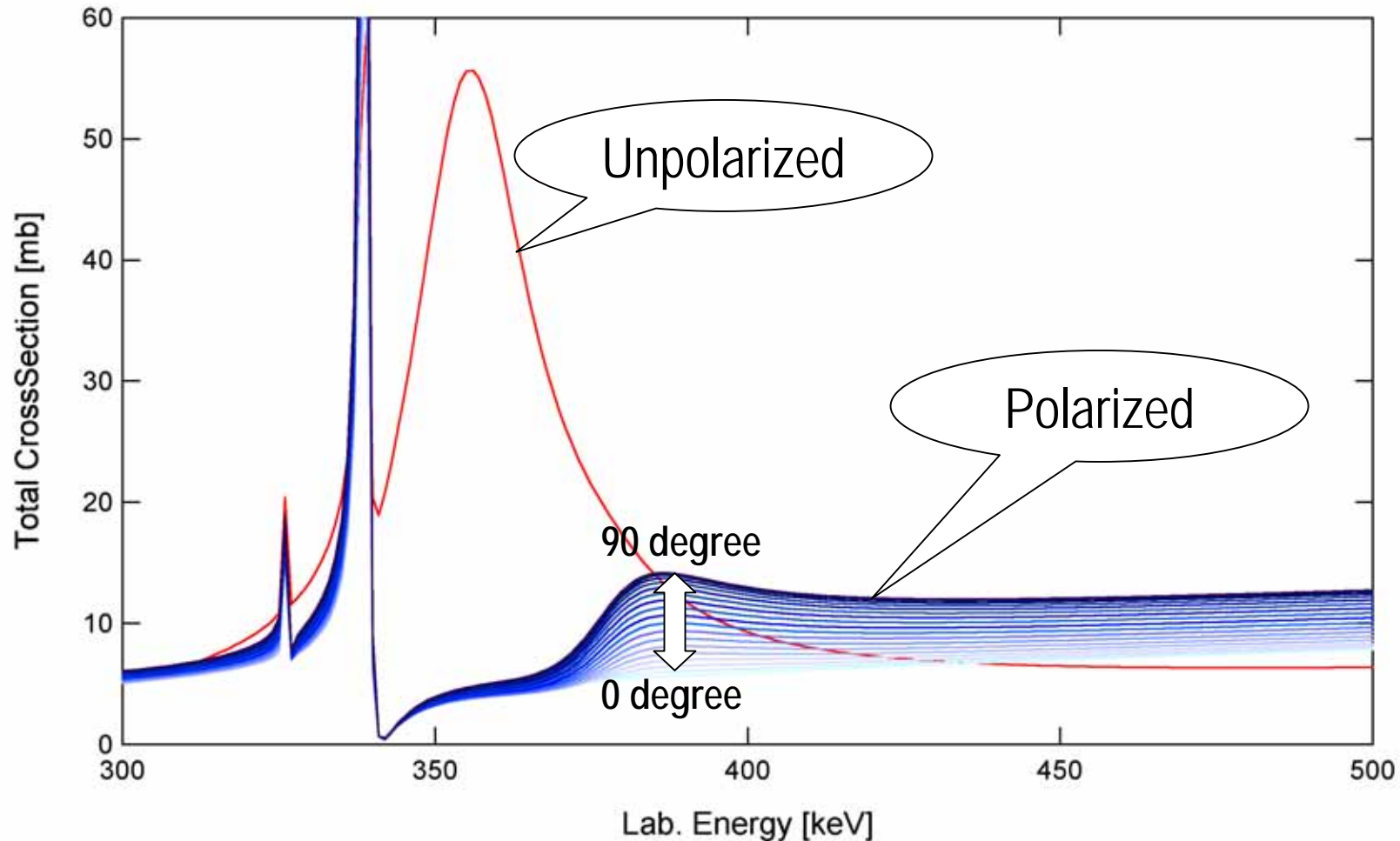
Polarization Angel Dependence for Total Cross Section A



N-³He states: 1S0

N-N states: 1S0, 3S1-3D1, 1P1, 3P0, 3P1, 3P2-3F2, 1D2, 3D2.

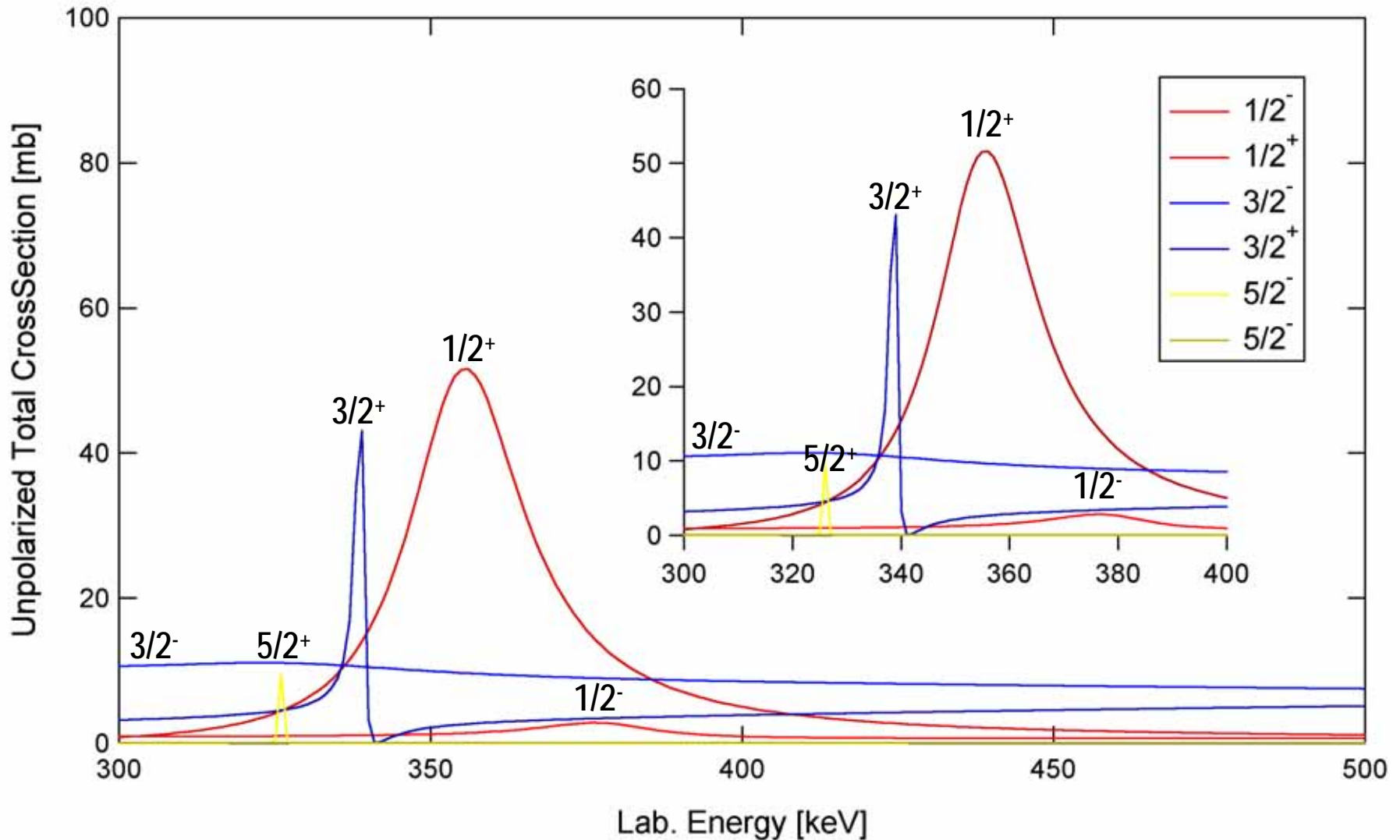
Polarization Angel Dependence for Total Cross Section F



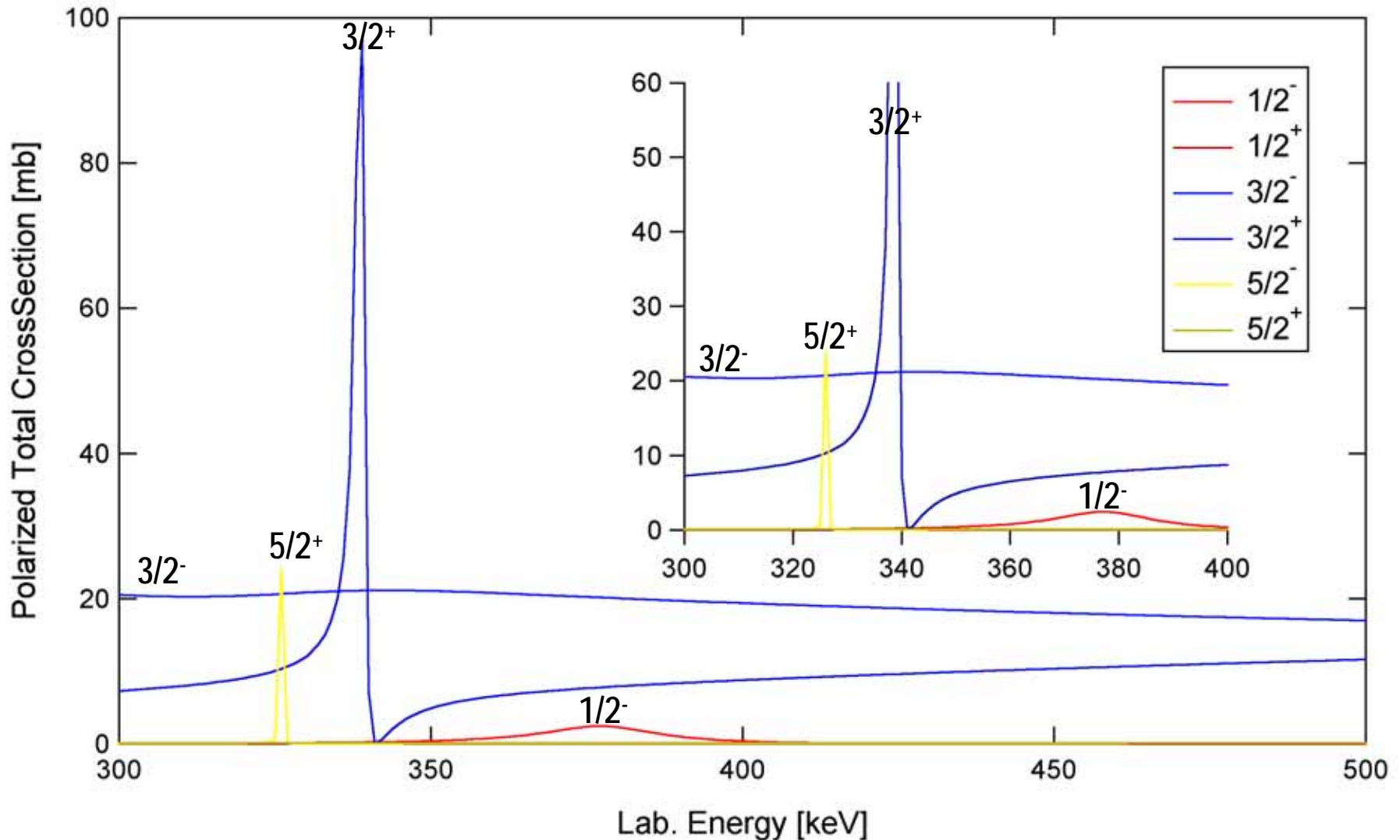
N-³He states: 1S₀, 3S₁, 1P₁, 3P₀, 3P₁, 3P₂, 3D₁

N-N states: 1S₀, 3S₁-3D₁, 1P₁, 3P₀, 3P₁, 3P₂-3F₂, 1D₂, 3D₂.

3-Body State Dependence for the Un-polarized Total Cross Section F



3-Body State Dependence for the Polarized Total Cross Section F



IV. Conclusion

- 1) 3-body Faddeev calculation for n-p- ^3He system is carried out, for full-states of AV-14, and N- ^3He RGM potentials.
- 2) It is found that three-resonances exist near the threshold.
- 3) Polarized and unpolarized cross sections are compared.
- 4) Two-body model predicts 1.5-times enhancement, but realistic three-body calculations predict more than that.

- 5) Polarized angle dependence is very sensitive to the reaction rate; 90-degree exceeds the others.
- 6) Exact Coulomb Faddeev treatment is necessary to find right position of resonance energies.
- 7) It is found that calculations are almost converged to two-body partial waves.

Appendix:

Input data for two-body Ranks:

No.	states	1	2	3	4
NN (AV14)	1S_0	1	1	1	6
	3S_1 - 3D_1	1	1	1	6
	1P_1	1	1	1	5
	3P_0	1	1	1	5
	3P_1	1	1	1	5
	3P_2 - 3F_2	1	1	1	7
	1D_2	1	1	1	5
	3D_2	1	1	1	5

No.	states	1	2	3	4
n- ³ He	¹ S ₀	1	1	3	3
(p- ³ He)	³ S ₁		1	1	3
	¹ P ₁		1	1	3
	³ P ₀		1	1	3
	³ P ₁		1	1	3
	³ P ₂		1	1	3
	³ D ₁		1	1	3
	¹ D ₂			1	3
	³ D ₂			1	3
	³ F ₂			1	3