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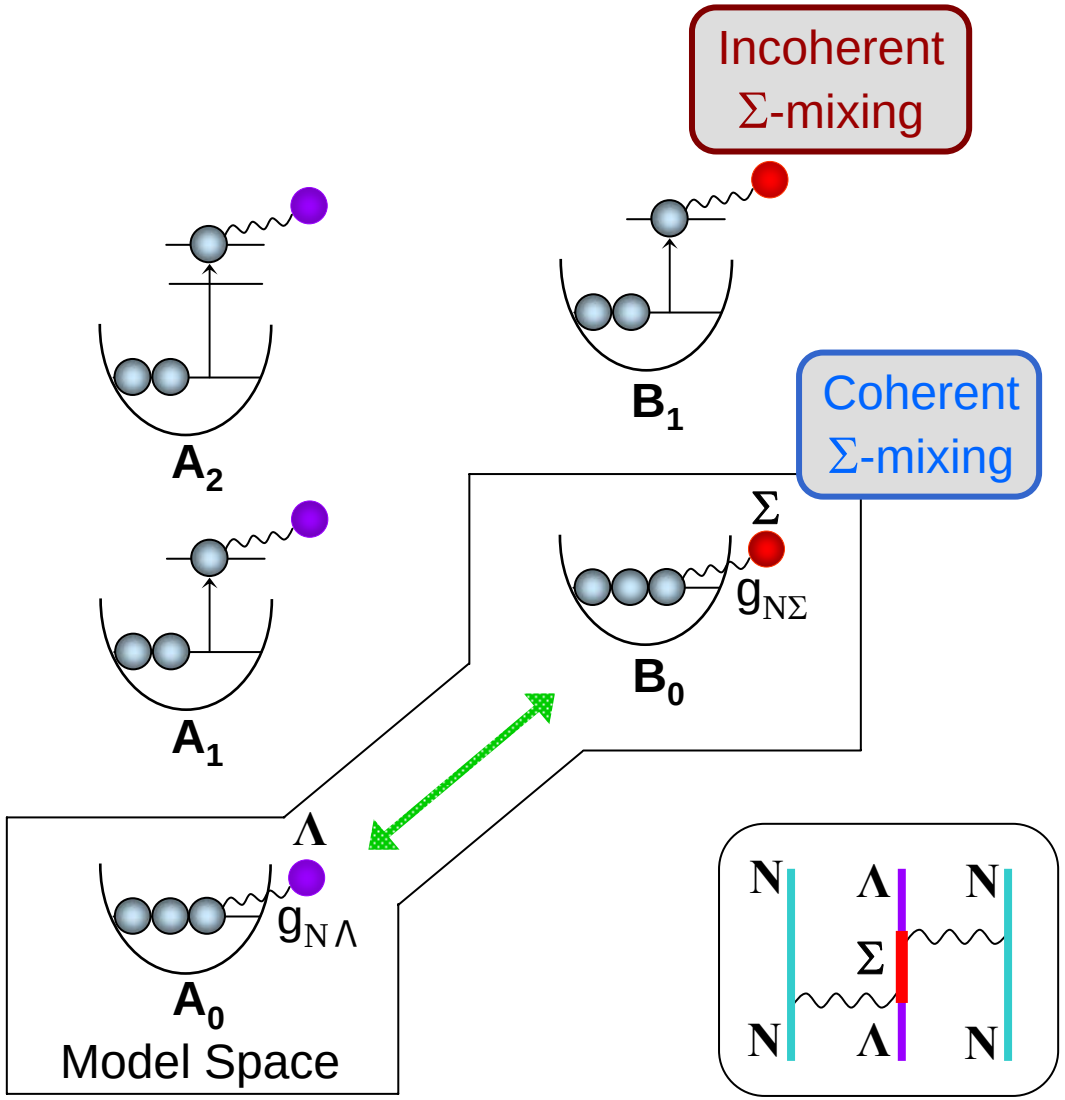
Feshbach Resonance due to Coherent Λ-Σ Coupling in ${}^{7}_{\Lambda}$He

San San Mon
University of Mandalay
Myanmar

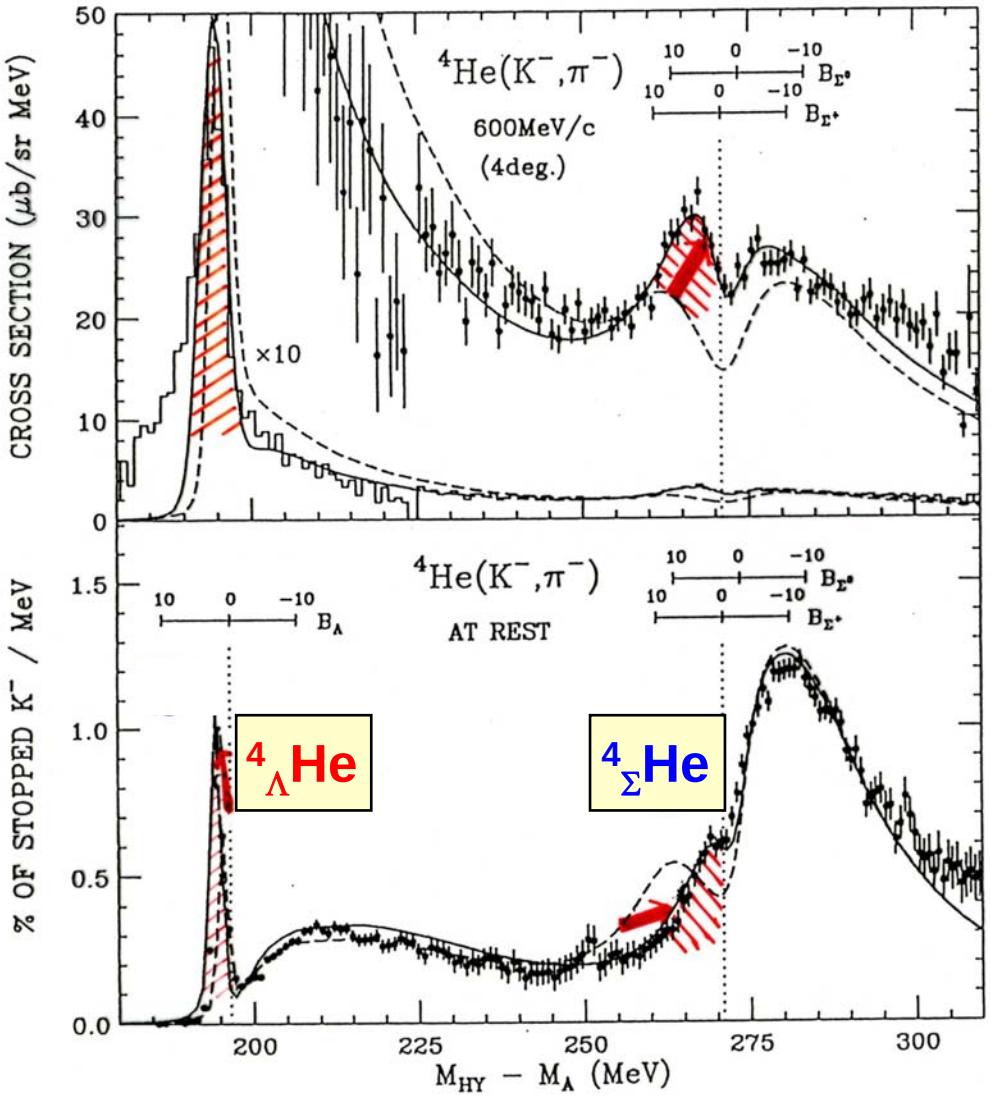
Khin Swe Myint
Tin Tin Nwe
Yoshinori Akaishi

Coherent Λ–Σ coupling



Theory:

T. Harada,
Phys. Rev. Lett. 81 (1998) 5287



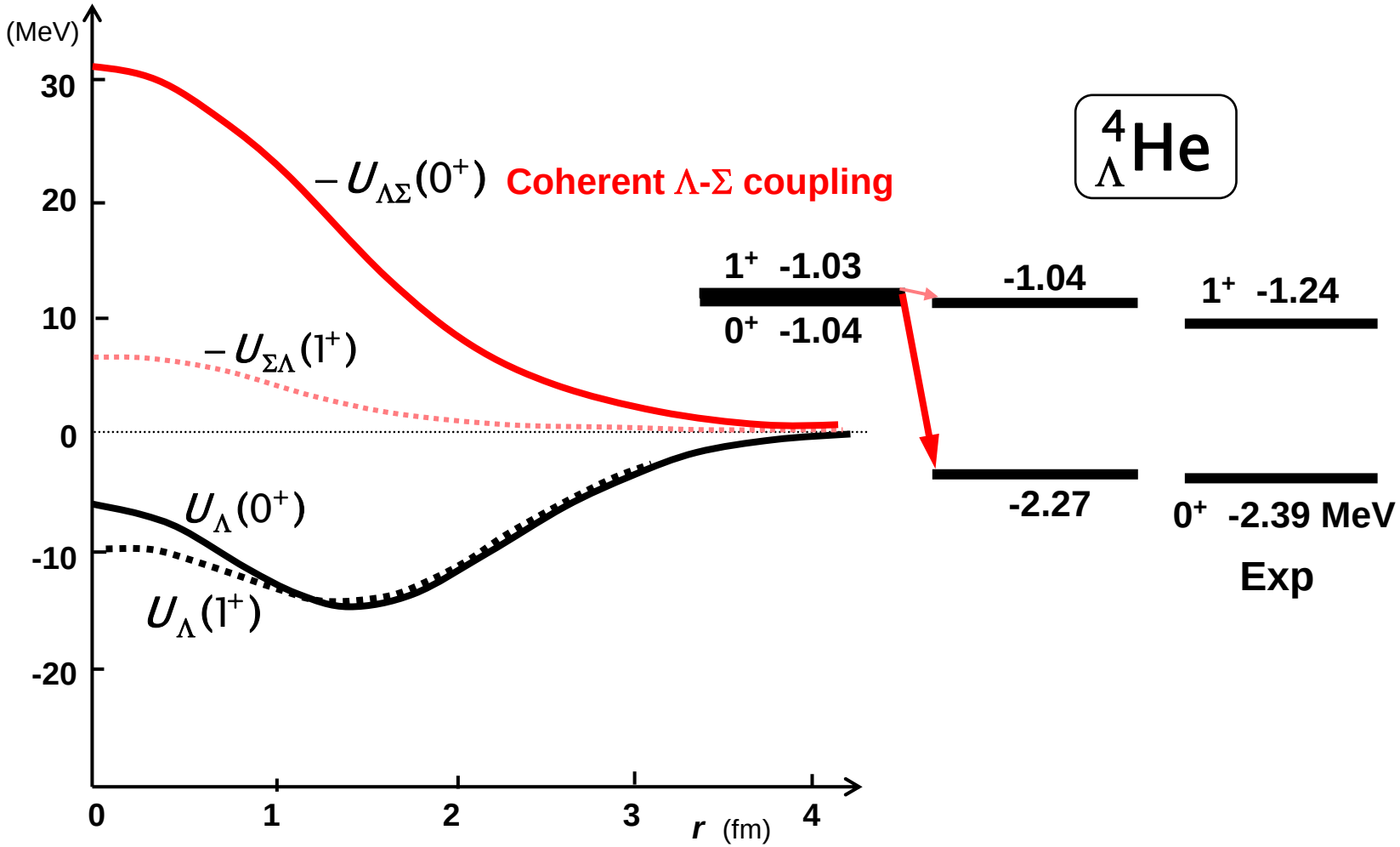
BNL : (1998)

T. Nagae, R.E. Chrien et al.,
Phys. Rev. Lett. **80** (1998) 1605.

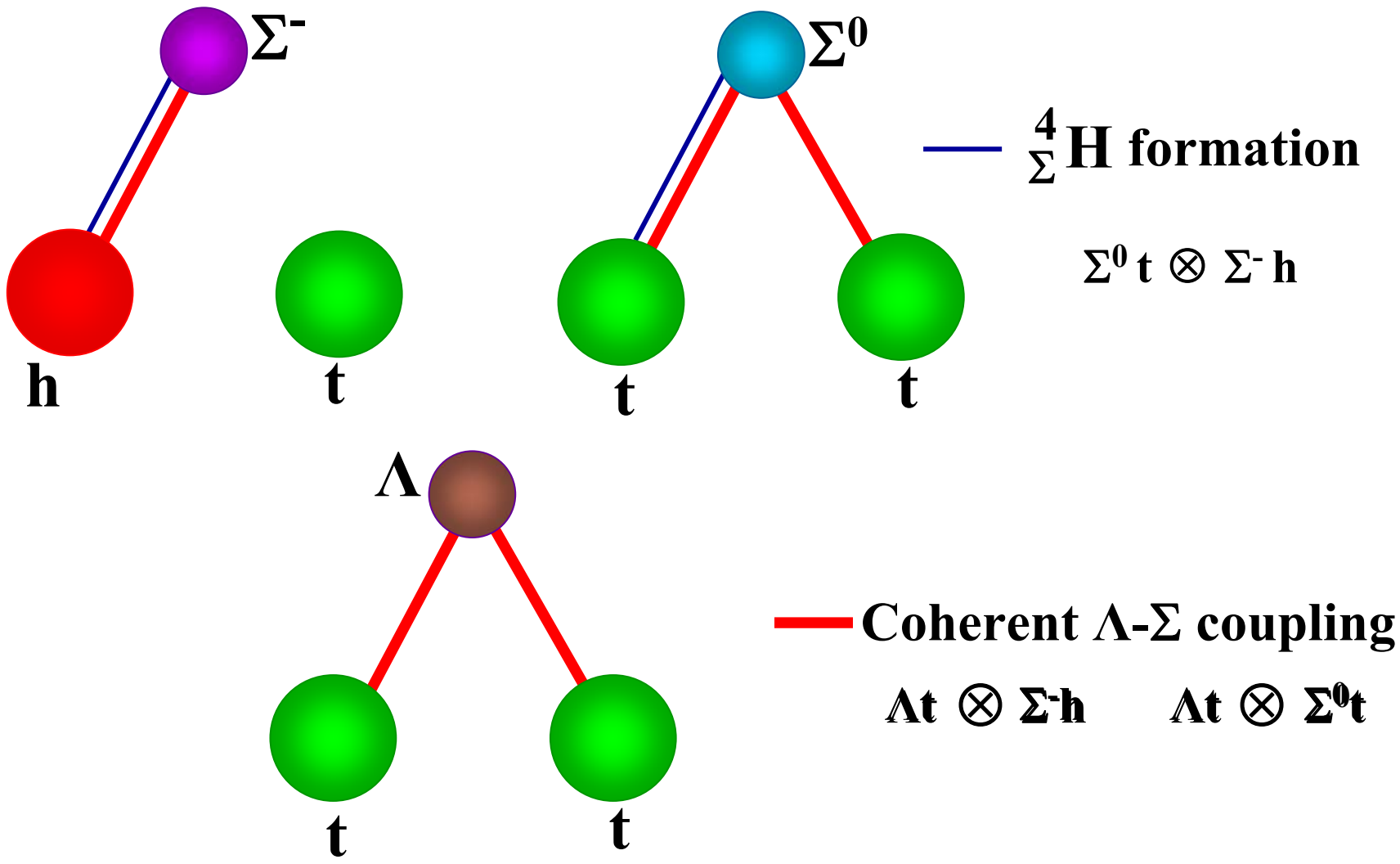
KEK : (1989)

R. Hayano et al.,
Phys. Lett. **231** (1989) 355.

Y- $(NNN)_{T=1/2}$ Interactions



Coupling Scheme in ${}^{7}_{\Lambda}$He



- **Three-body Hamiltonian is**

$$H = -\frac{\hbar^2}{2M_c}\nabla^2_{\vec{R}_c} - \frac{\hbar^2}{2\mu_c}\nabla^2_{\vec{r}_c} + \left\{V_{tt}(\vec{r}_1) + V_{\Lambda t}(\vec{r}_2) + V_{\Lambda t}(\vec{r}_3) + V_{Pauli}(\vec{r}_1, \vec{r}_1')\right\}$$

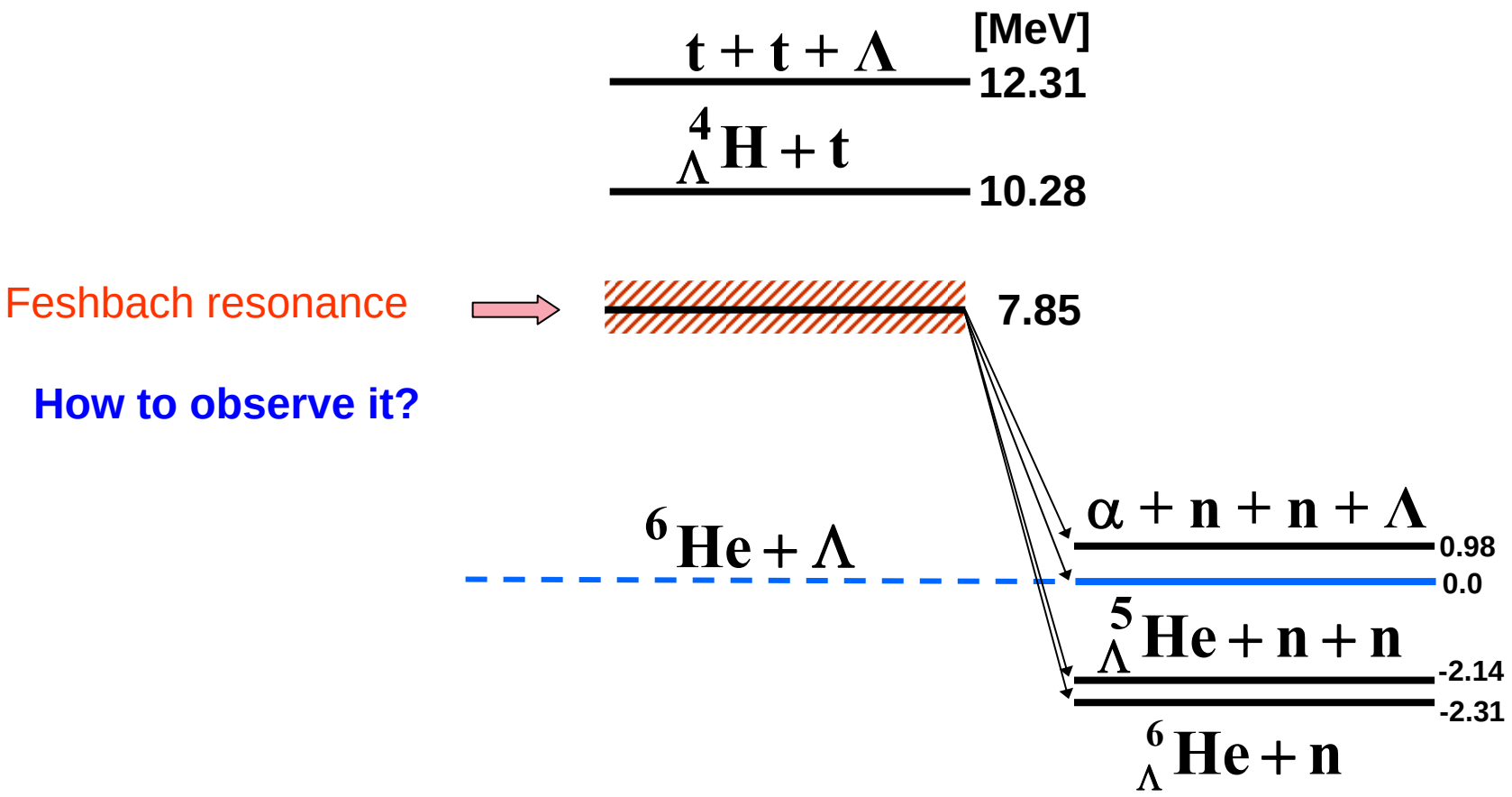
- **V_{Pauli} is included to take into account Pauli exclusion effect between two tritons**

$$V_{Pauli}(\vec{r}, \vec{r}') = \lim_{\lambda \to \infty} \lambda \sum_f \left|\Phi_f(\vec{r})\right\rangle\left\langle\Phi_f(\vec{r}')\right|$$

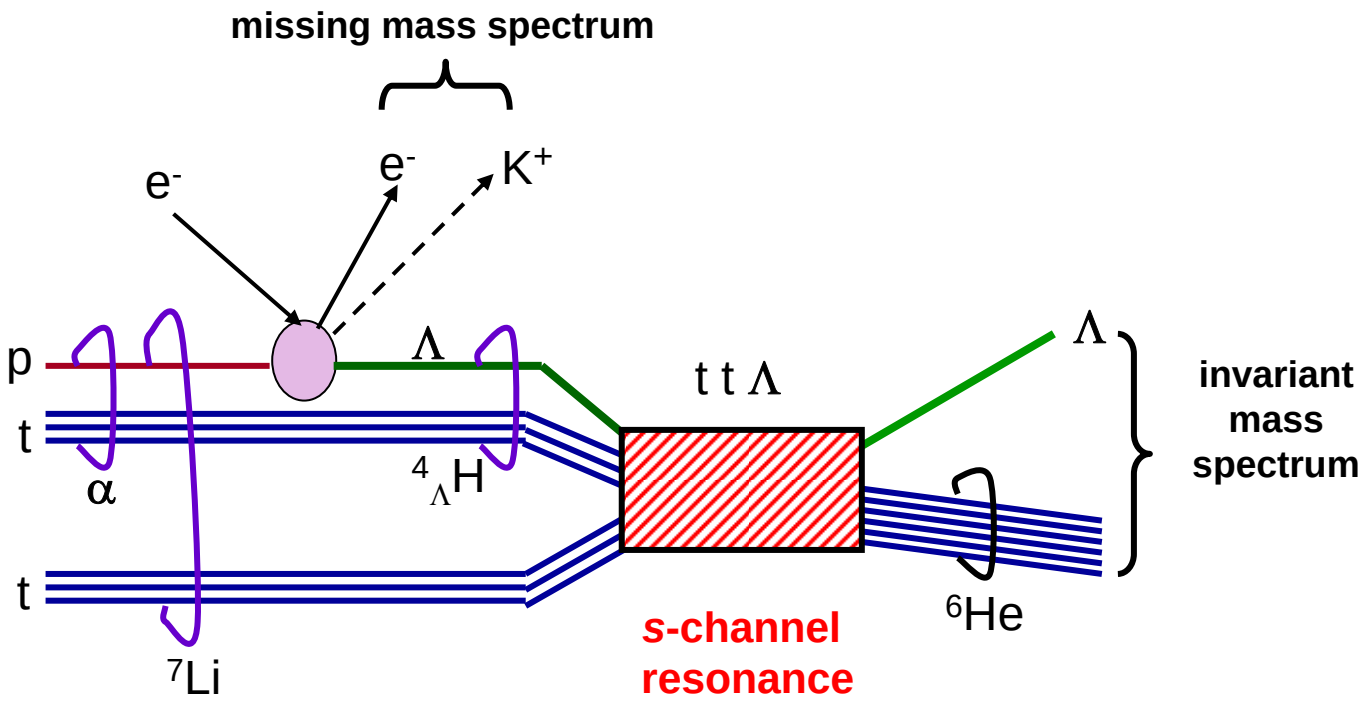
- **Gaussian basis wave function is spanned over three coupled channels**

$$\Psi(\vec{r}, \vec{R}) = \sum_{c=1}^{3} \sum_{i_c j_c} A^{(c)}_{i_c j_c} e^{-(\frac{\vec{r}_c}{b_i})^2} e^{-(\frac{\vec{R}_c}{B_j})^2}$$

$^{7}_{\Lambda}\mathrm{He}$



Mechanism of ^{7}Li (e^- ,e^- K^+) $^{7}_{\Lambda}$He reaction



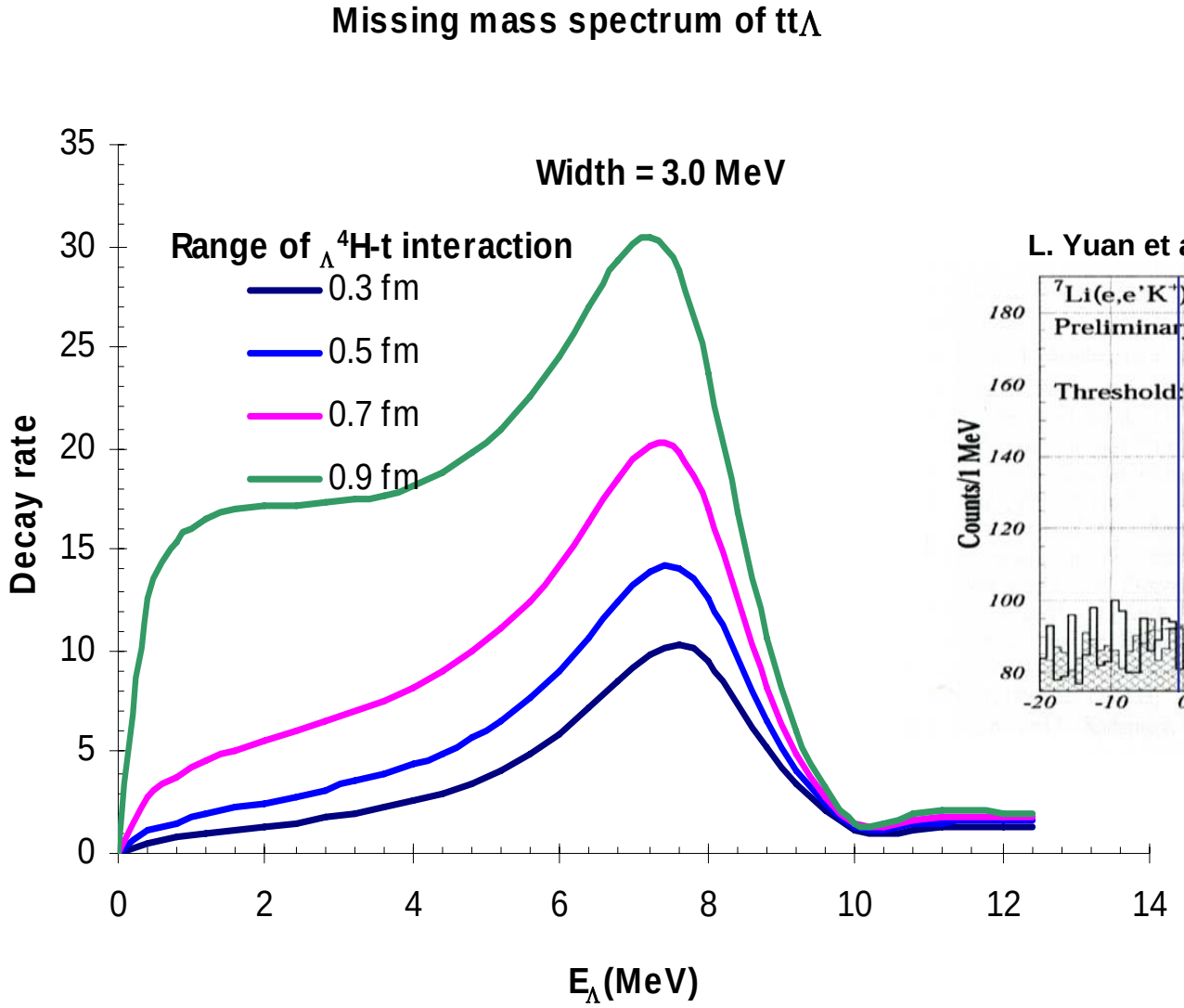
Separable potential

$$\left\langle \vec{k}' \middle| \upsilon_{ij} \middle| \vec{k} \right\rangle = g_i(\vec{k}') U_{ij} g_j(\vec{k})$$

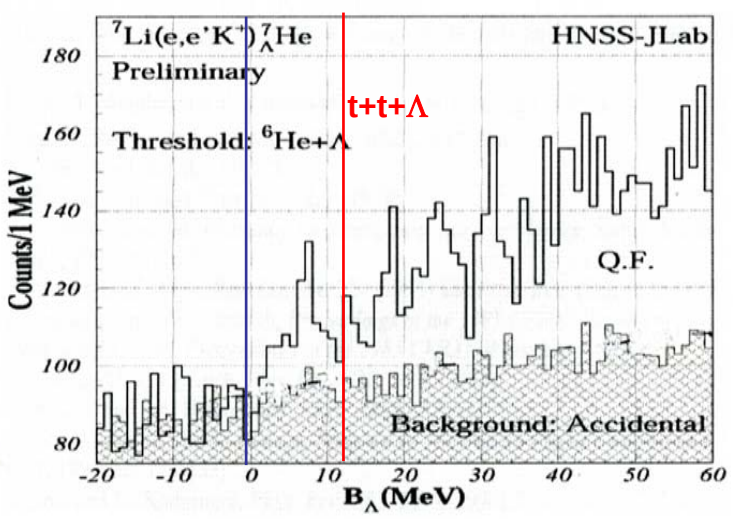
i,j = 1,2

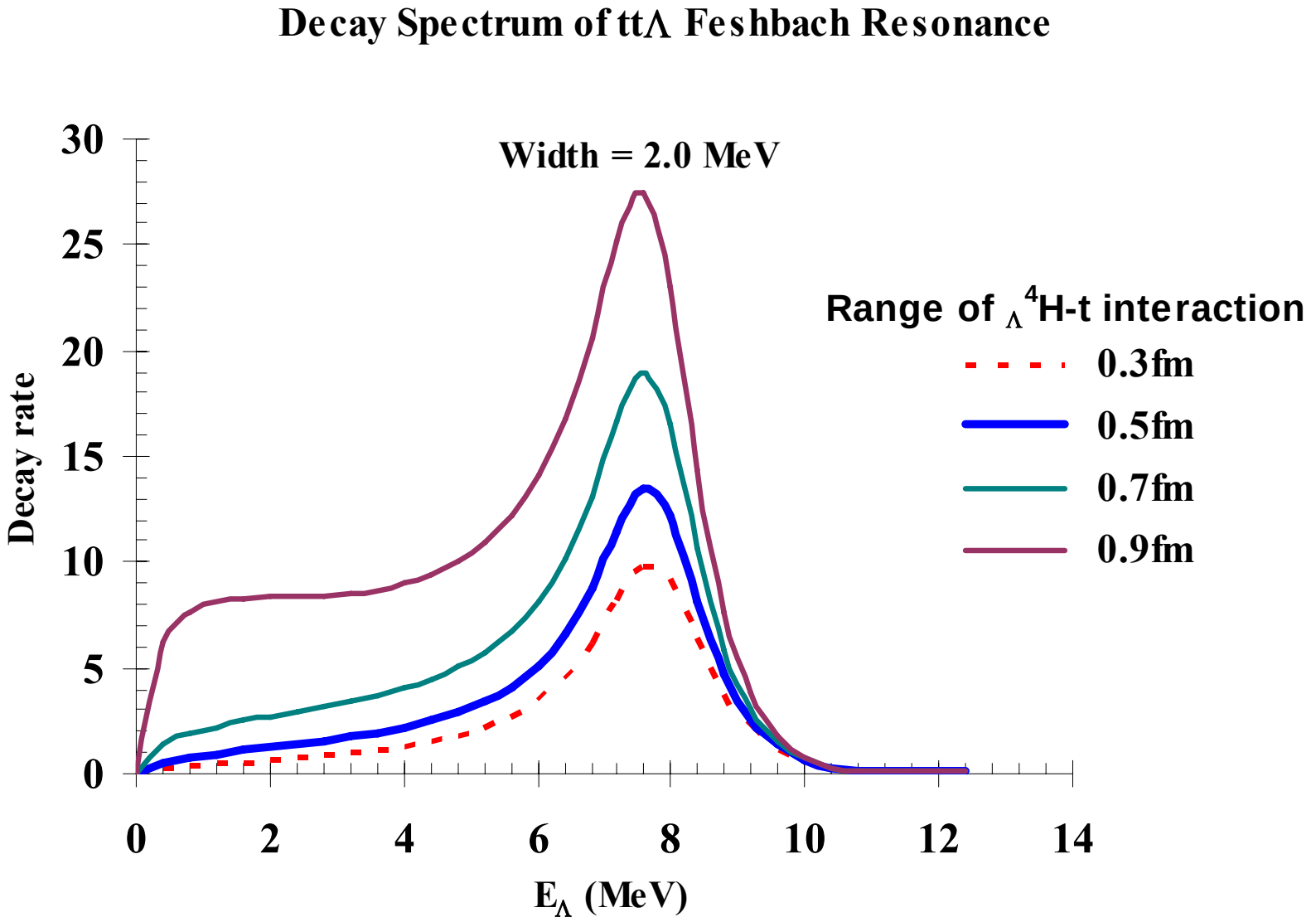
$$g_i(\vec{k}) = \frac{\Lambda_i^2}{\Lambda_i^2 + \vec{k}^2}$$

Missing mass spectrum of ttΛ Feshbach resonance

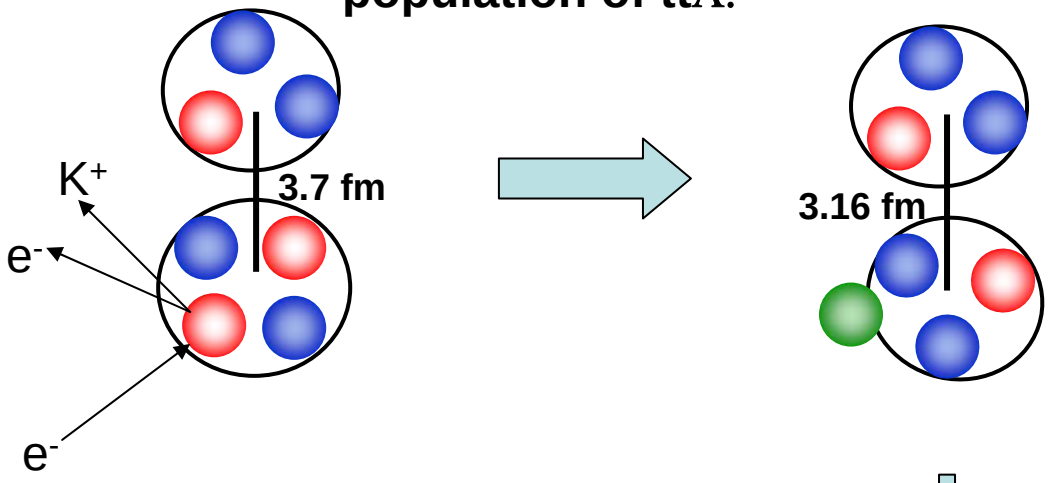


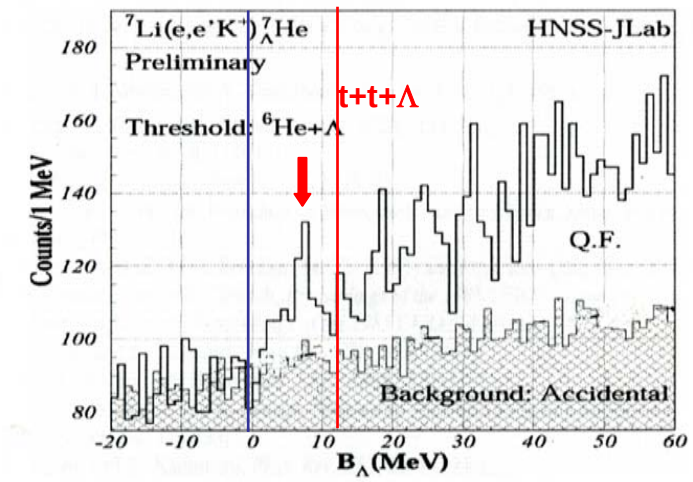
L. Yuan et al., Phys. Rev. C73 (2006) 044607



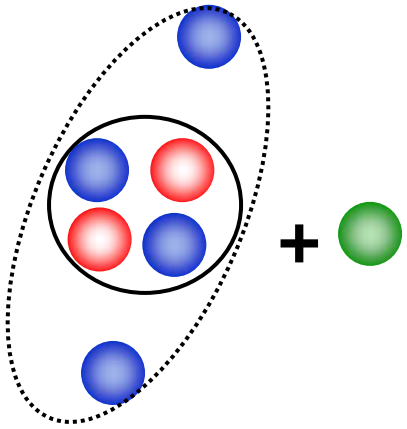

Decay Spectrum of ttΛ Feshbach Resonance
Width = 2.0 MeV
Range of ΛH-t interaction
0.3fm
0.5fm
0.7fm
0.9fm
Decay rate
0
5
10
15
20
25
30
0
2
4
6
8
10
12
14
E_Λ (MeV)

Similar structure bet. α-t and t-t , gives strong population of ttΛ.





Different structure bet. t-t and ^{6}He ensures the formation of quasi-stable Feshbach resonance.



Concluding Remarks

- From our coupled–channel three-body t + t + Λ model analysis, a bound state is found at 4.46 MeV below the t+t+Λ threshold, and 7.85 MeV above the ^{6}He + Λ threshold.

- It is a Feshbach resonance because it is open to ^{6}He + Λ , $^{6}_{\Lambda}$He + n , $^{5}_{\Lambda}$He + n + n, α + n + n + Λ channels.

- All decay channels can be included analytically, since the interaction is of s-channel nature via ttΛ resonance.

- ^{7}Li (e,e'K^{+})$^{7}_{\Lambda}$He experiments with high statistics are awaited !


Thank You.