Institute of Corpuscular Physics, University of Valência, Spain.

Institute of Physics, University of São Paulo, Brazil.

Study of the BDD and $BD\bar{D}$ systems

Jorgivan M. Dias

In collaboration with: V. R. Debastiani
S. Sakai
L. Roca
E. Oset

São Paulo Research Foundation

Introduction: three-body systems

$B D \bar{D}$

$B D D$

Introduction: three-body systems

$B D \bar{D}$

$B D D$

three-body interactions

Introduction: three-body systems

$B D \bar{D}$

$B D D$

three-body interactions $\Rightarrow$ States/ resonances

Introduction: three-body systems

$BD\bar{D}$

BDD

three-body interactions → States/ resonances with three-body structure

Introduction: three-body systems

$BD\bar{D}$

BDD

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States/

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Examples

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Examples

$\pi\bar{K}N$

meson-meson-baryon

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States/ resonances

with three-body structure

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$\pi\bar{K}N$

$J = \frac{1}{2}^+$

Phys. Rev. C 77, 042203 (2008).

Low-lying excited baryons

meson-meson-baryon

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$B D \bar{D}$

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Phys. Rev. D 80, 094012 (2009).

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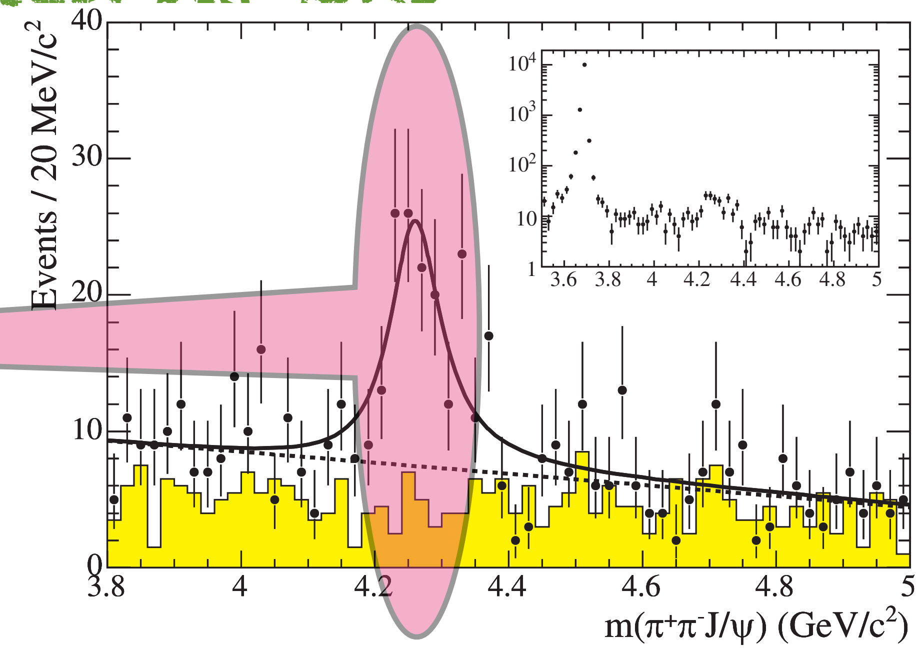
$Y(4260)$

BABAR



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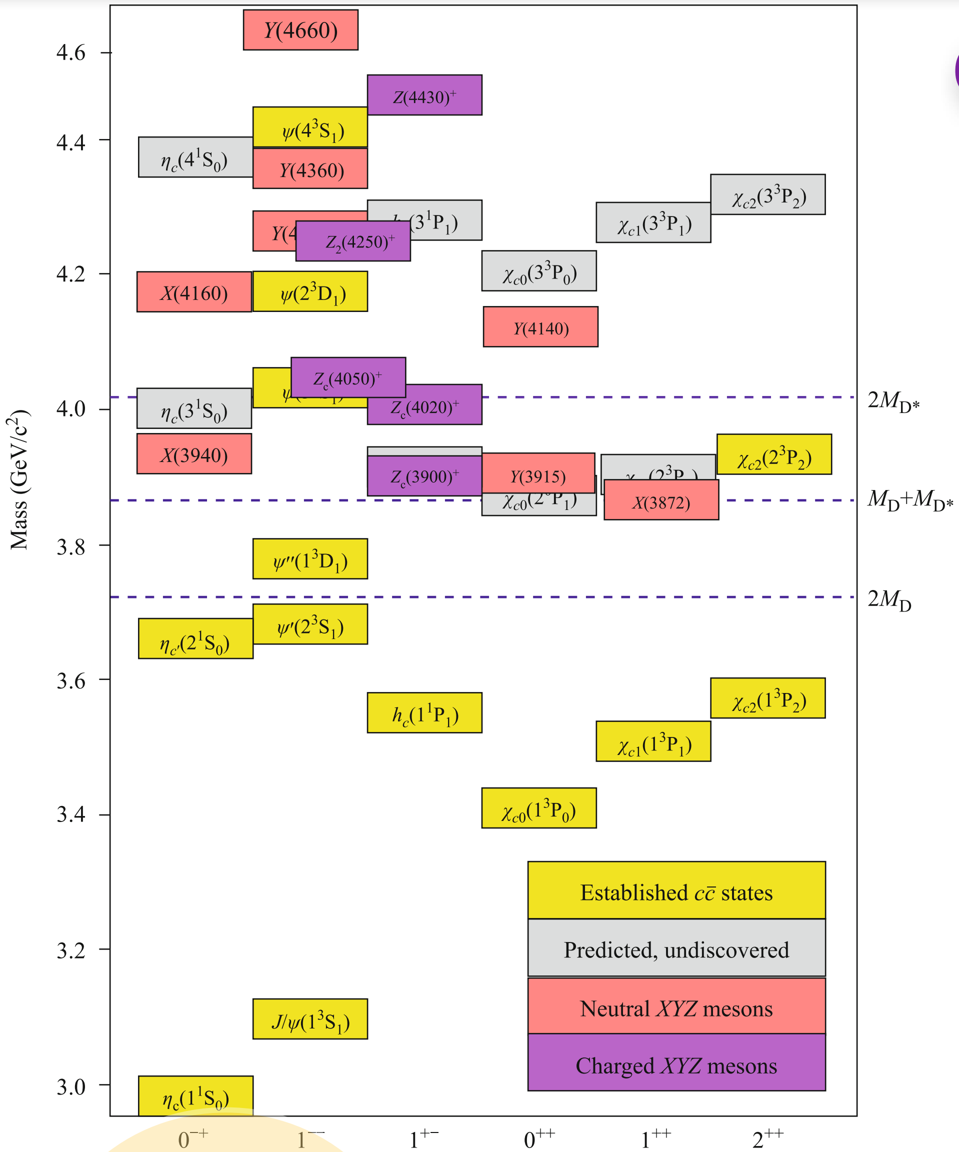
Introduction: charm sector



Charmonium Spectrum

$J/\psi K\bar{K}$

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meson-meson-meson

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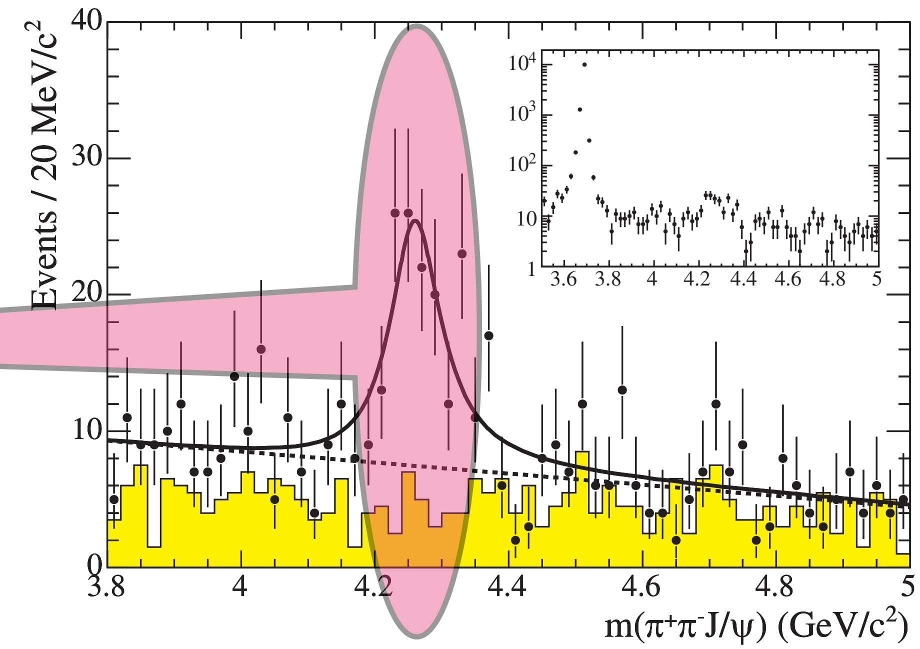

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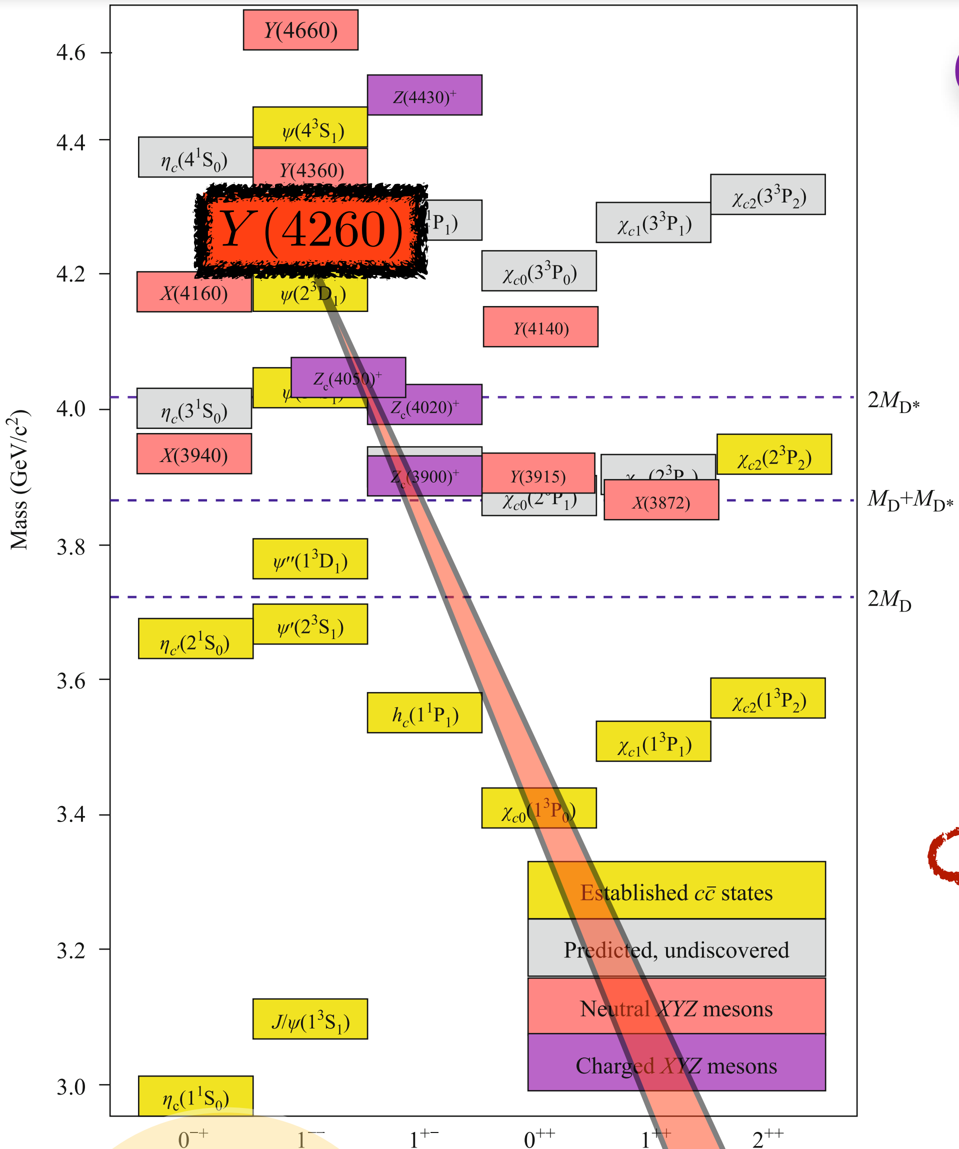
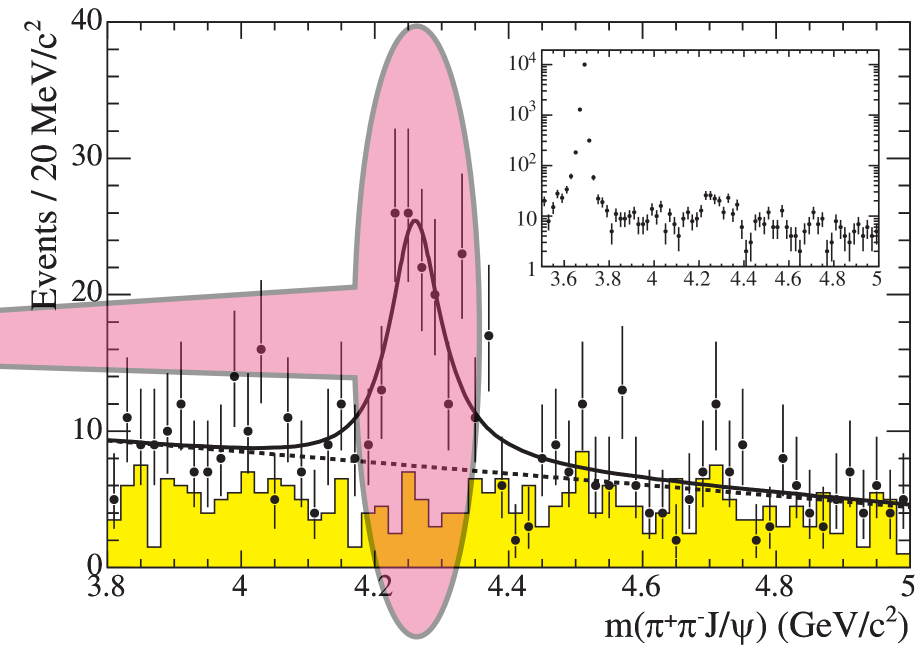


Charmonium Spectrum

Candidate to be exotic!



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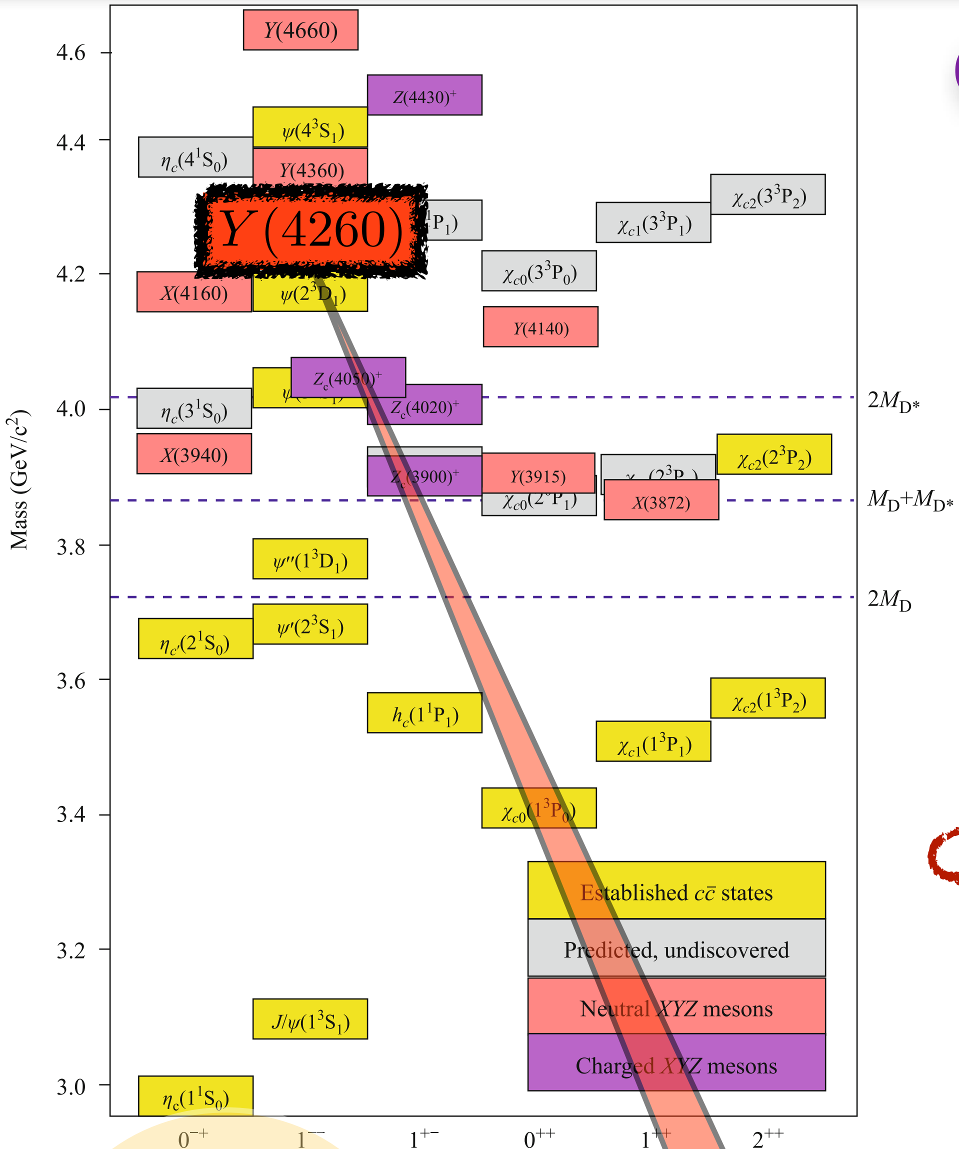

Charmonium Spectrum

$$Z_c^{\pm}(3900),\ Z_c^{\pm}(3885),\ X(3872),\ \ldots$$

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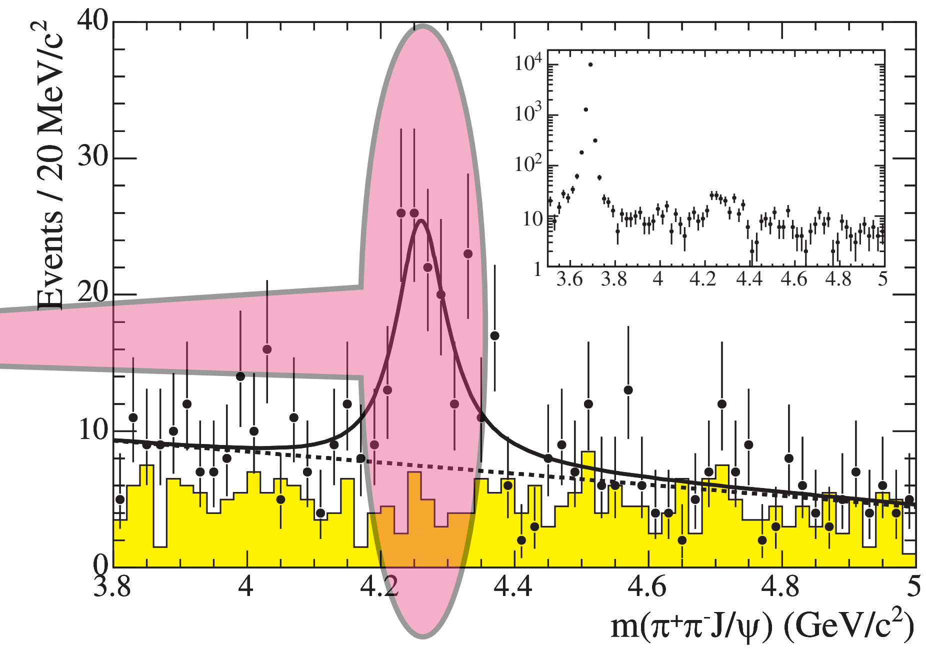

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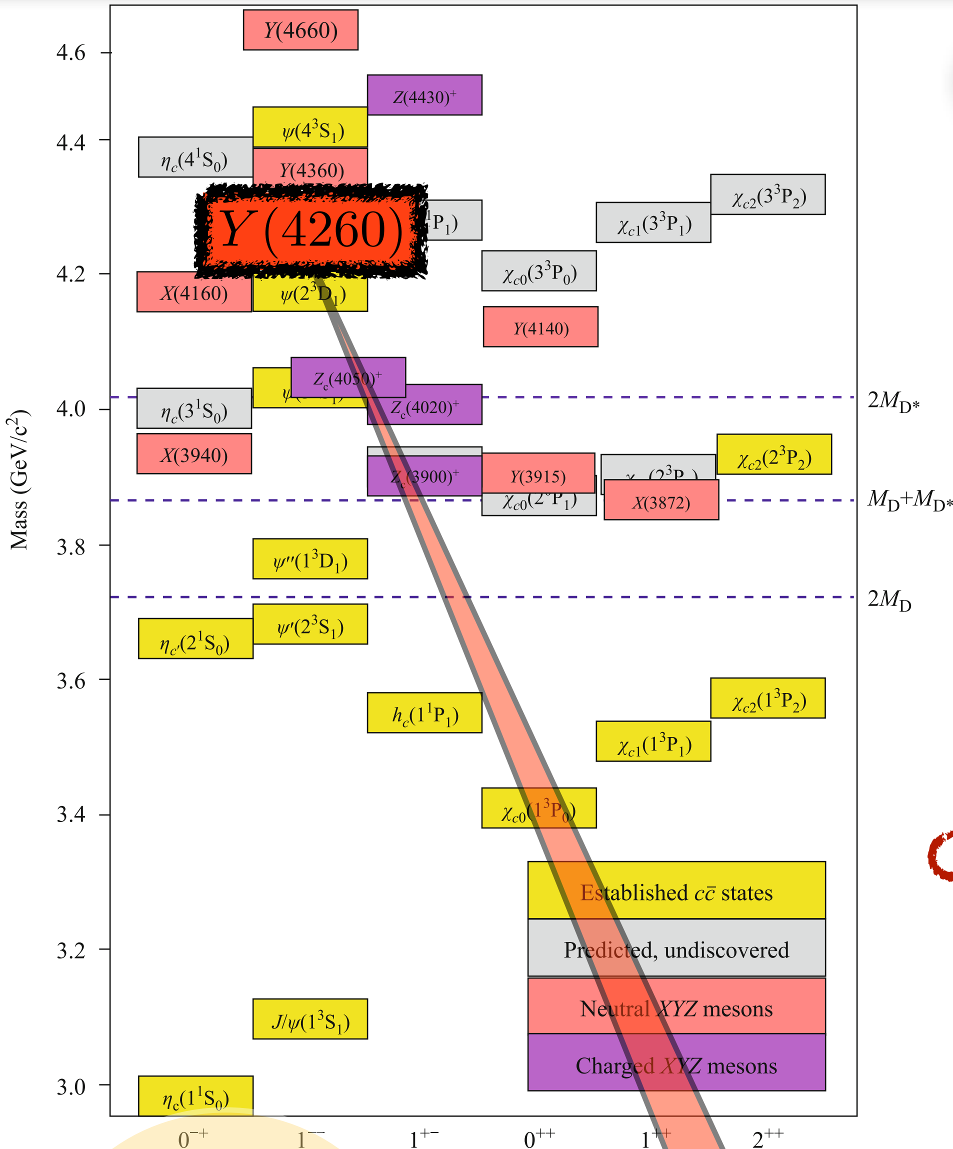

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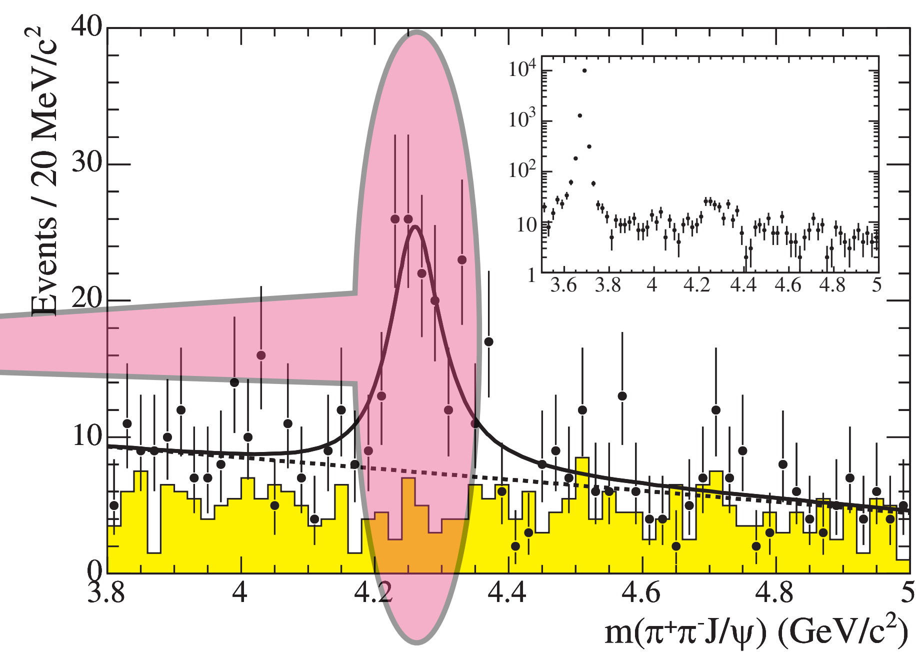

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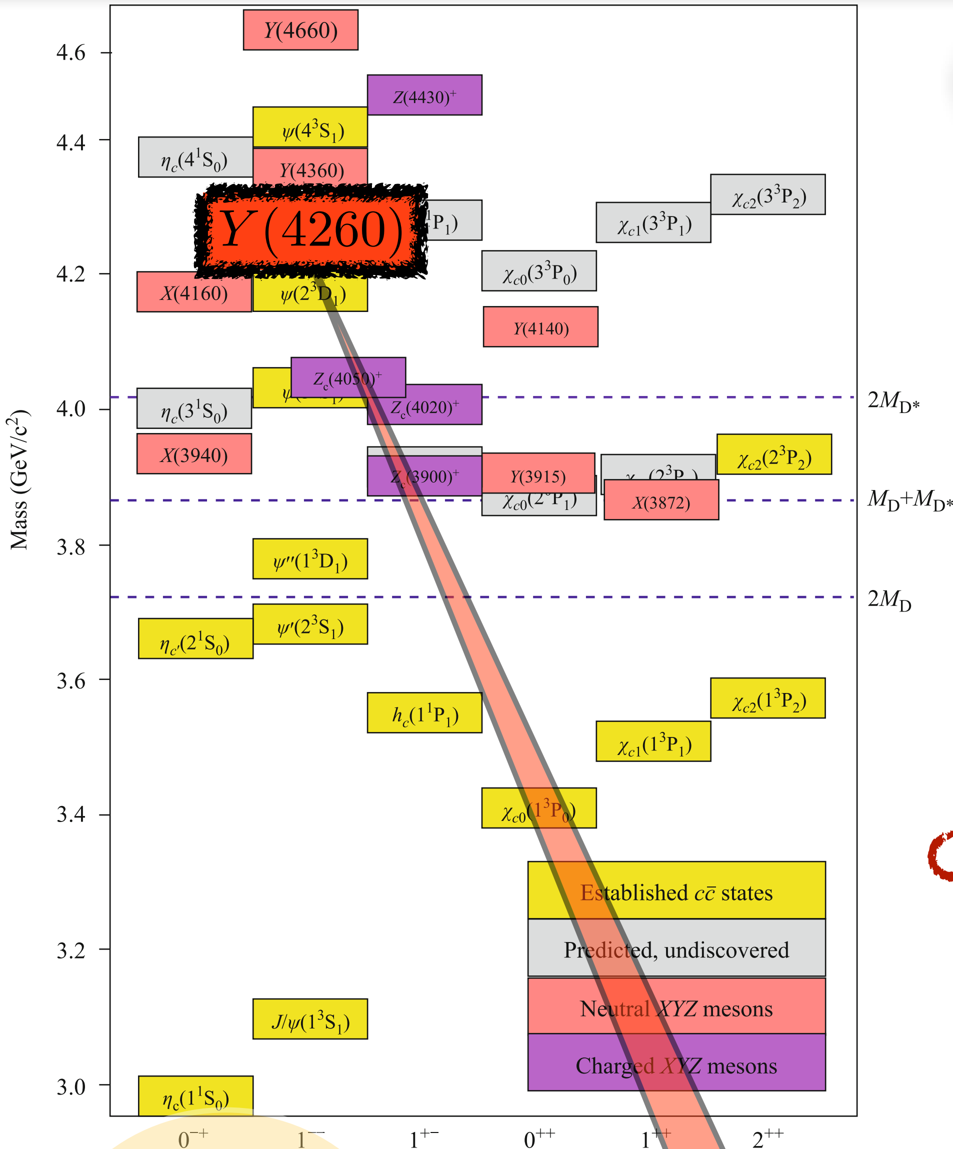

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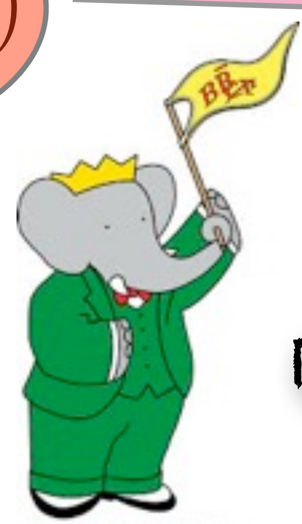

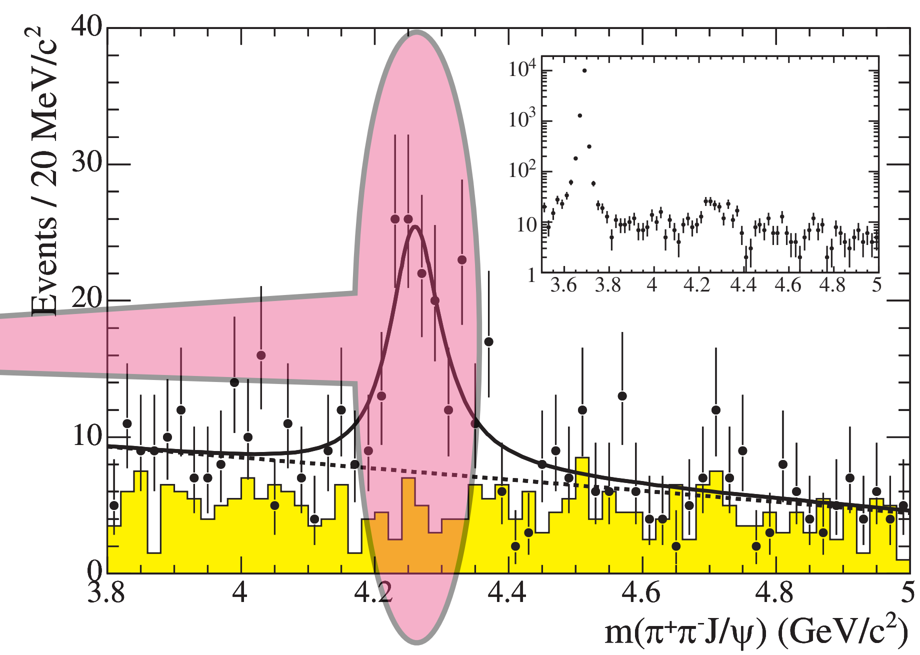

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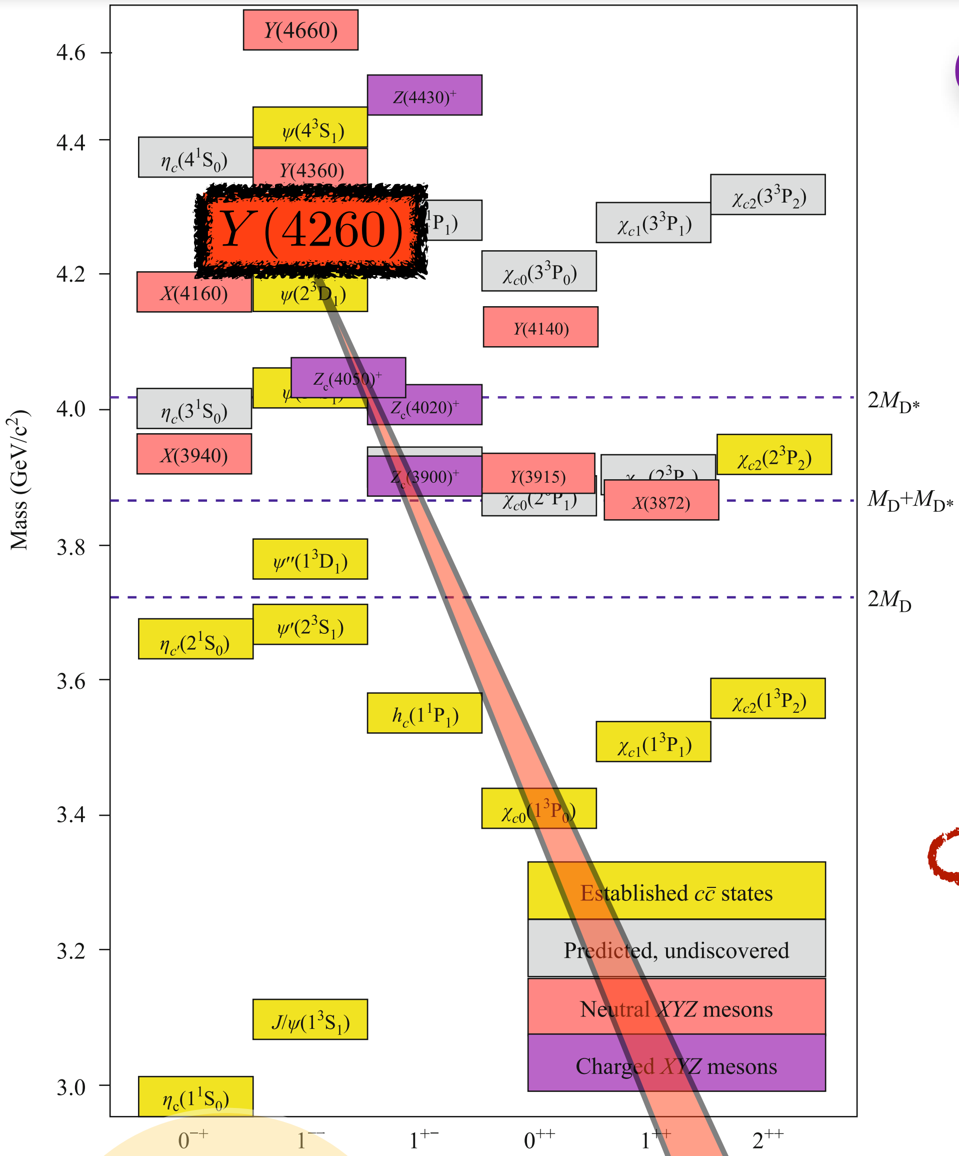

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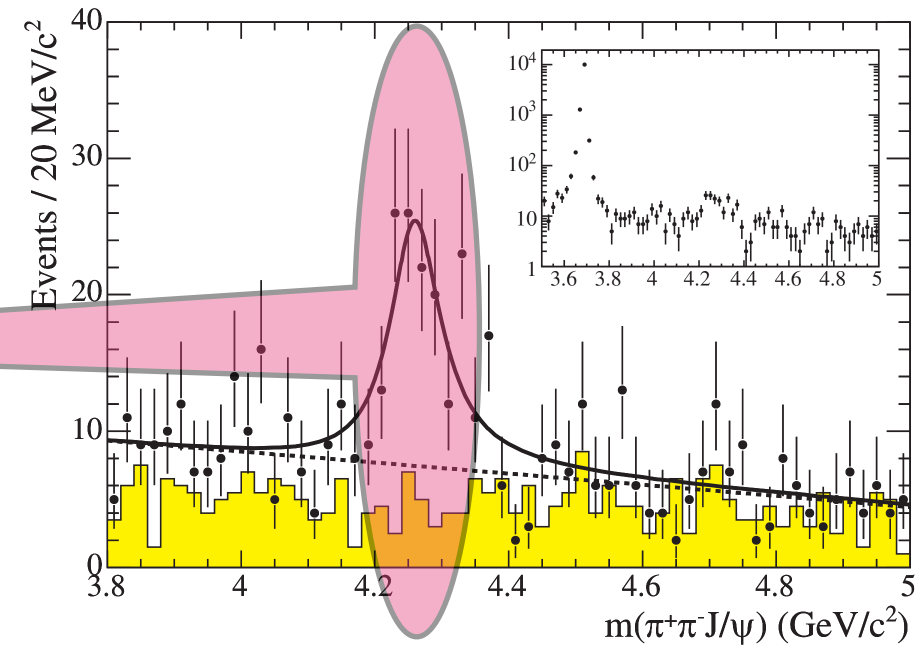

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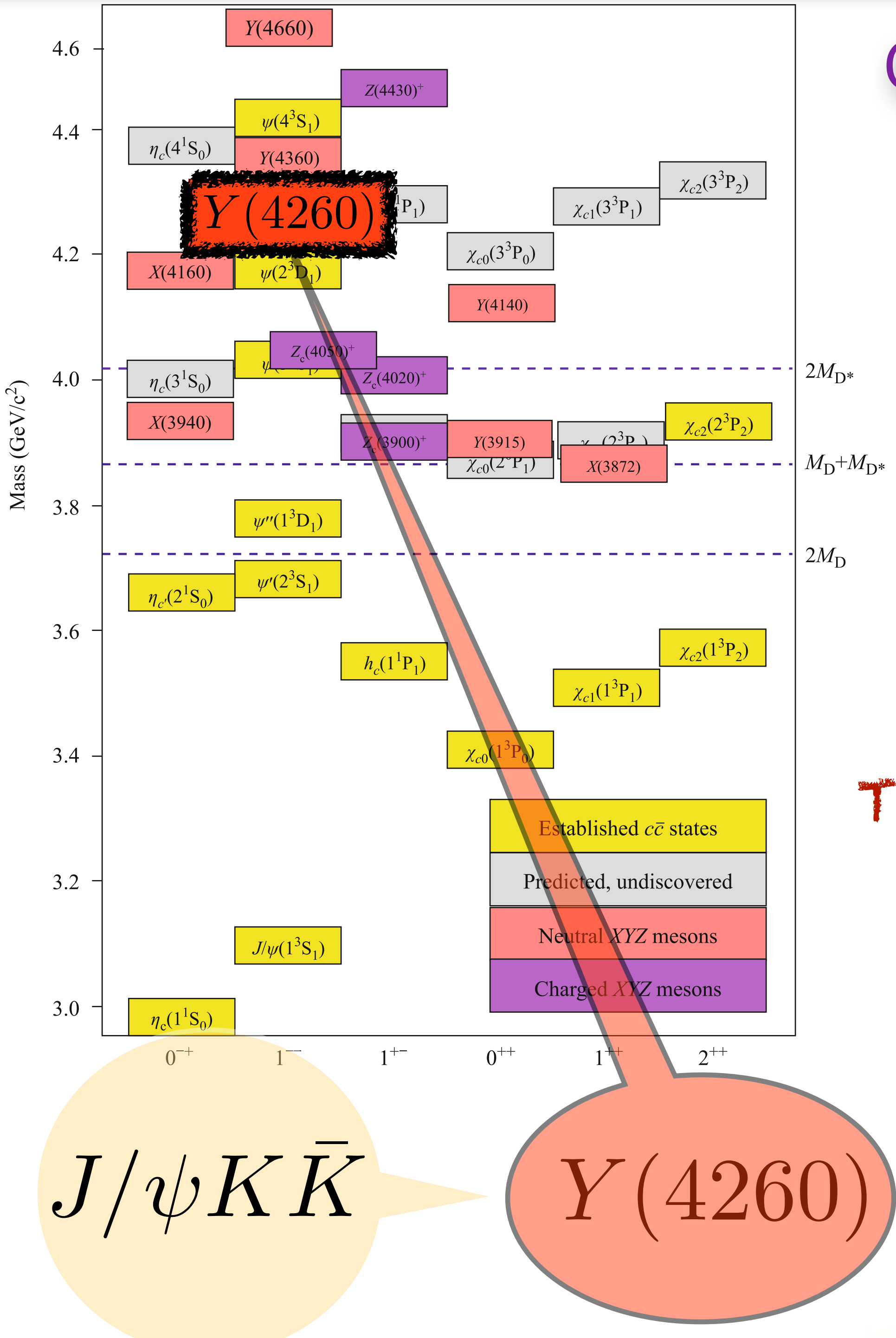

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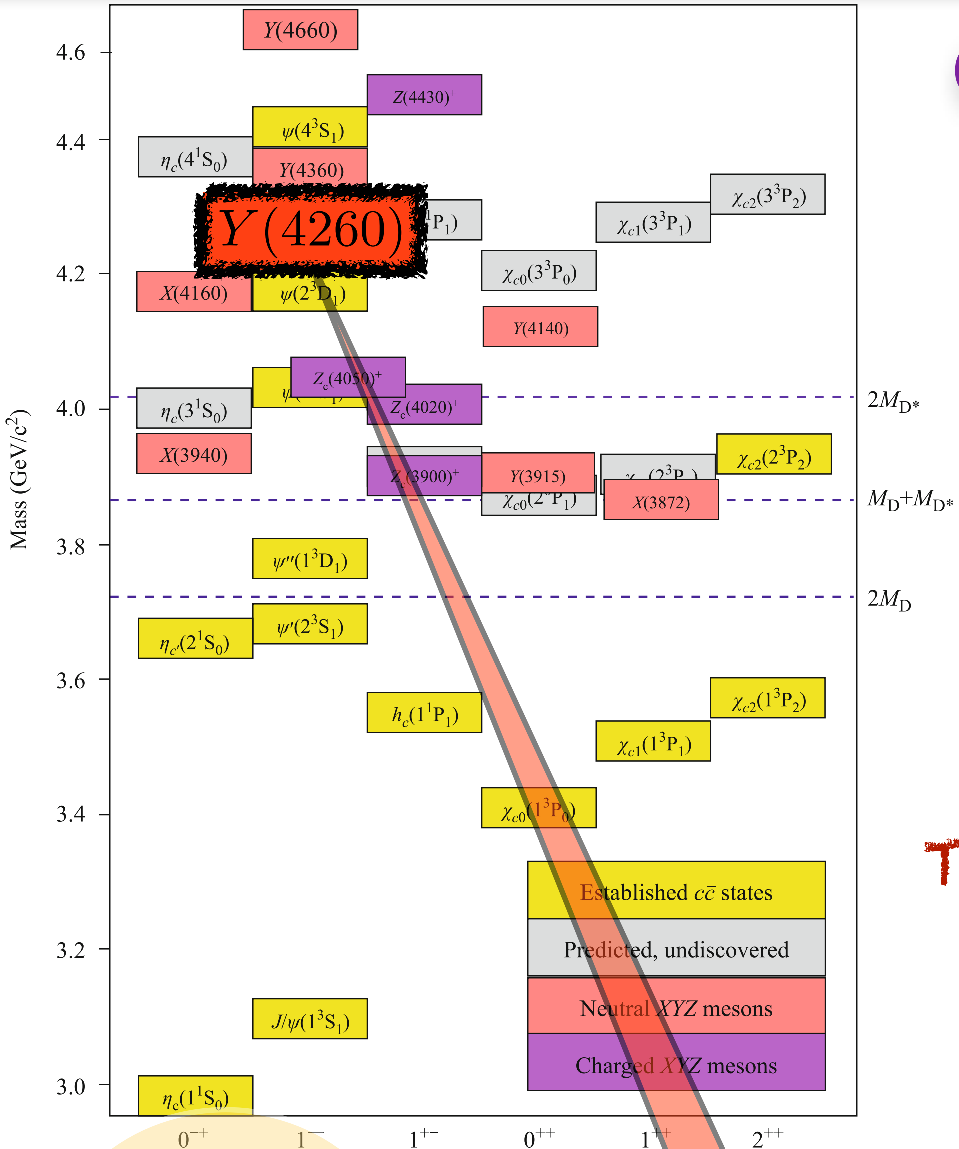

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meson-meson-meson

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Phys. Rev. D 96, 016014 (2017).

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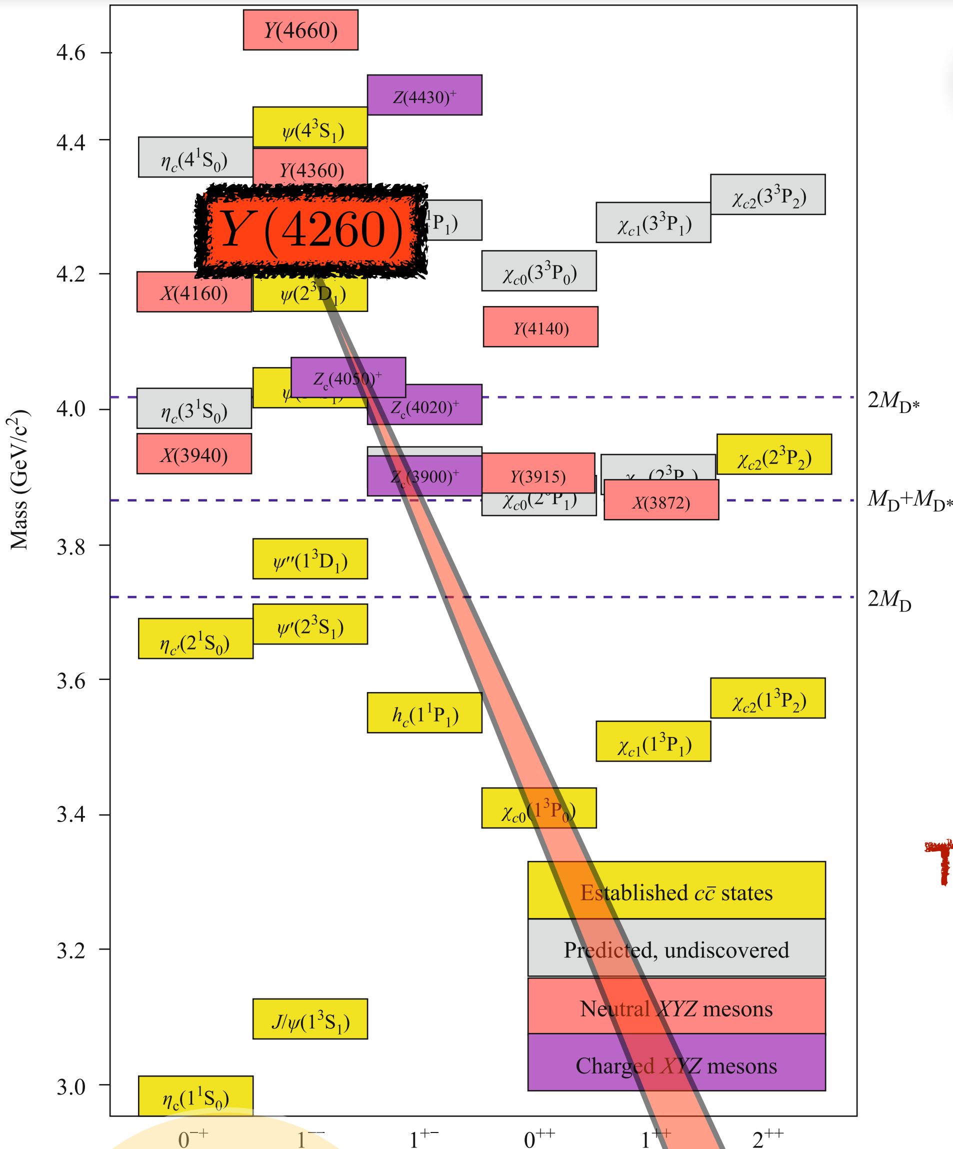

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$$+\bar{K} = D^*_{s0}(2317)\bar{K}$$

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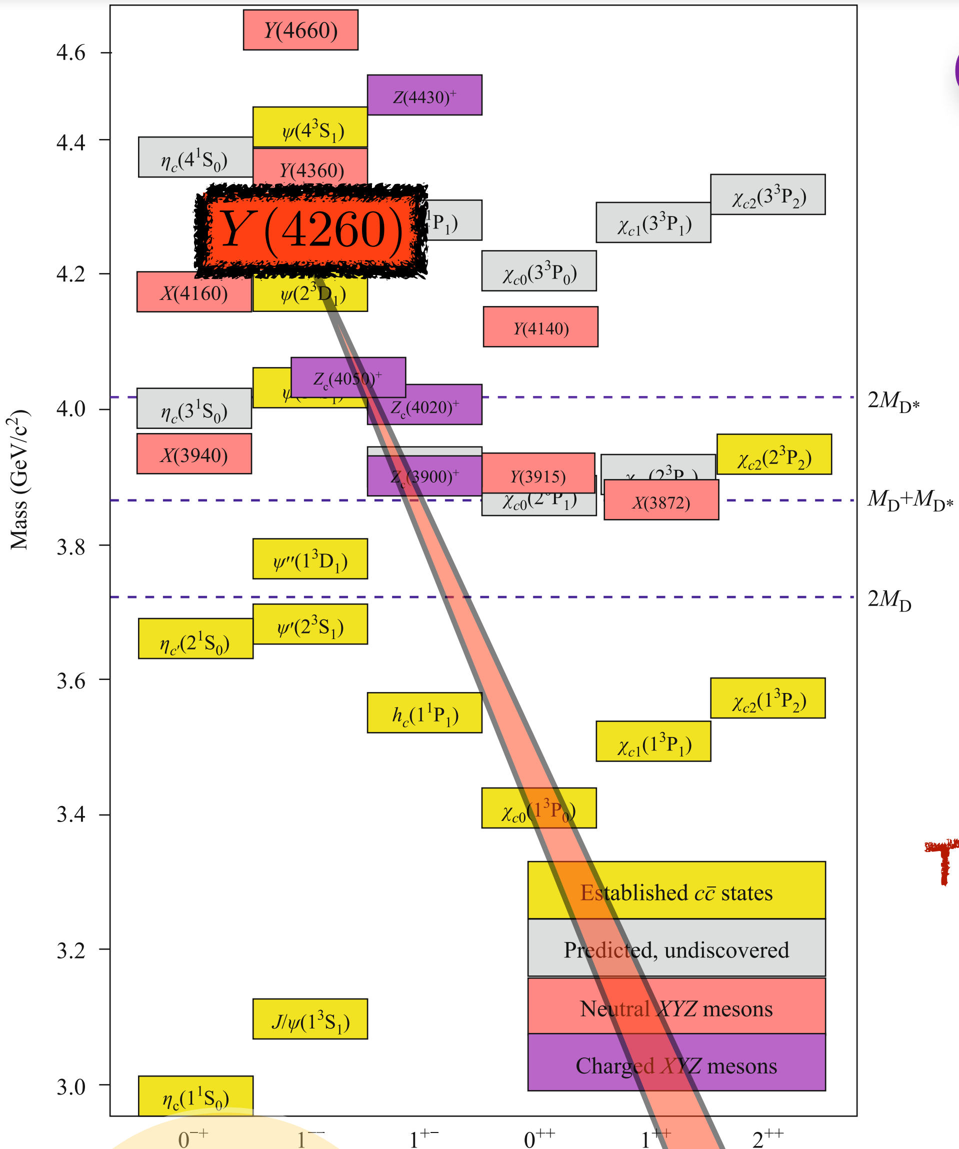

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$$DK + \bar{K} = D^*_{s0}(2317)\bar{K} / D f_0(980)$$

or $DK\bar{K}$ $f_0(980)$

Phys. Rev. D 96, 016014 (2017).

Phys. Rev. D 87, 034025 (2013).

$J/\psi K\bar{K}$ $Y(4260)$

meson-meson-meson

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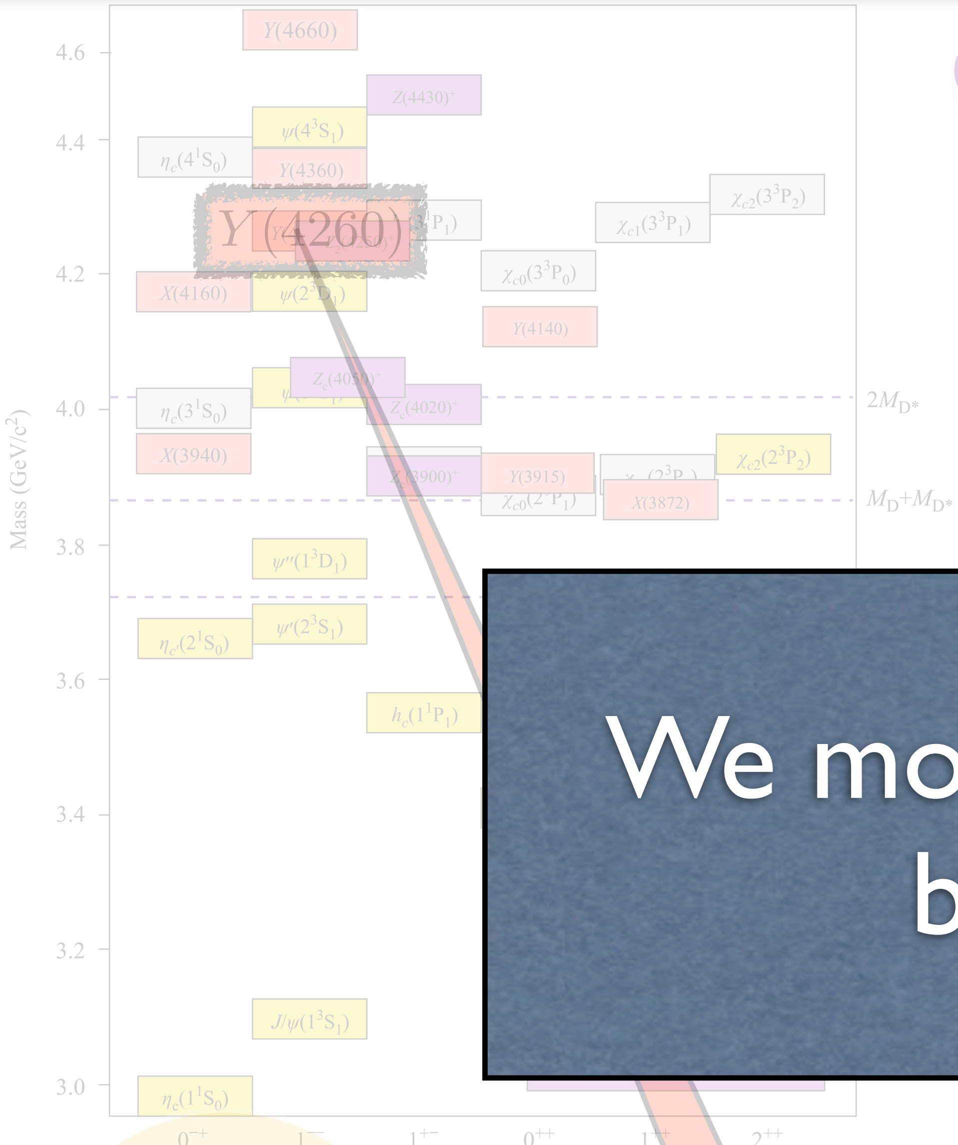

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they seem to have a two-body structure...

$D\bar{D}\quad D^*\bar{D}^*$ strongly attractive to bind!

added?...

We move a step forward to bottom sector!

$+K - D_{s0}(2317)\bar{K}/Df_0(980)$

$J/\psi K\bar{K}$ $Y(4260)$

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meson-meson-meson

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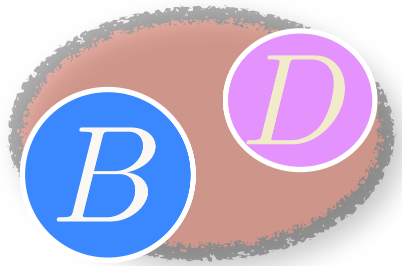
Introduction: charm + bottom

Recently,

arXiv.:1704.02196.



interaction

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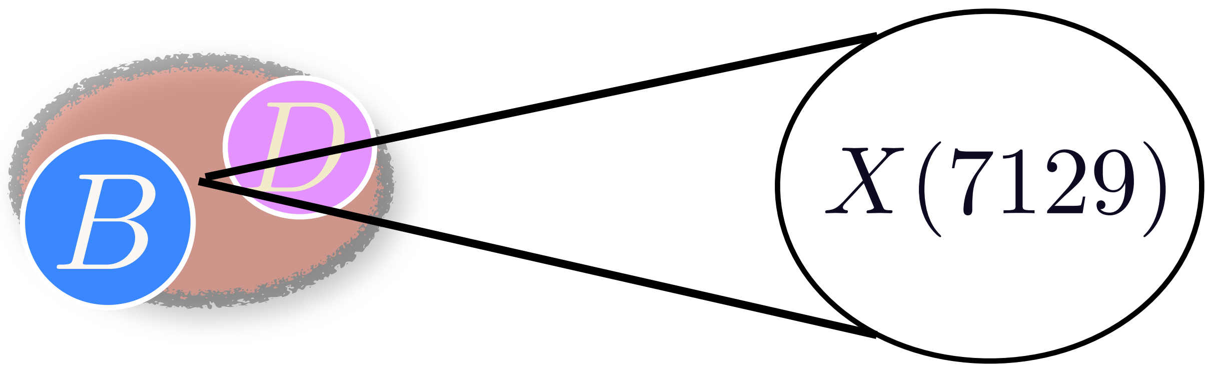

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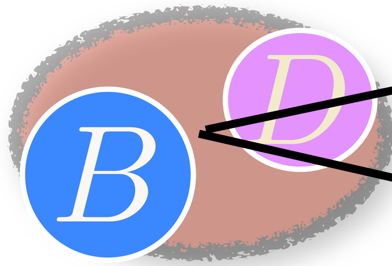

interaction

$X(7129) + \bar{D}$ or D ?

$$BD\bar{D}\ (BDD)$$

Introduction: charm + bottom

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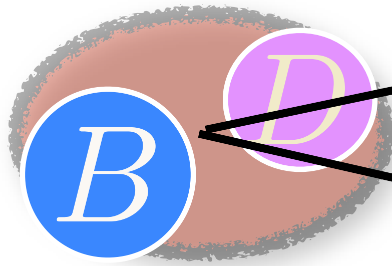

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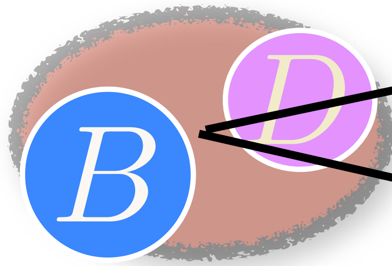

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Introduction: charm + bottom

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B D

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Ludvig Faddeev.

Introduction: charm + bottom

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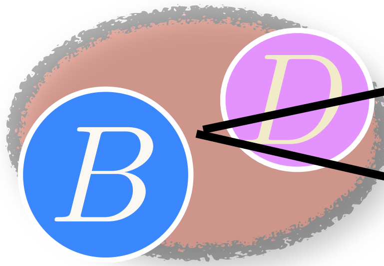

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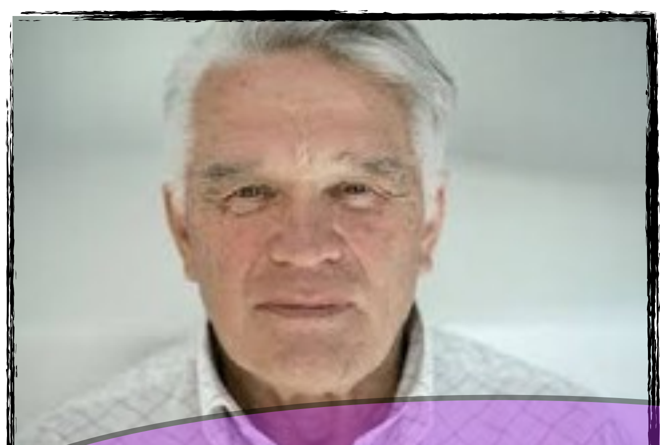

Ludvig Faddeev.

Faddeev equations

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it's solution is quite involved!

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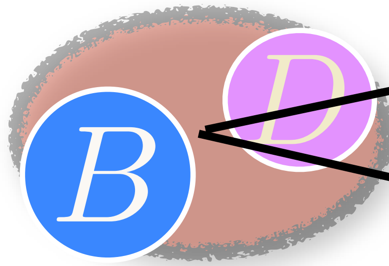

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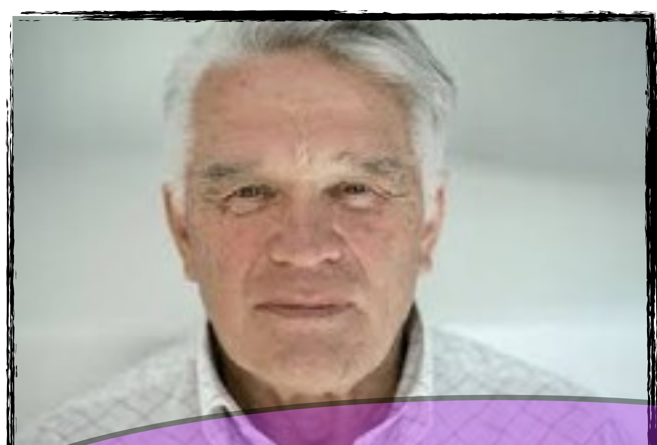

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Formalism: Fixed Center Approximation (FCA)

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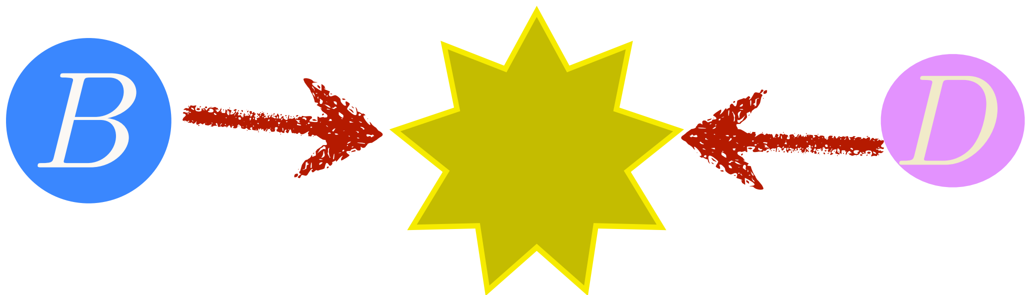

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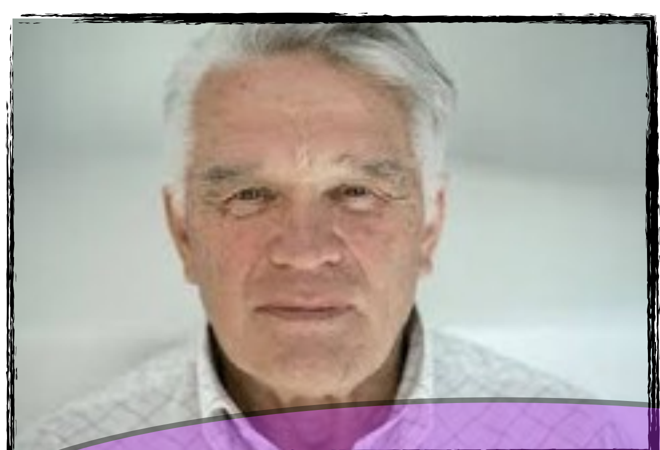

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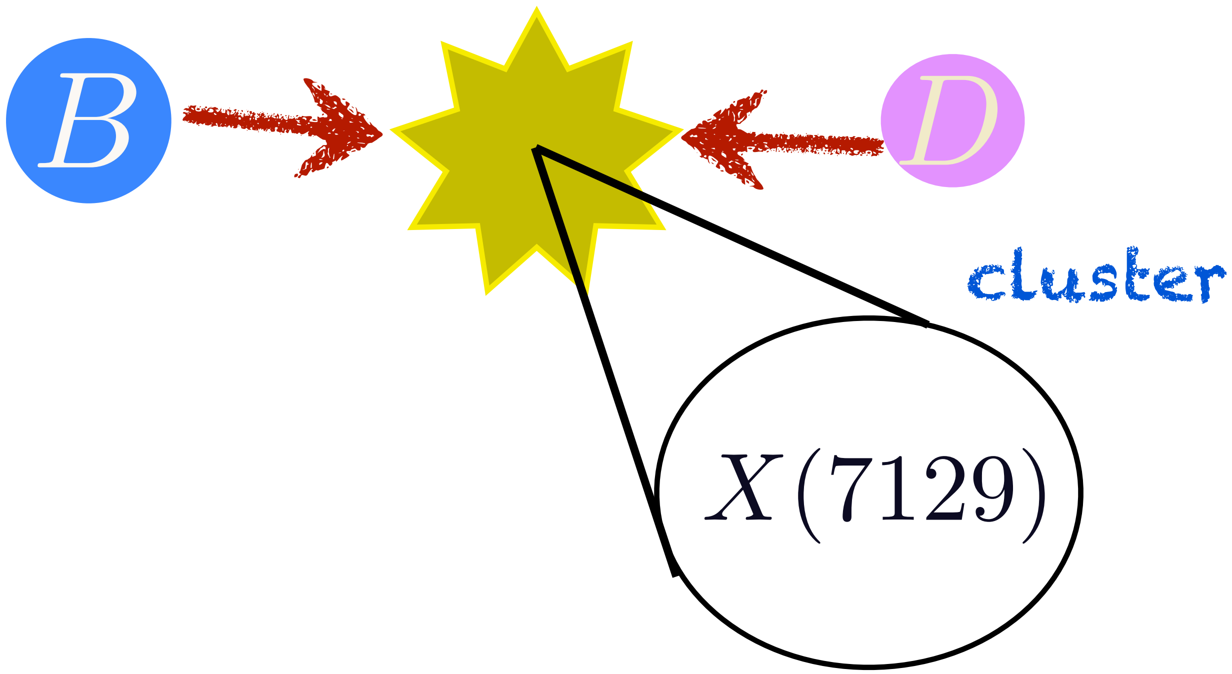

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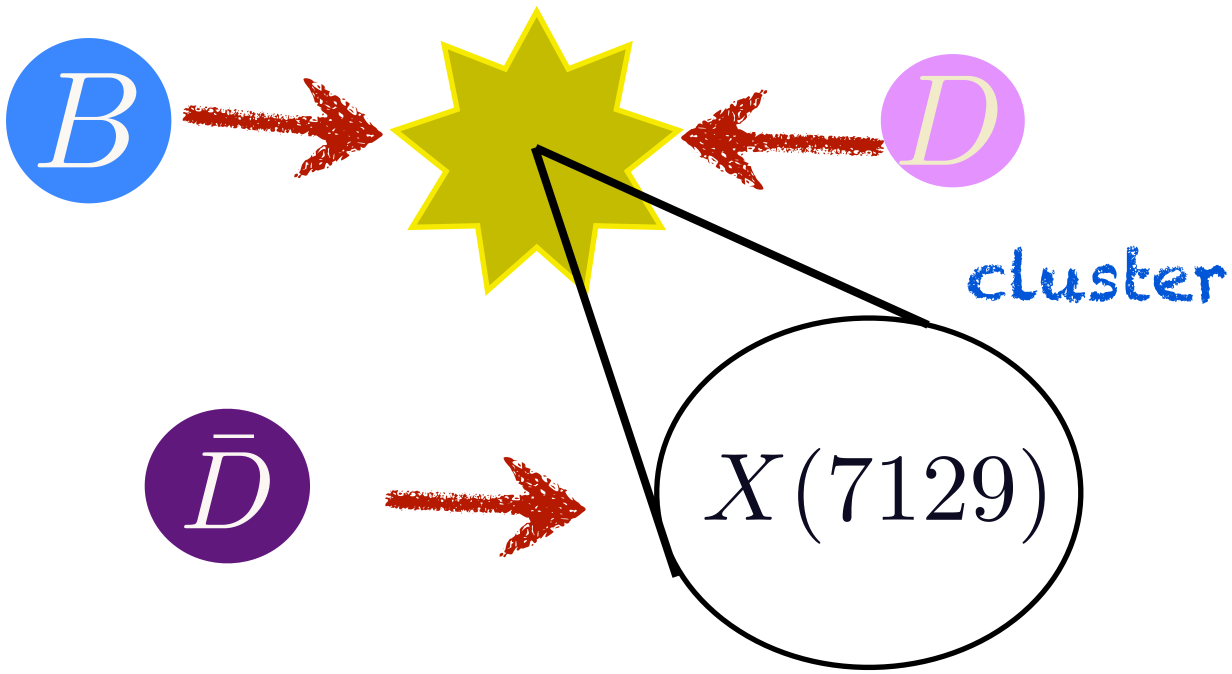

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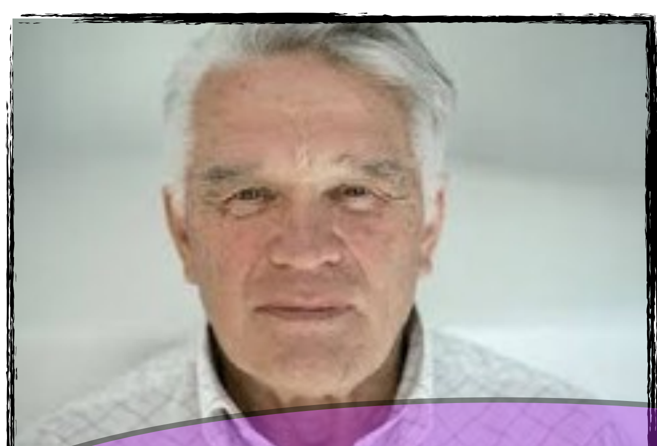

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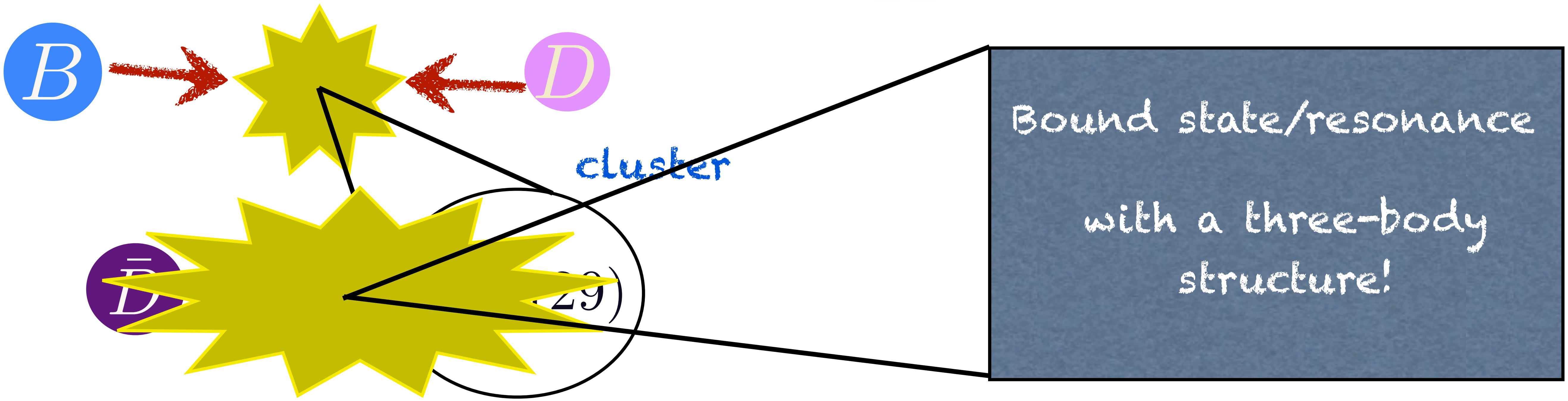

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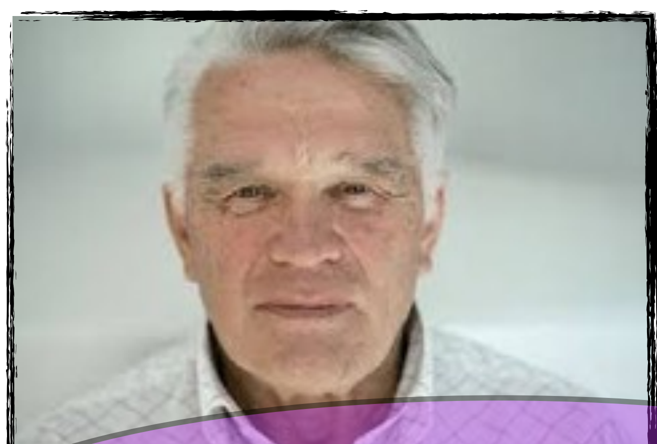

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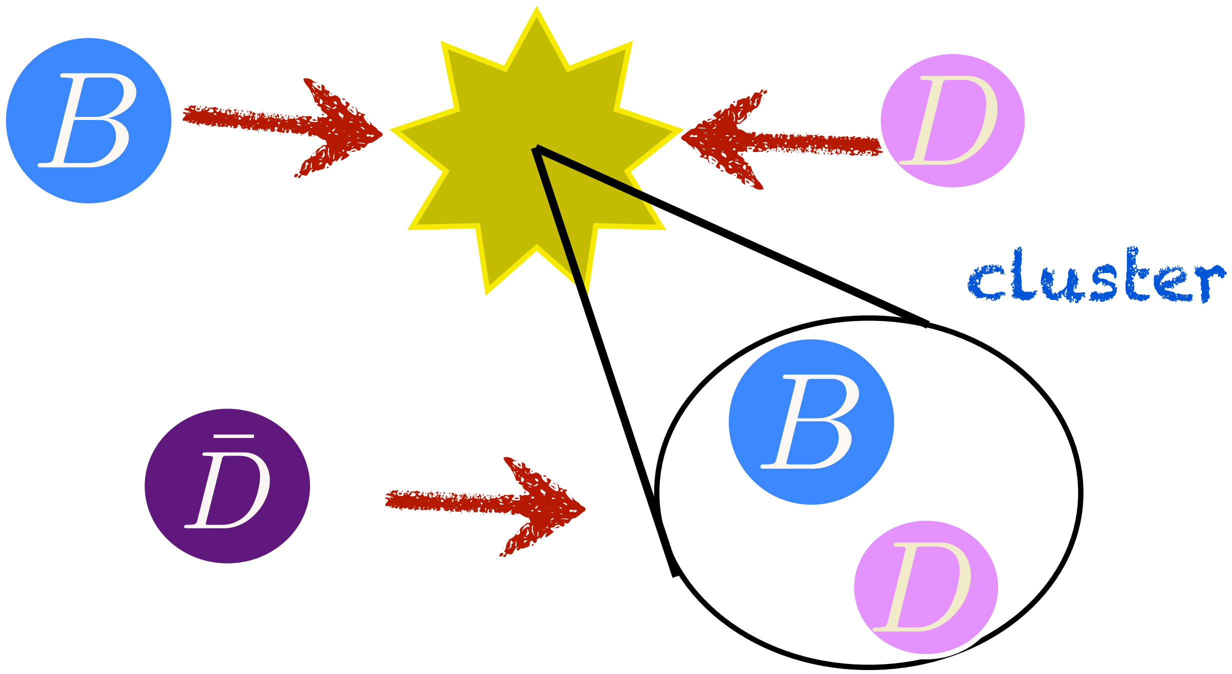

More concretely...

Bound state/resonance

with a three-body structure!

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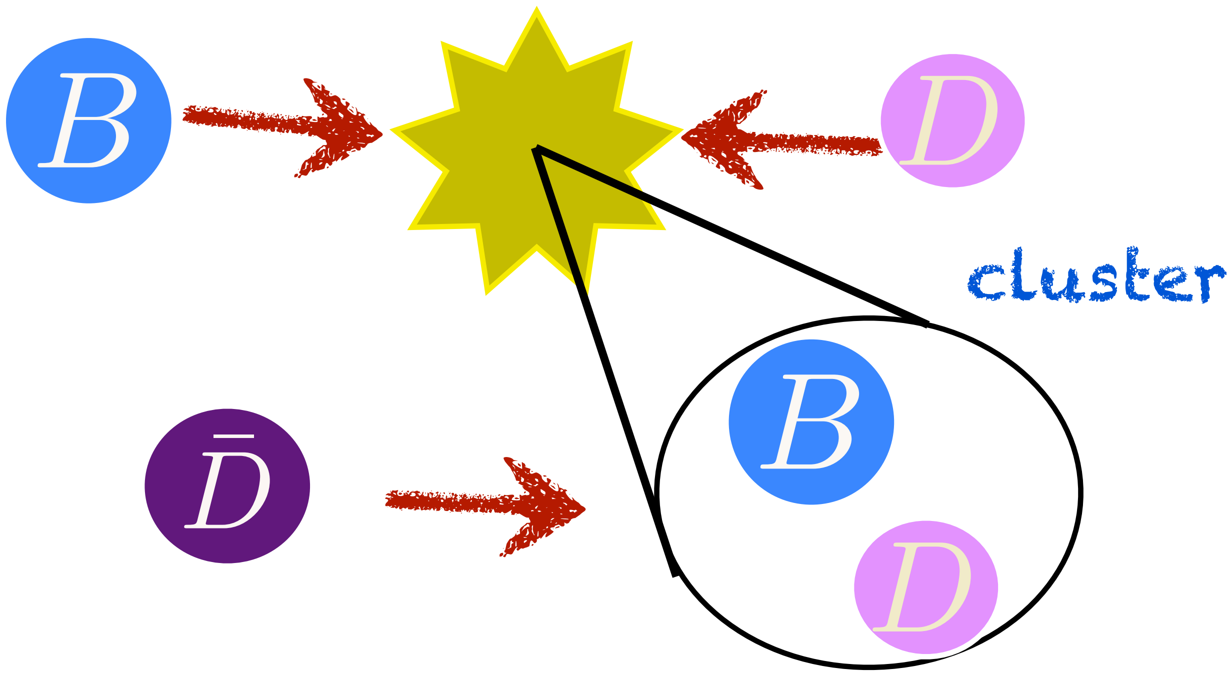

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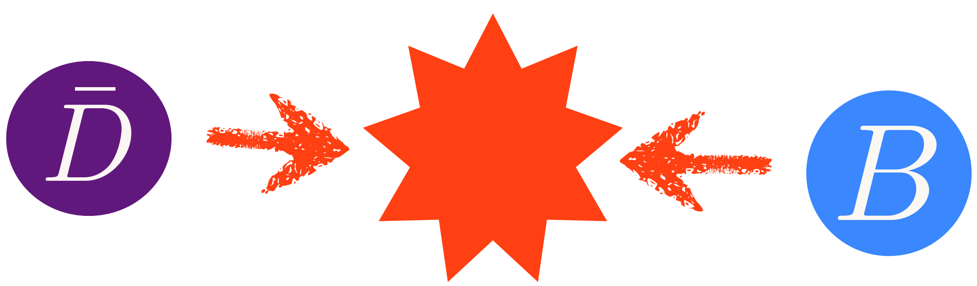

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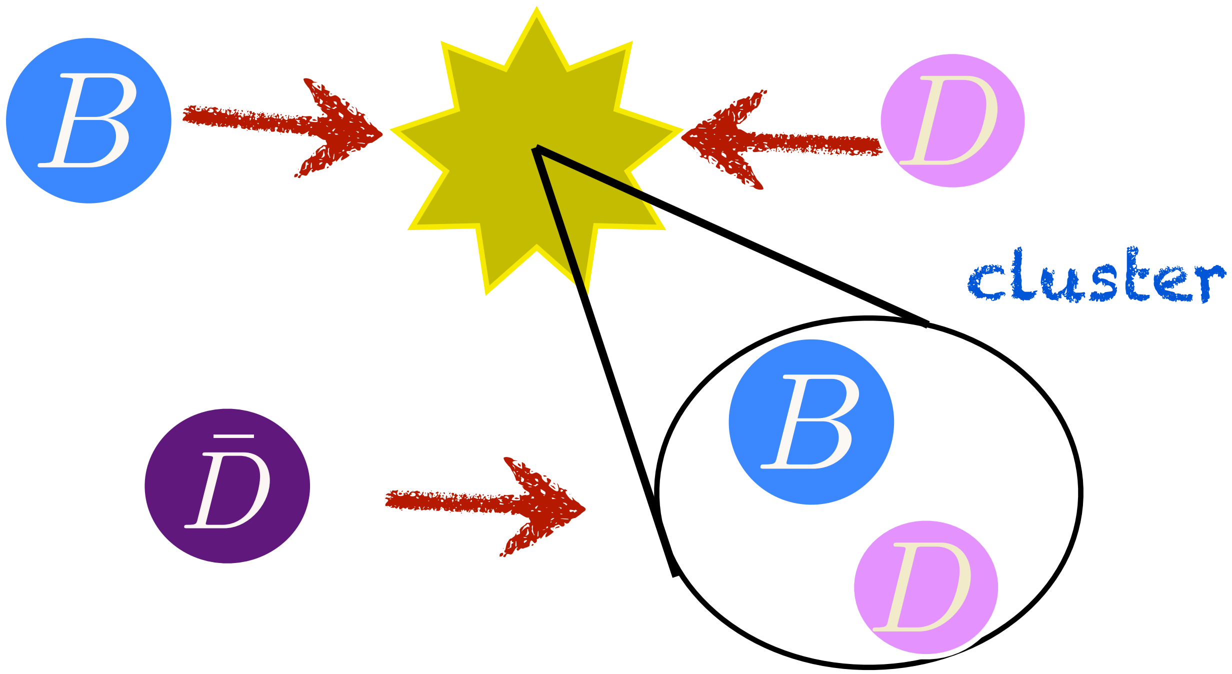

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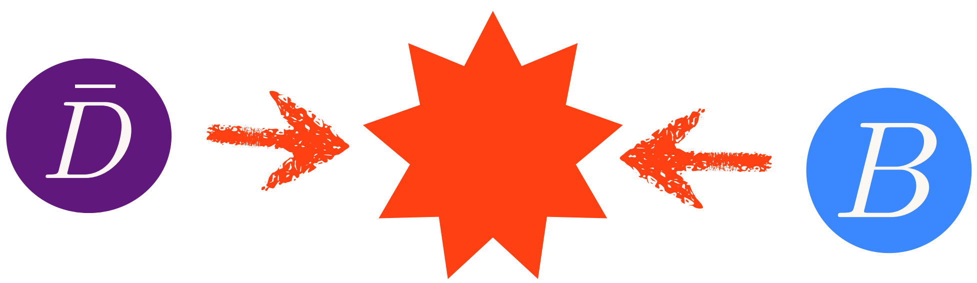
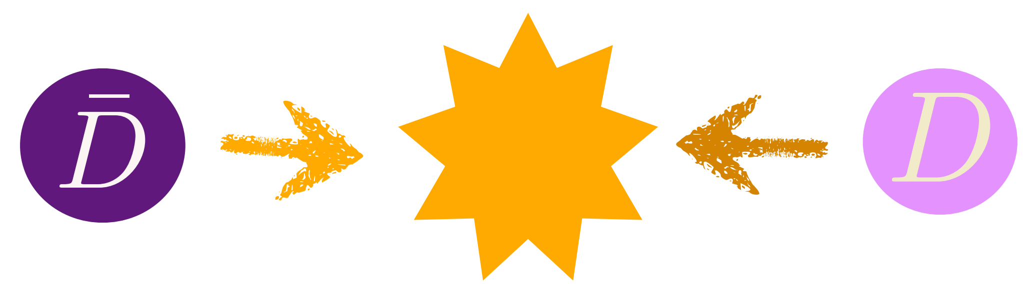


and with



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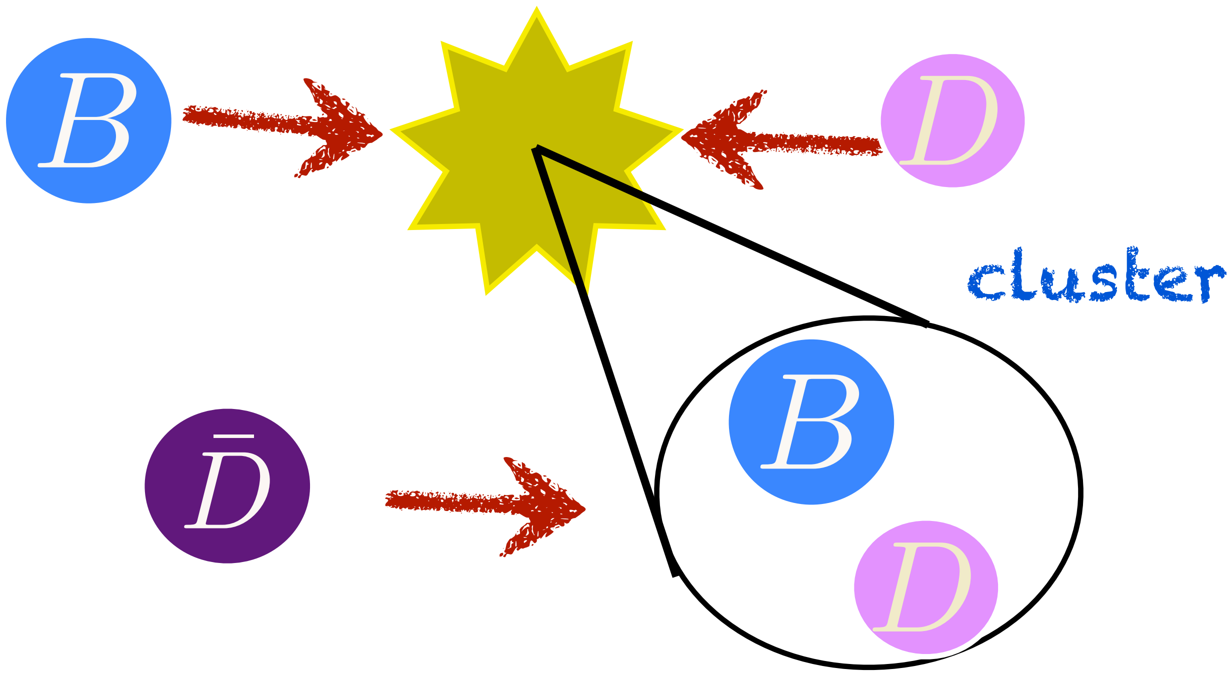
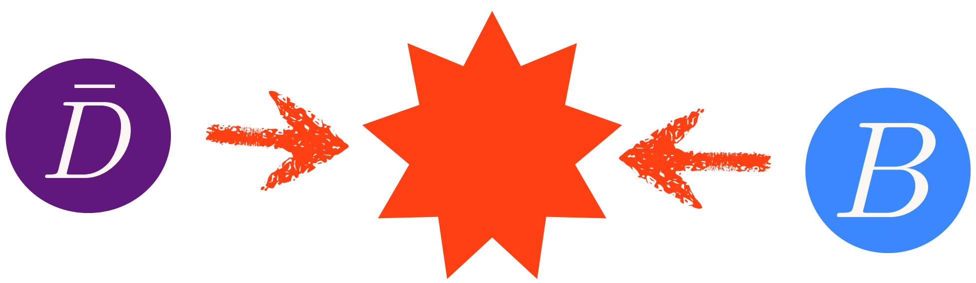


Bound state/resonance

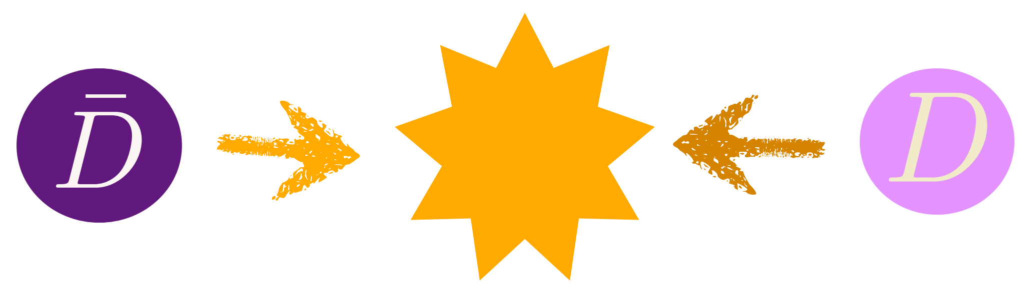
with a three-body structure!

More concretely...

and with

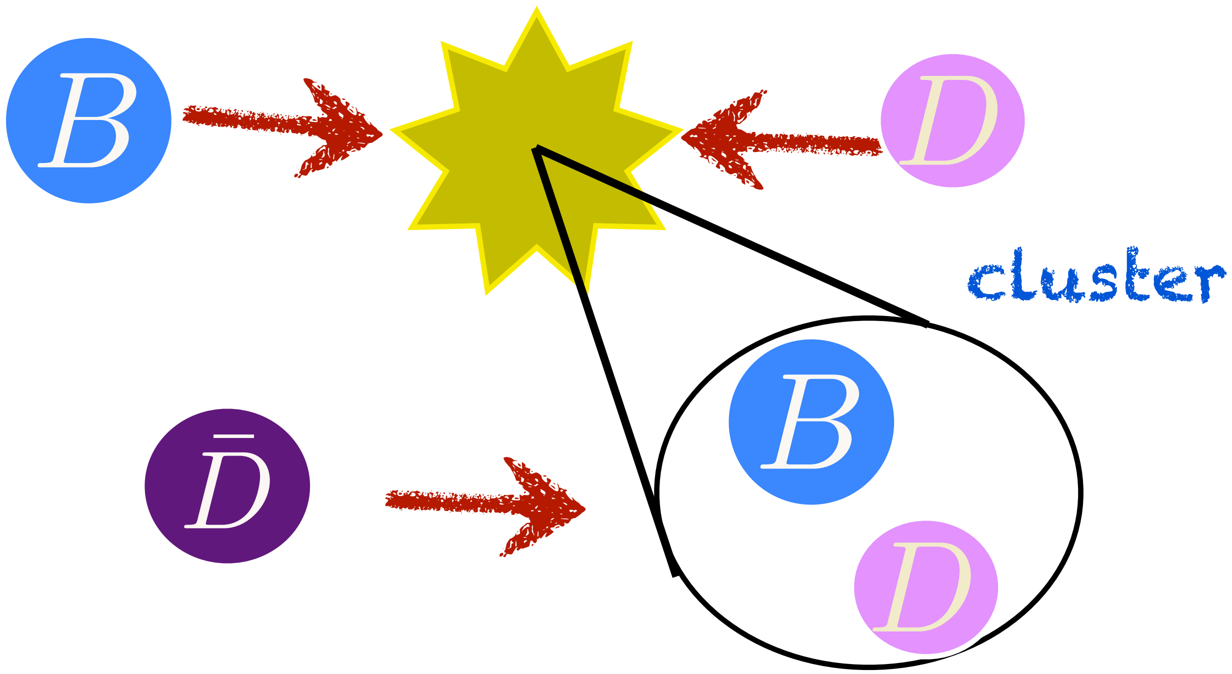


$$t_{B\bar{D}}(s')$$



$$t_{D\bar{D}}(s'')$$

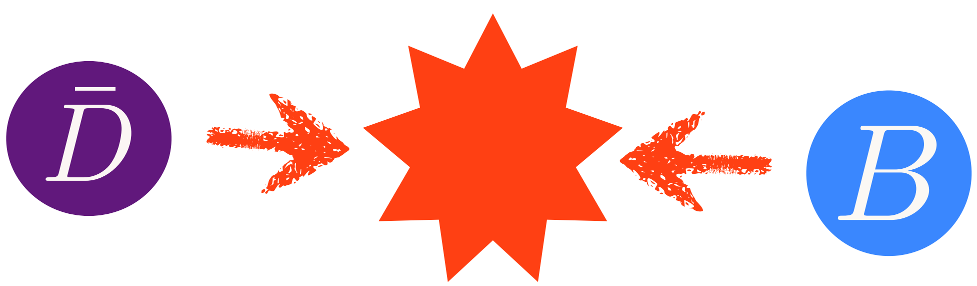
Formalism: Fixed Center Approximation (FCA)



Bound state/resonance

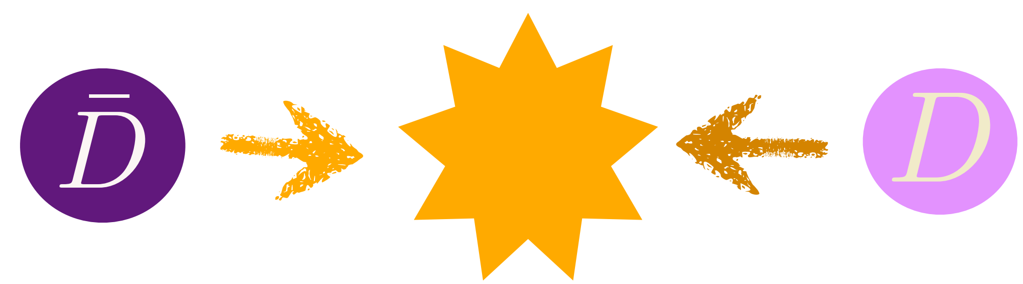
with a three-body structure!

More concretely...

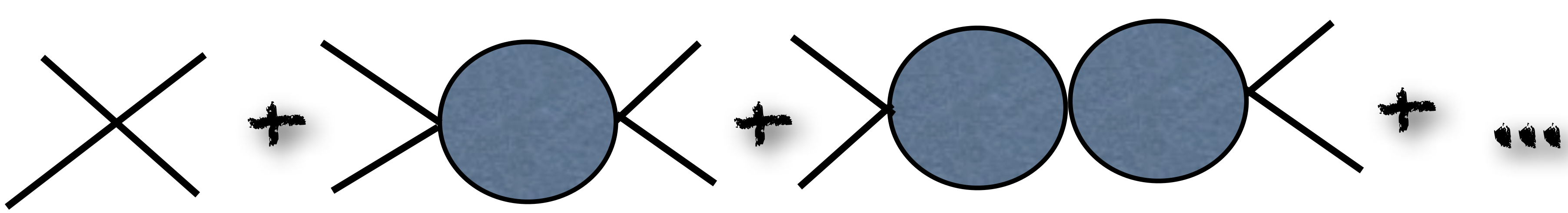


$t_{B\bar{D}}(s')$

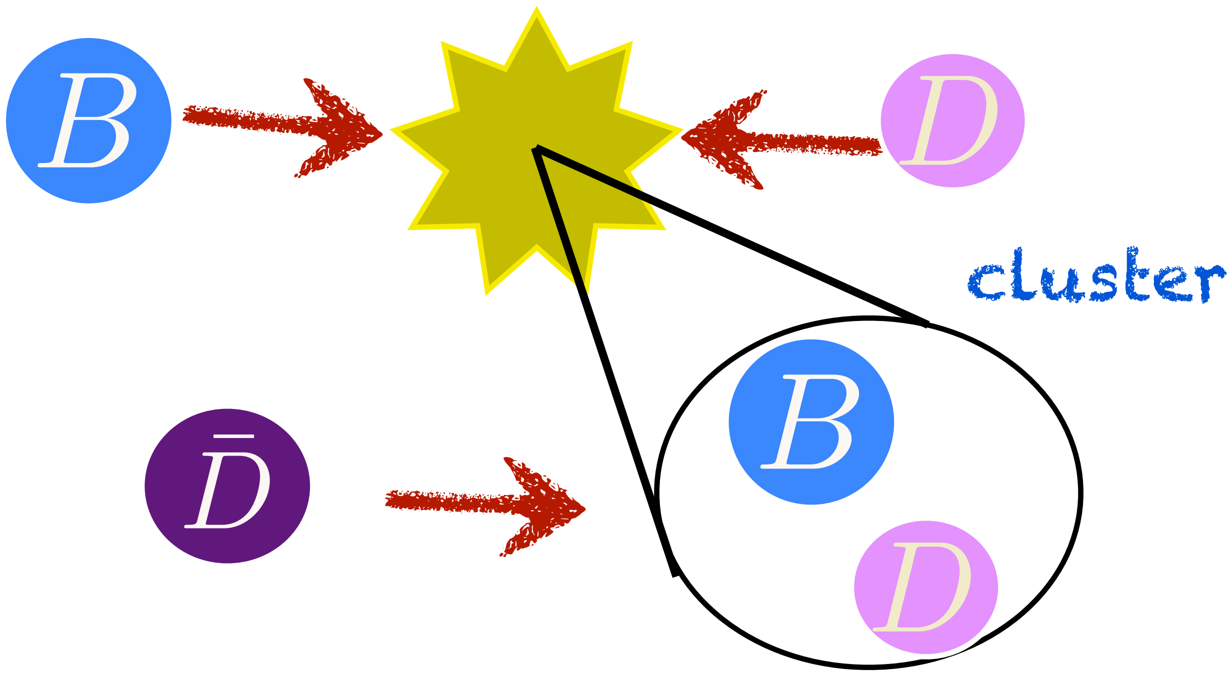
and with



$t_{D\bar{D}}(s'')$



Formalism: Fixed Center Approximation (FCA)

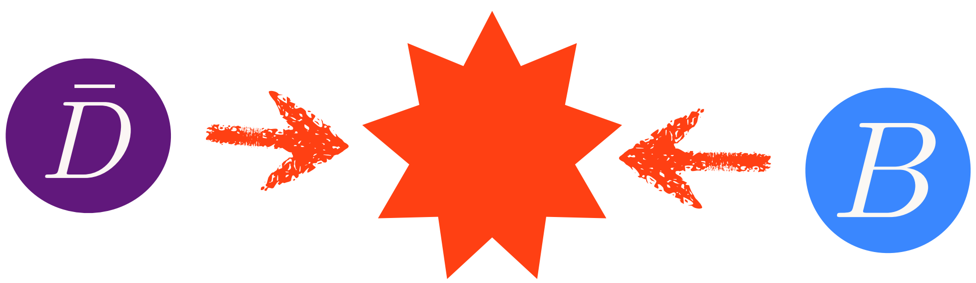


Bound state/resonance

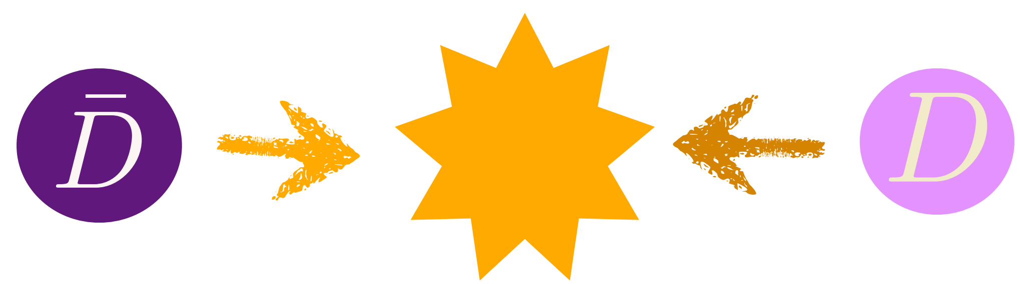
with a three-body structure!

More concretely...

and with



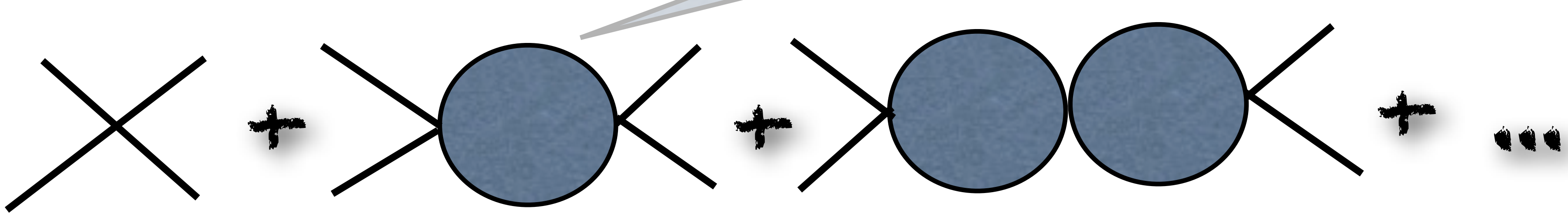
$t_{B\bar{D}}(s')$



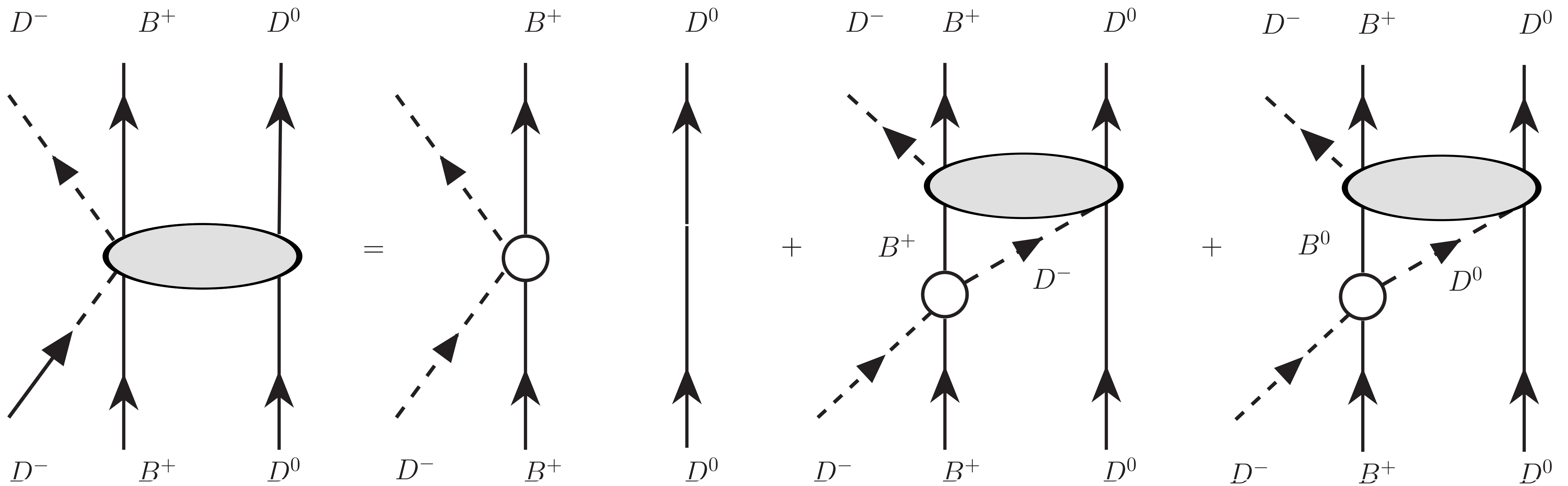
$t_{D\bar{D}}(s'')$

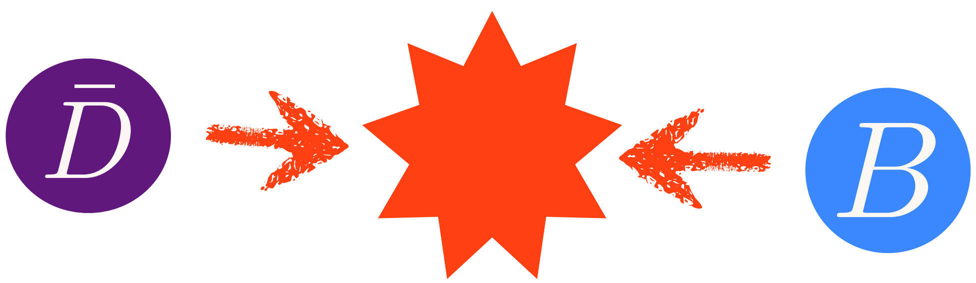
$$t = \frac{v}{1 - vG}$$

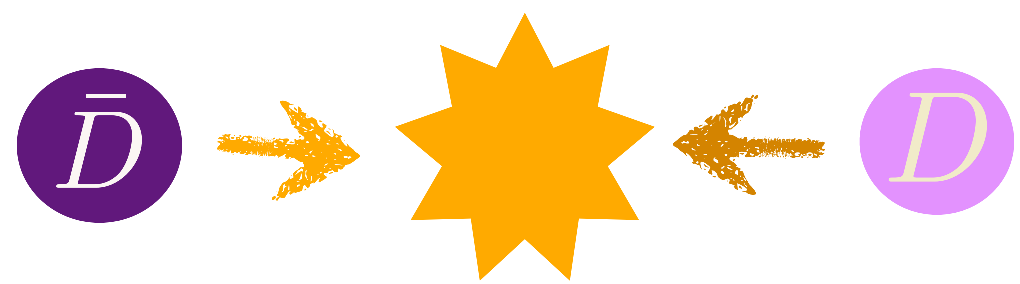
Loop function



Formalism: Fixed Center Approximation (FCA)



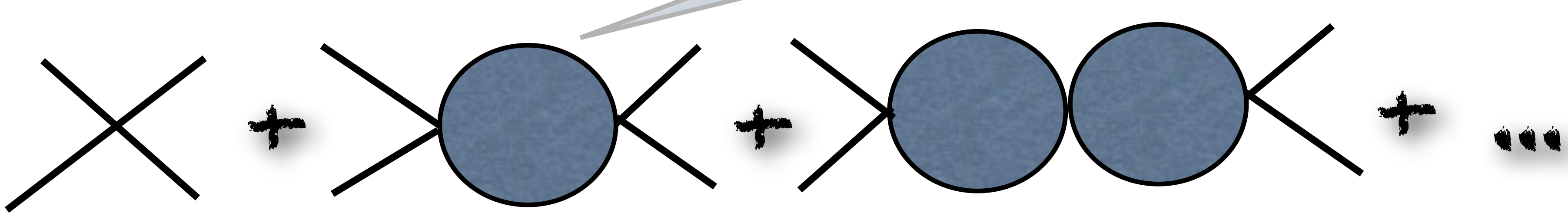




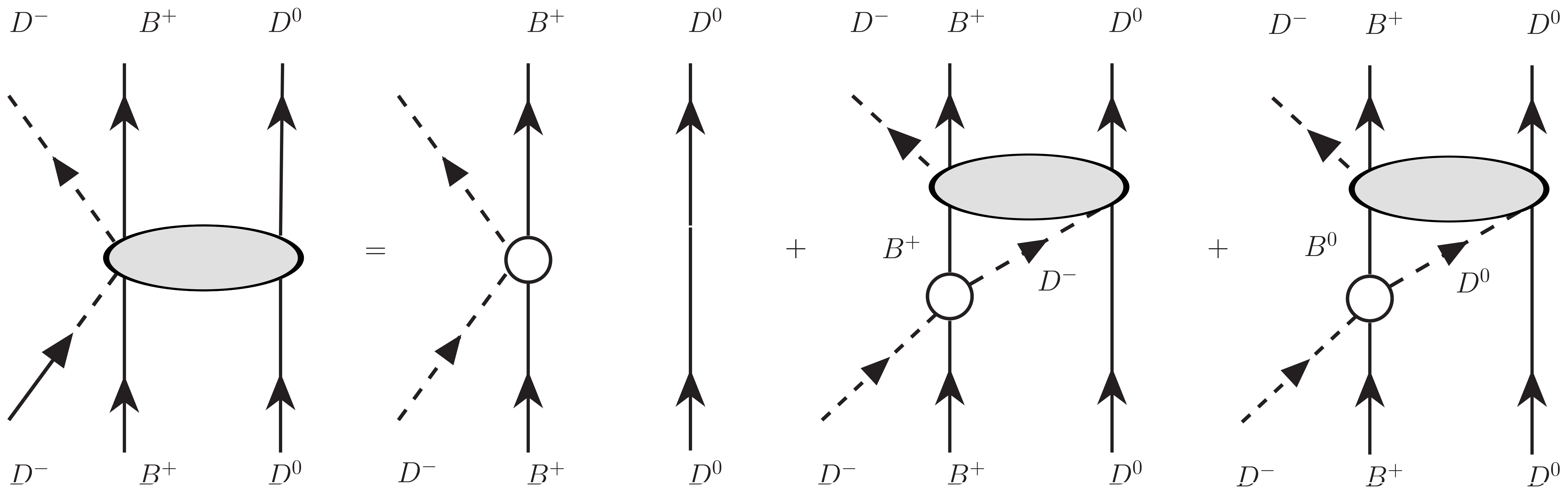
$t_{B\bar{D}}(s')$ $t_{D\bar{D}}(s'')$

$$t = \frac{v}{1 - vG}$$

Loop function



Formalism: Fixed Center Approximation (FCA)



$$T_{11}^{\mathrm{FCA}}(s) = t_1 + t_1 G_0 T_{41}^{\mathrm{FCA}} + t_2 G_0 T_{61}^{\mathrm{FCA}}$$

We have to take into account all channels

1) $D^-[B^+D^0]$	4) $[B^+D^0]D^-$
2) $D^-[B^0D^+]$	5) $[B^0D^+]D^-$
3) $\bar{D}^0[B^0D^0]$	6) $[B^0D^0]\bar{D}^0$

Formalism: Fixed Center Approximation (FCA)

$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

We have to take into account all channels

1) $D^-[B^+D^0]$ 4) $[B^+D^0]D^-$

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3) $\bar{D}^0[B^0D^0]$ 6) $[B^0D^0]\bar{D}^0$

Formalism: Fixed Center Approximation (FCA)

$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

which solution is given by

$$T_{ij}^{\mathrm{FCA}}(s) = \sum_{l=1}^{6} \left[1 - \tilde{V}^{\mathrm{FCA}}(s)\, G_0(s) \right]_{il}^{-1} V_{lj}^{\mathrm{FCA}}(s)\,,$$

We have to take into account all channels

$1)\ D^-[B^+D^0]$ $\quad 4)\ [B^+D^0]D^-$

$2)\ D^-[B^0D^+]$ $\quad 5)\ [B^0D^+]D^-$

$3)\ \bar{D}^0[B^0D^0]$ $\quad 6)\ [B^0D^0]\bar{D}^0$

Formalism: Fixed Center Approximation (FCA)

$$T_{ij}^{\rm FCA}(s) = V_{ij}^{\rm FCA}(s) + \sum_k \tilde{V}_{ik}^{\rm FCA}(s) G_0 T_{kj}^{\rm FCA}(s)$$

which solution is given by

$$T_{ij}^{\rm FCA}(s) = \sum_{l=1}^{6} \left[1 - \tilde{V}^{\rm FCA}(s)\, G_0(s) \right]^{-1}_{il} V_{lj}^{\rm FCA}(s)\,,$$

$$V^{\rm FCA} = \begin{pmatrix} t_1 & 0 & t_2 & 0 & 0 & 0 \\ 0 & t_3 & 0 & 0 & 0 & 0 \\ t_2 & 0 & t_4 & 0 & 0 & 0 \\ 0 & 0 & 0 & t_5 & 0 & 0 \\ 0 & 0 & 0 & 0 & t_6 & t_7 \\ 0 & 0 & 0 & 0 & t_7 & t_8 \end{pmatrix}, \qquad \tilde{V}^{\rm FCA} = \begin{pmatrix} 0 & 0 & 0 & t_1 & 0 & t_2 \\ 0 & 0 & 0 & 0 & t_3 & 0 \\ 0 & 0 & 0 & t_2 & 0 & t_4 \\ t_5 & 0 & 0 & 0 & 0 & 0 \\ 0 & t_6 & t_7 & 0 & 0 & 0 \\ 0 & t_7 & t_8 & 0 & 0 & 0 \end{pmatrix}.$$

We have to take into account all channels

1) $D^-[B^+D^0]$ 4) $[B^+D^0]D^-$

2) $D^-[B^0D^+]$ 5) $[B^0D^+]D^-$

3) $\bar{D}^0[B^0D^0]$ 6) $[B^0D^0]\bar{D}^0$

Results: uncertainties...

$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

Results: uncertainties...

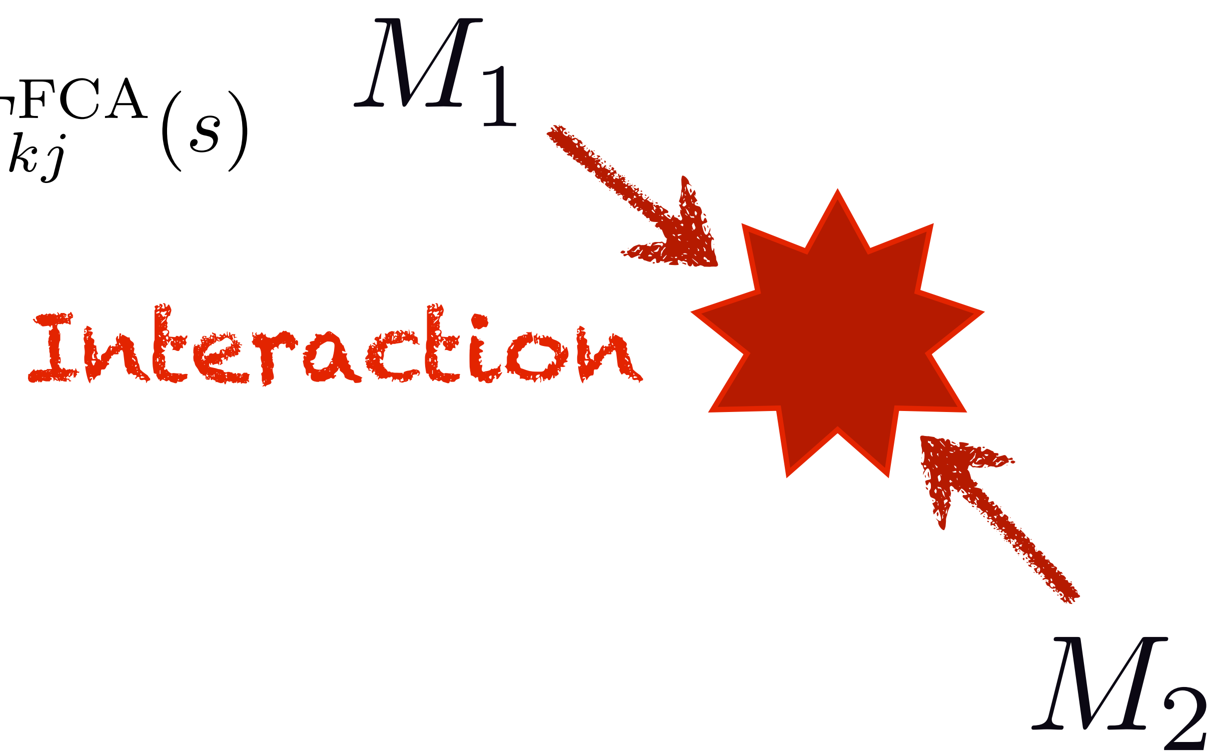
$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

$$t_{ij}(s)$$

Results: uncertainties...

$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

$t_{ij}(s)$



Results: uncertainties...

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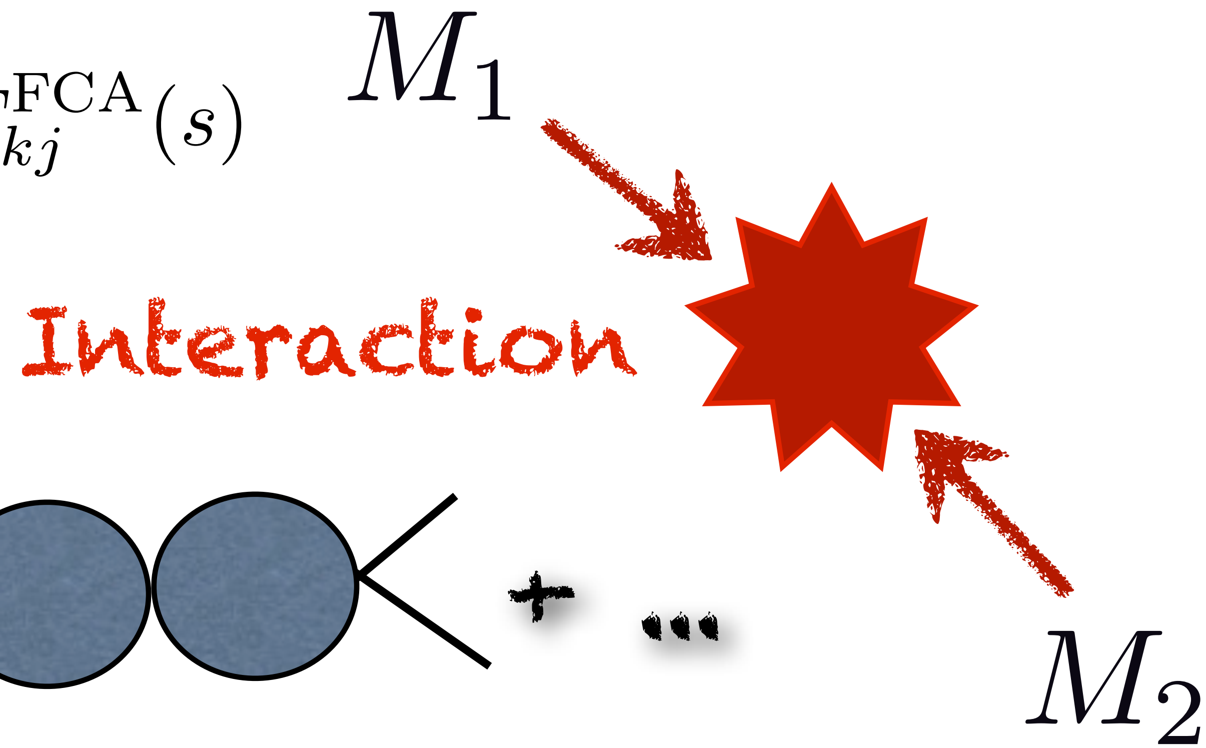
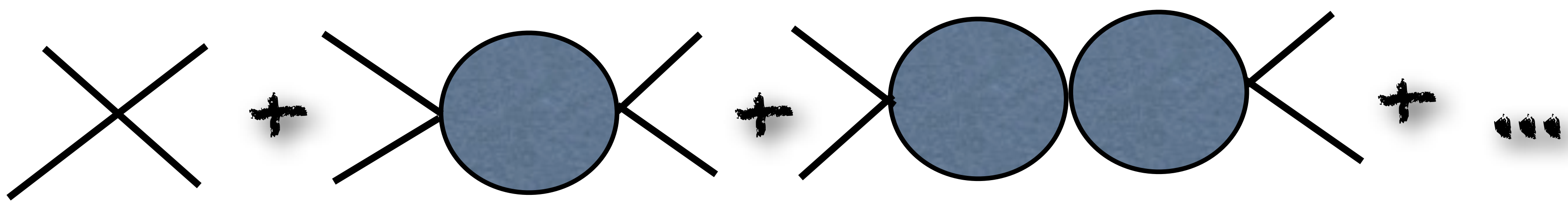
$t_{ij}(s)$





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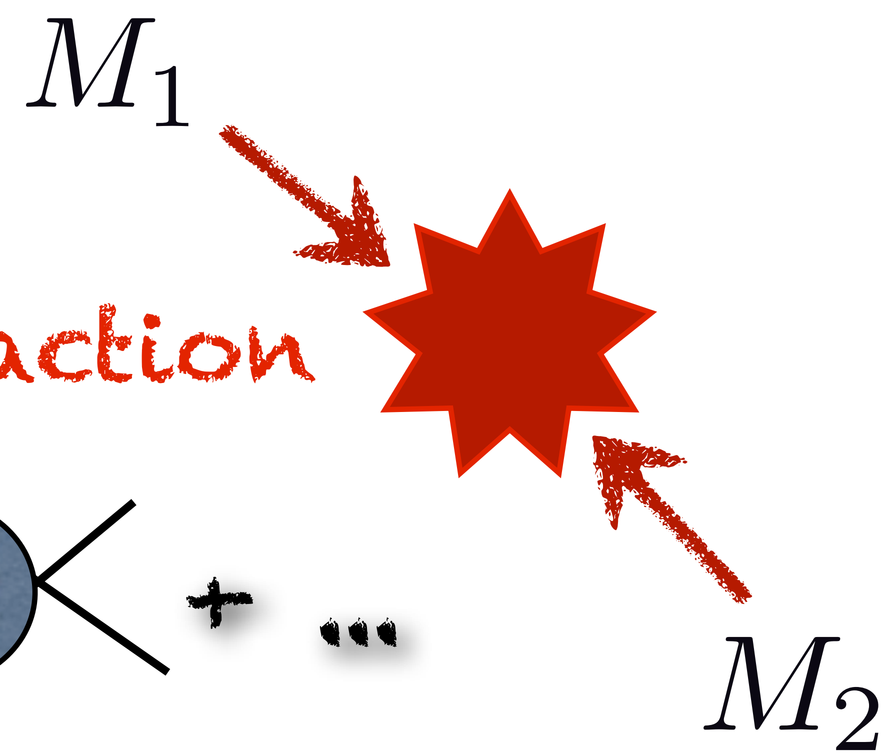
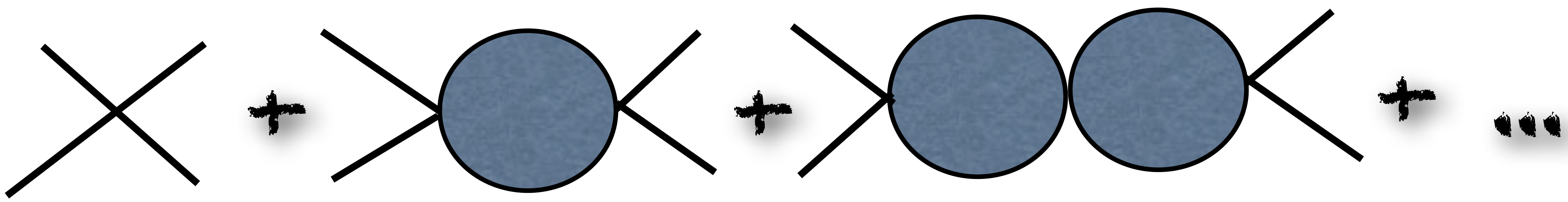


Interaction

$$t_{ij}(s)$$



$$t = \frac{v}{1 - vG}$$

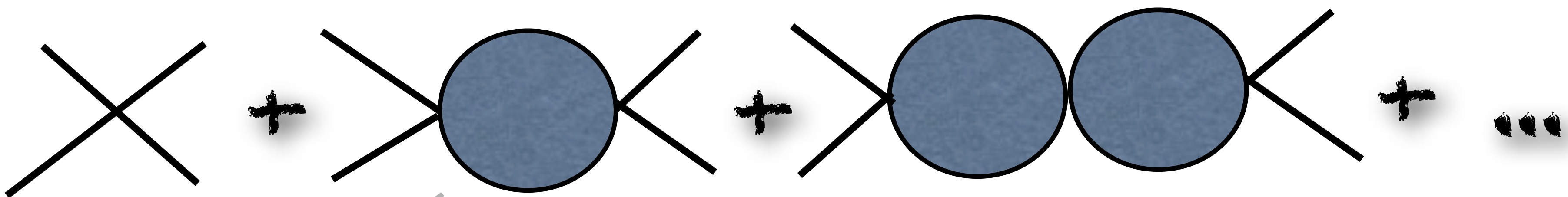
Results: uncertainties...

$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

M_1

$t_{ij}(s)$

Interaction



M_2

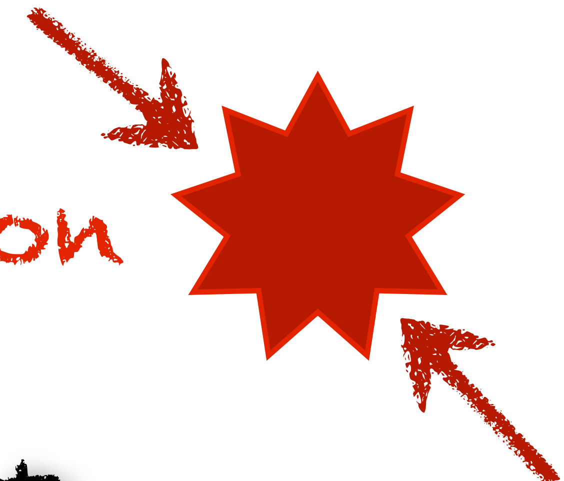
$$t = \frac{v}{1 - vG}$$

Loop function

Results: uncertainties...

$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

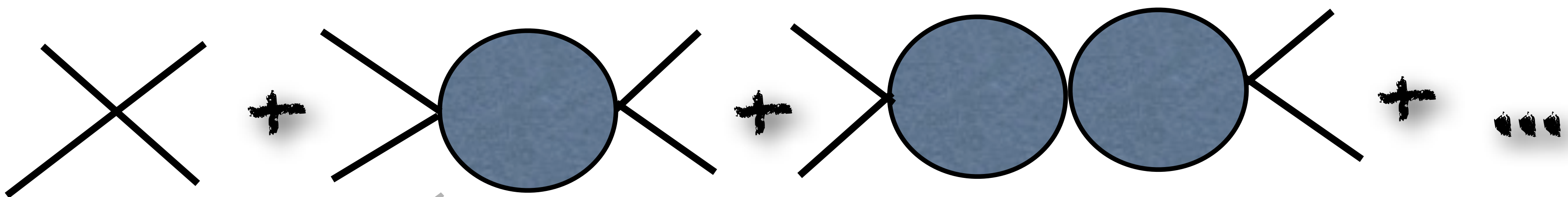
M_1



Interaction

M_2

$t_{ij}(s)$



$$t = \frac{v}{1 - vG}$$

Loop function

Regularized by a cut-off

$|\vec{q}_{max}| =$

Results: uncertainties...

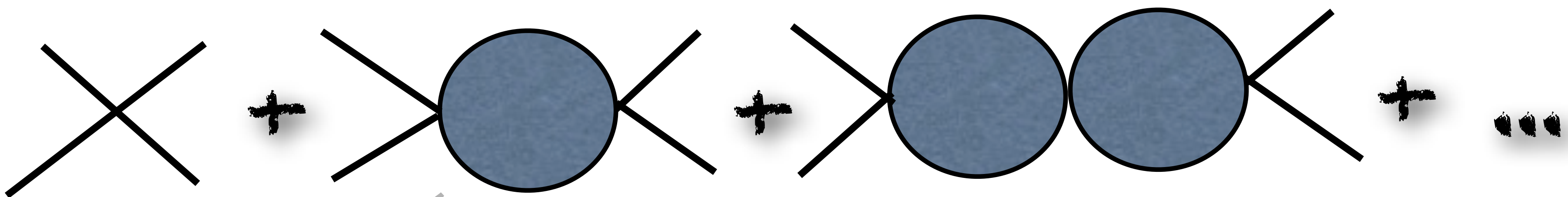
$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

M_1

Interaction

M_2

$t_{ij}(s)$



$$t = \frac{v}{1 - vG}$$

Loop function

Regularized by a cut-off

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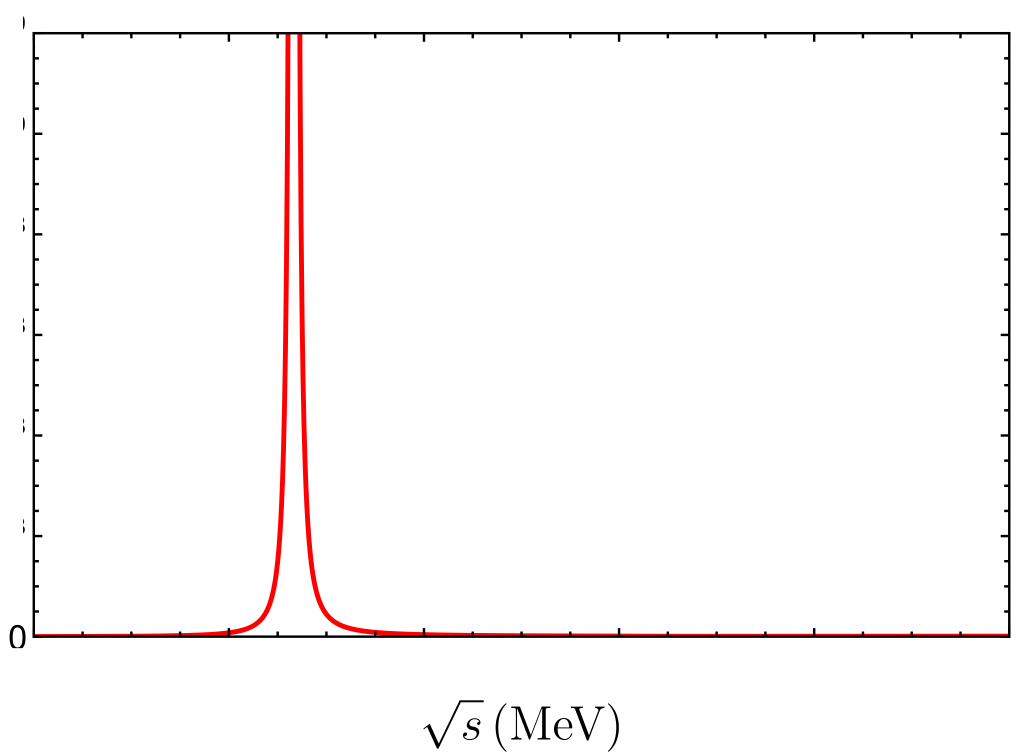


Results: uncertainties...

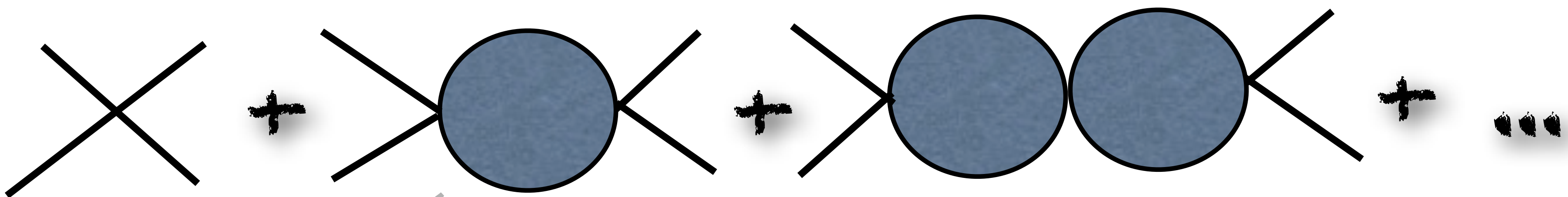
$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

M_1

Interaction

M_2

$$t_{ij}(s)$$

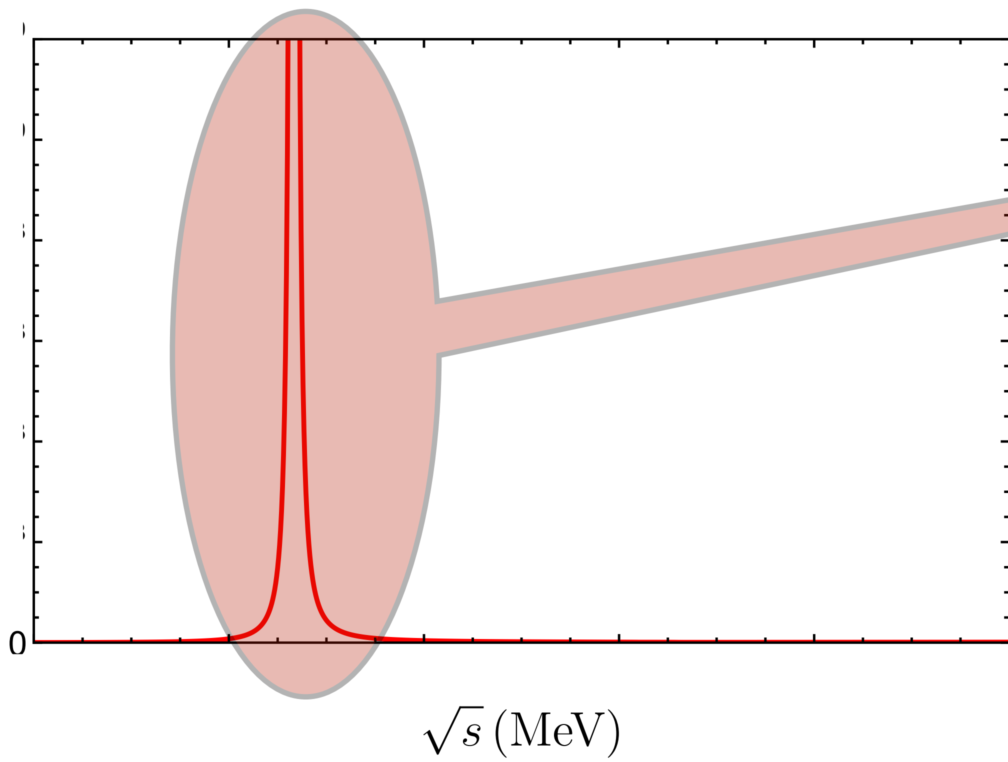


$$t = \frac{v}{1 - vG}$$

Loop function

Regularized by a cut-off

$$|\vec{q}_{max}| = 600\,\mathrm{MeV}$$



Results: uncertainties...

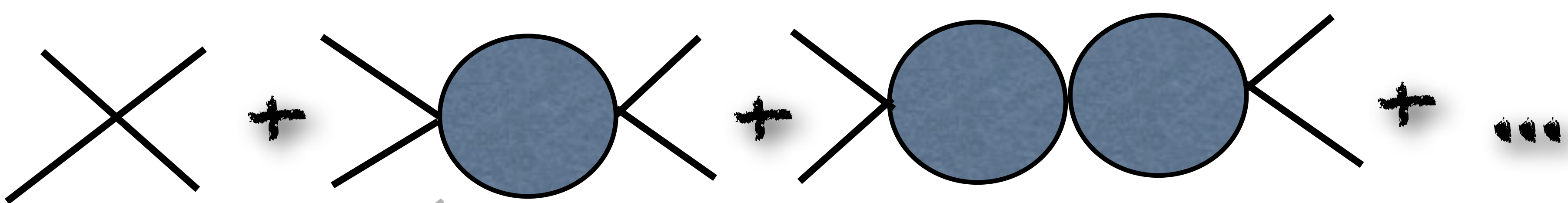
$$T_{ij}^{\rm FCA}(s) = V_{ij}^{\rm FCA}(s) + \sum_k \tilde{V}_{ik}^{\rm FCA}(s) G_0 T_{kj}^{\rm FCA}(s)$$

M_1

Interaction

M_2

$t_{ij}(s)$



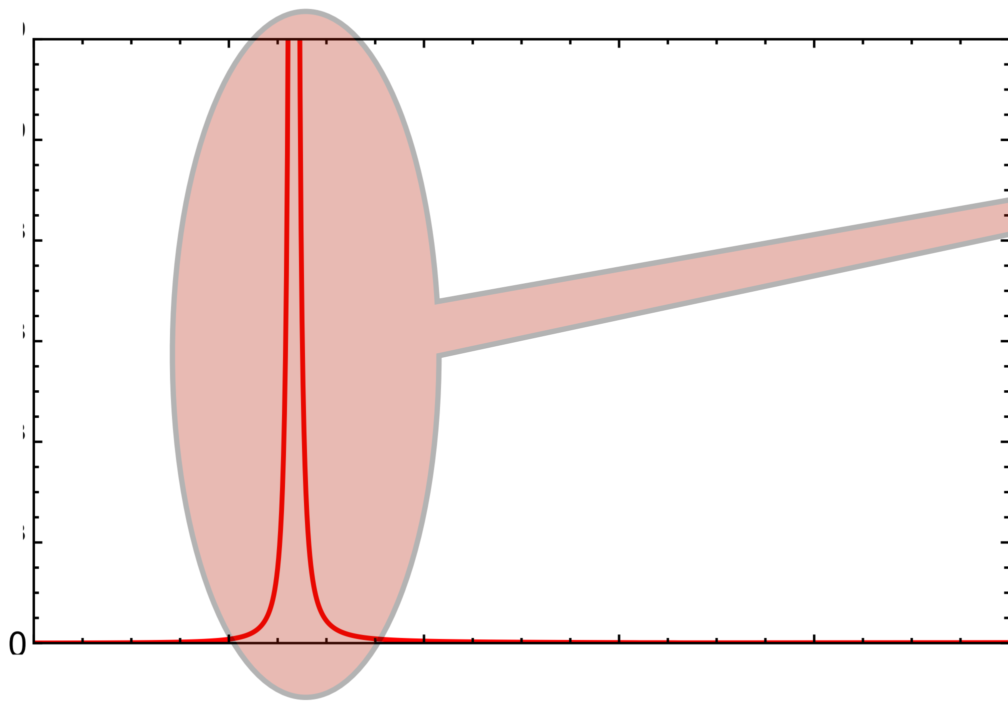
$$t = \frac{v}{1 - vG}$$

Loop function

Regularized by a cut-off

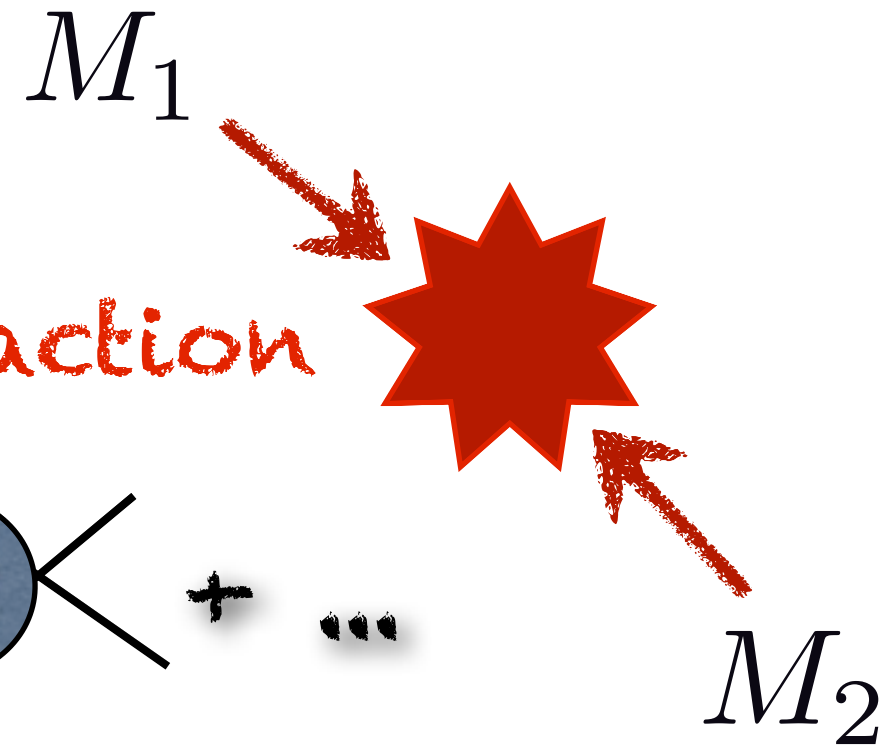
$|\vec{q}_{max}| =$ 600 MeV

arXiv:1704.02196



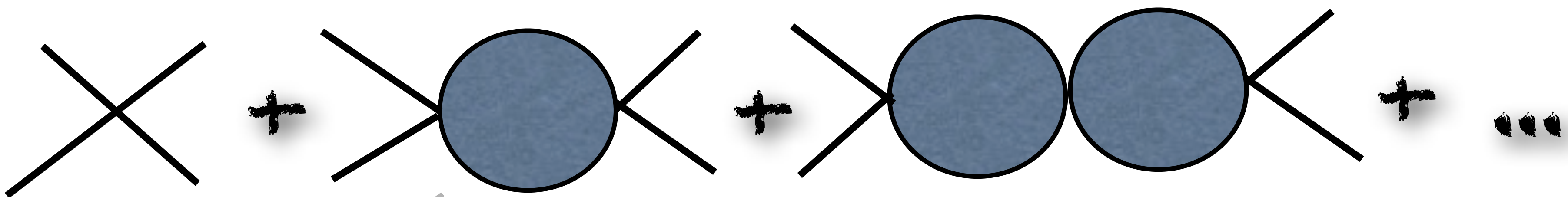
Results: uncertainties...

$$T_{ij}^{\rm FCA}(s) = V_{ij}^{\rm FCA}(s) + \sum_k \tilde{V}_{ik}^{\rm FCA}(s) G_0 T_{kj}^{\rm FCA}(s)$$



Interaction

$t_{ij}(s)$

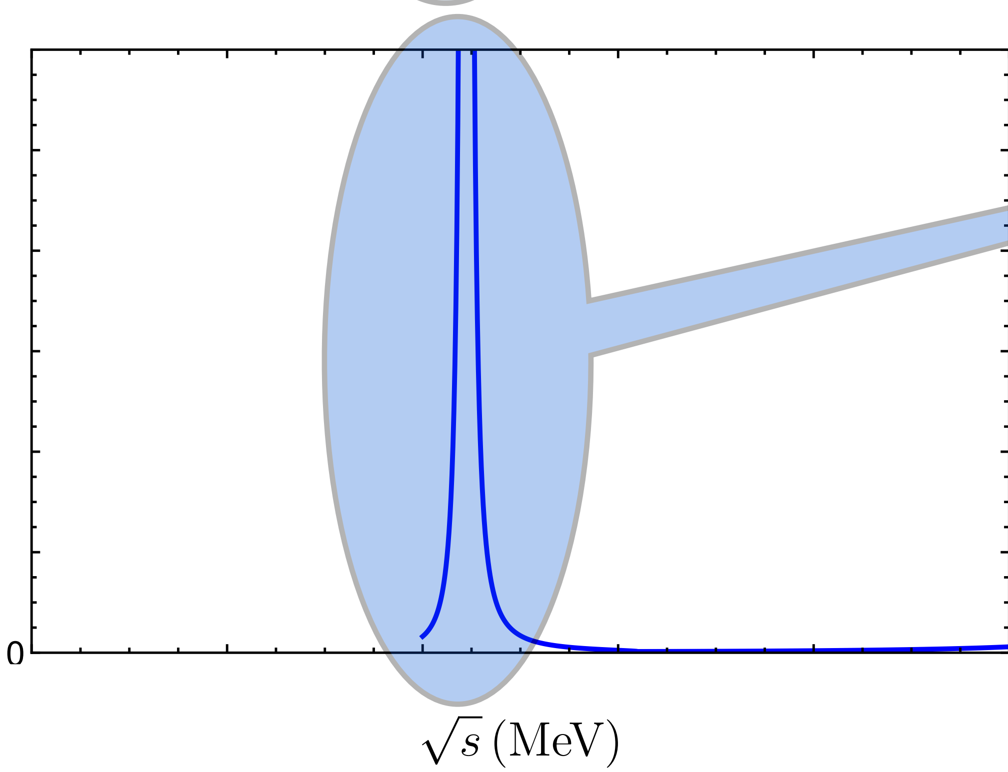


$$t = \frac{v}{1 - vG}$$

Loop function

Regularized by a cut-off

$|\vec{q}_{max}| = 400 - 600\,\mathrm{MeV}$



arXiv:1704.02196

Therefore. . .

Results: uncertainties...

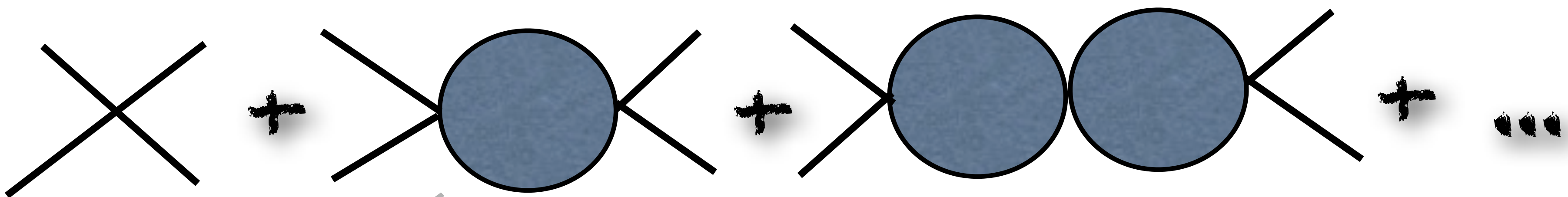
$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

M_1

Interaction

M_2

$t_{ij}(s)$

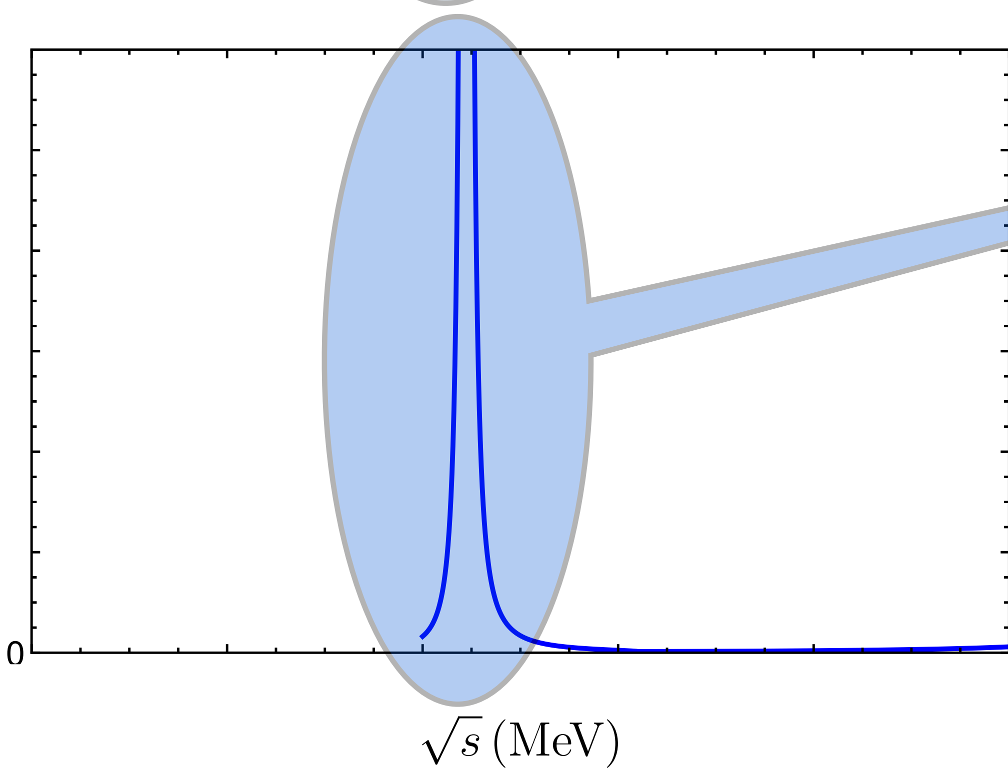


$$t = \frac{v}{1 - vG}$$

Loop function

Regularized by a cut-off

$$|\vec{q}_{max}| = 400 - 600\,\mathrm{MeV}$$



arXiv:1704.02196

Therefore. . .

source of uncertainty

Results: uncertainties...

$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

$t_{ij}(s)$

M_1

Interaction

$t_{ij}(s')$ two-body center of mass

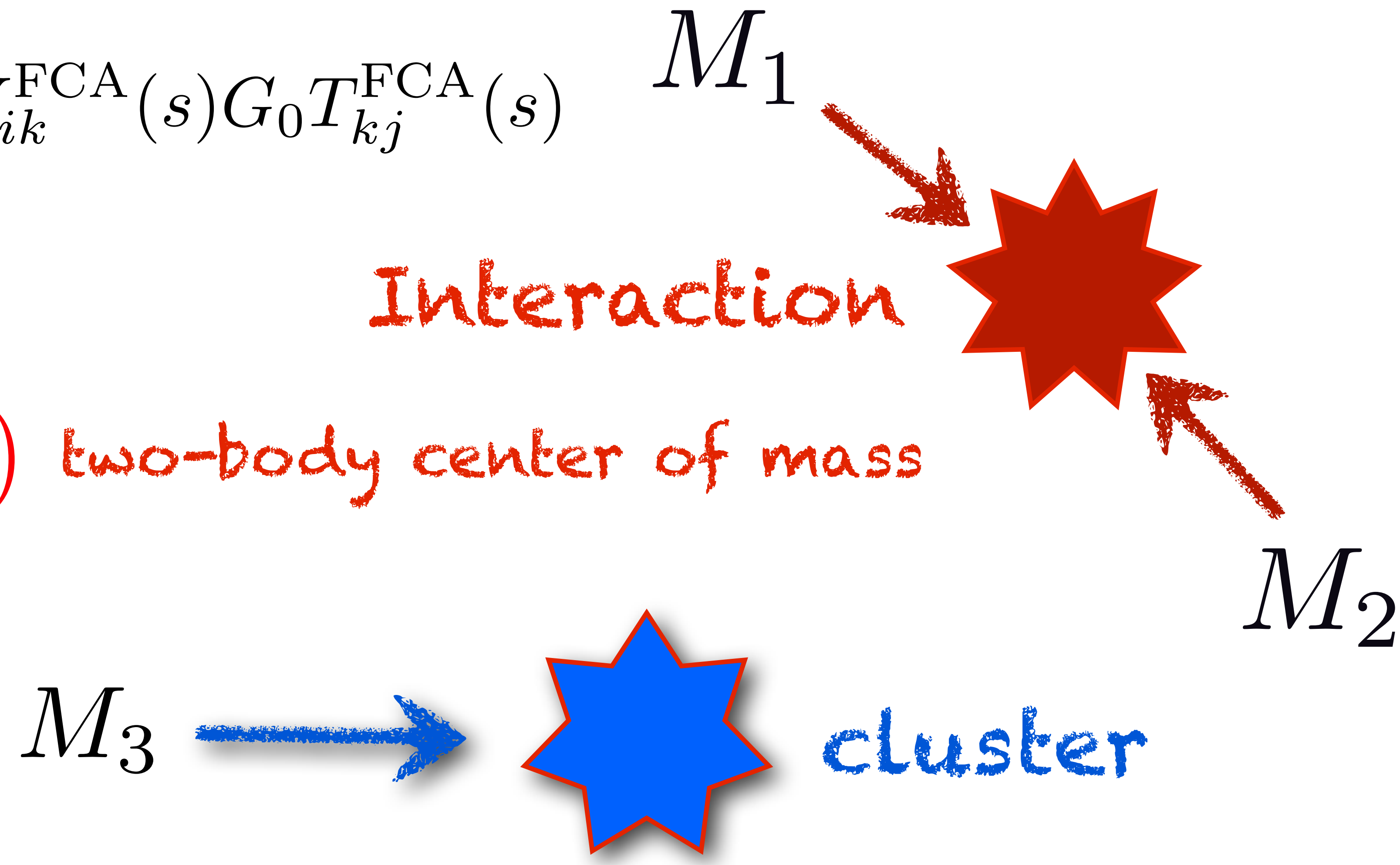
M_2

Results: uncertainties...

$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

$t_{ij}(s)$

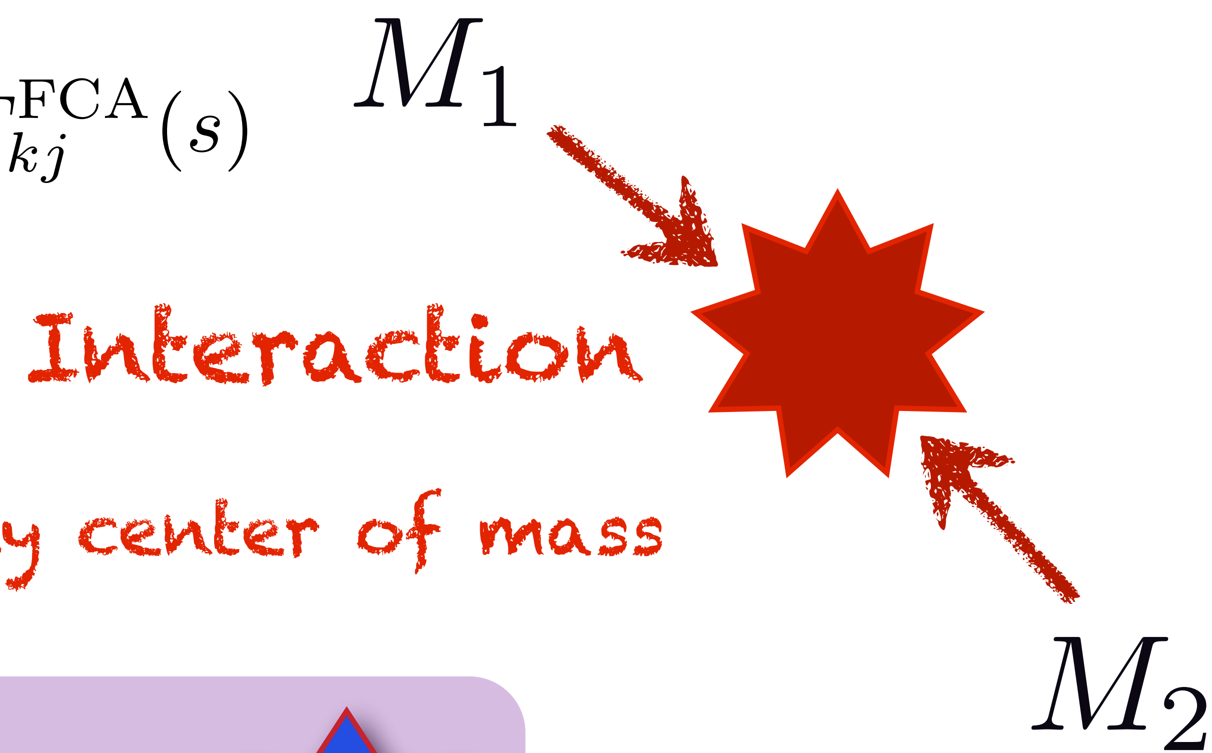
$t_{ij}(s')$ two-body center of mass



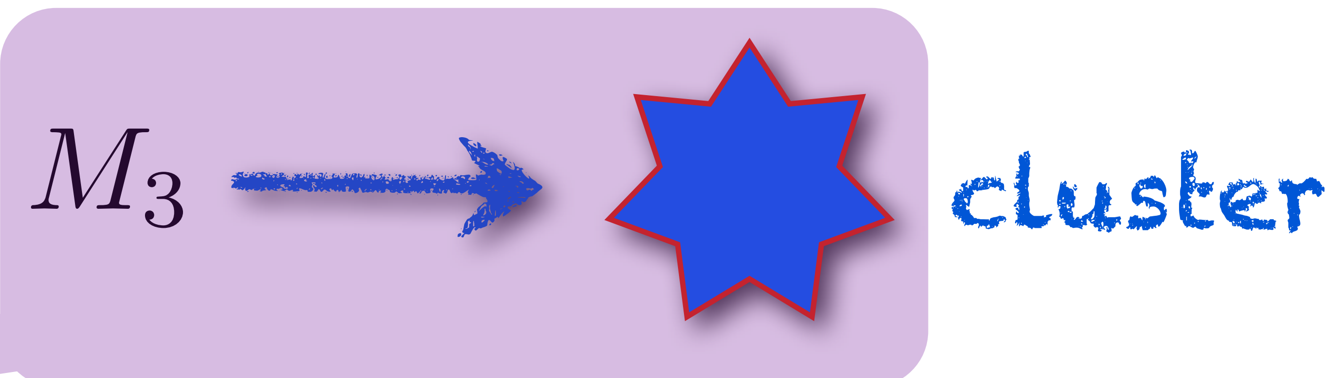
Results: uncertainties...

$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

$t_{ij}(s)$



$t_{ij}(s')$ two-body center of mass



three-body center of mass!

Results: uncertainties...

$$T_{ij}^{\text{FCA}}(s) = V_{ij}^{\text{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\text{FCA}}(s) G_0 T_{kj}^{\text{FCA}}(s)$$

M_1

Interaction

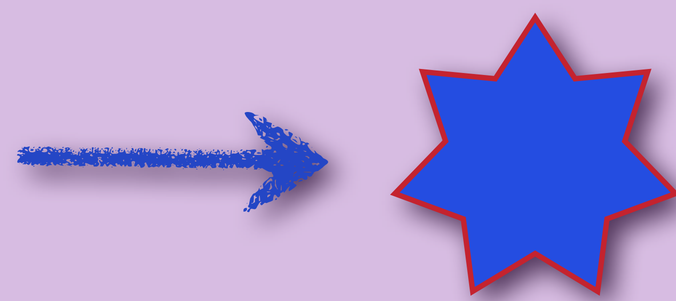
$t_{ij}(s)$

$t_{ij}(s')$ two-body center of mass

M_2

$$\boxed{s \neq s'}$$

M_3



cluster

three-body center of mass!

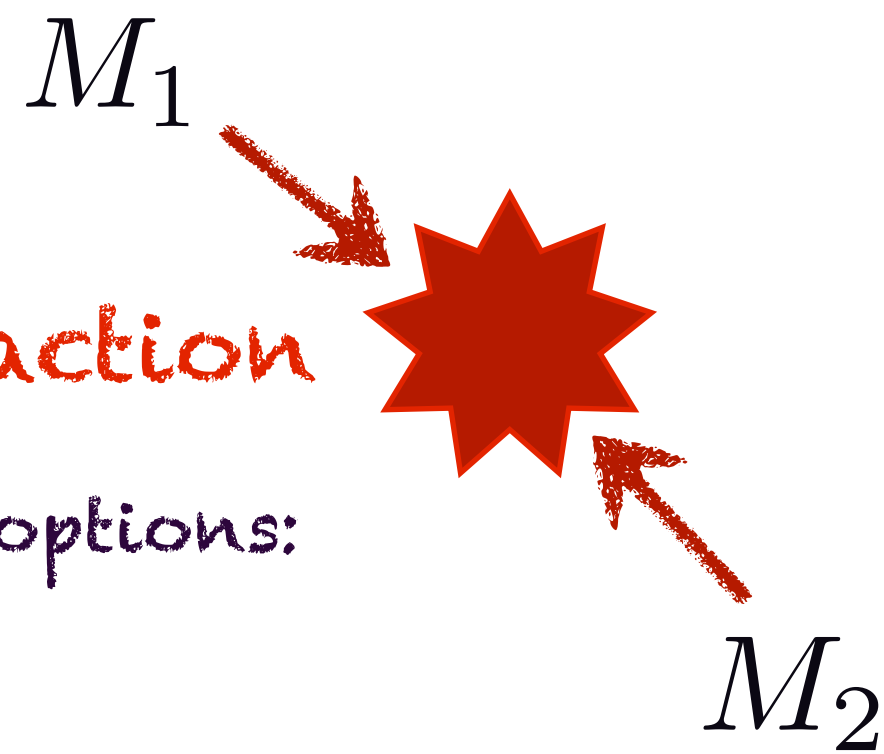
So, we need to write s' in terms of s!

Results: uncertainties...

$$T_{ij}^{\text{FCA}}(s) = V_{ij}^{\text{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\text{FCA}}(s) G_0 T_{kj}^{\text{FCA}}(s)$$

$t_{ij}(s)$

Interaction



We have two options:

$$\boxed{s \neq s'}$$

1 -

Results: uncertainties...

$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

$t_{ij}(s)$

We have two options:

$$\boxed{s \neq s'}$$

1 -

Phys. Rev. 82, 094017 (2010) , Phys. Rev. 82, 094017 (2010).

$$s_{H_3H_1(2)} = m_{H_3}^2 + m_{H_1(2)}^2 + \frac{1}{2M_c^2}(s - m_{H_1(2)}^2 - M_c^2)(M_c^2 + m_{H_1(2)}^2 - m_{H_3}^2)$$

Results: uncertainties...

$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

M_1

$t_{ij}(s)$

Interaction

We have two options:

$$\boxed{s \neq s'}$$

M_2

Prescription I

Phys. Rev. 82, 094017 (2010) , Phys. Rev. 82, 094017 (2010).

$$s_{H_3 H_1(2)} = m_{H_3}^2 + m_{H_1(2)}^2 + \frac{1}{2M_c^2}(s - m_{H_1(2)}^2 - M_c^2)(M_c^2 + m_{H_1(2)}^2 - m_{H_3}^2)$$

Results: uncertainties...

$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

M_1

$t_{ij}(s)$

Interaction

We have two options:

$$\boxed{s \neq s'}$$

M_2

Prescription I

Phys. Rev. 82, 094017 (2010) , Phys. Rev. 82, 094017 (2010).

$$s_{H_3 H_1(2)} = m_{H_3}^2 + m_{H_1(2)}^2 + \frac{1}{2M_c^2}(s - m_{H_1(2)}^2 - M_c^2)(M_c^2 + m_{H_1(2)}^2 - m_{H_3}^2)$$

2 -

$$s_{H_3 H_1(2)} = \left(\frac{\sqrt{s}}{M_c^2 + m_{H_3}^2}\right)^2 \left(m_{H_3} + \frac{m_{H_{1(2)}} M_c}{m_{H_{1(2)}} + m_{H_3}}\right)^2 - |\vec{P}_2|^2$$

Results: uncertainties...

$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

$$t_{ij}(s)$$

M_1

Interaction

M_2

We have two options:

$$\boxed{s \neq s'}$$

Prescription I

Phys. Rev. 82, 094017 (2010) , Phys. Rev. 82, 094017 (2010).

$$s_{H_3 H_1(2)} = m_{H_3}^2 + m_{H_1(2)}^2 + \frac{1}{2M_c^2}(s - m_{H_1(2)}^2 - M_c^2)(M_c^2 + m_{H_1(2)}^2 - m_{H_3}^2)$$

2 -

$$|\vec{P}_2|^2 \approx 2\mu B$$

$$s_{H_3 H_1(2)} = \left(\frac{\sqrt{s}}{M_c^2 + m_{H_3}^2}\right)^2 \left(m_{H_3} + \frac{m_{H_1(2)} M_c}{m_{H_1(2)} + m_{H_3}}\right)^2 - |\vec{P}_2|^2$$

Results: uncertainties...

$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

M_1

$t_{ij}(s)$

Interaction

We have two options:

M_2

$$\boxed{s \neq s'}$$

Prescription I

Phys. Rev. 82, 094017 (2010) , Phys. Rev. 82, 094017 (2010).

$$s_{H_3 H_1(2)} = m_{H_3}^2 + m_{H_1(2)}^2 + \frac{1}{2M_c^2}(s - m_{H_1(2)}^2 - M_c^2)(M_c^2 + m_{H_1(2)}^2 - m_{H_3}^2)$$

2 - Taking into account the binding...

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2 - Taking into account the binding...

It shares the cluster binding energy

Phys. Rev. 96, 016014 (2017)

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Results: uncertainties...

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Prescription II

It shares the cluster binding energy

Phys. Rev. 96, 016014 (2017)

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Results: BDDbar system...

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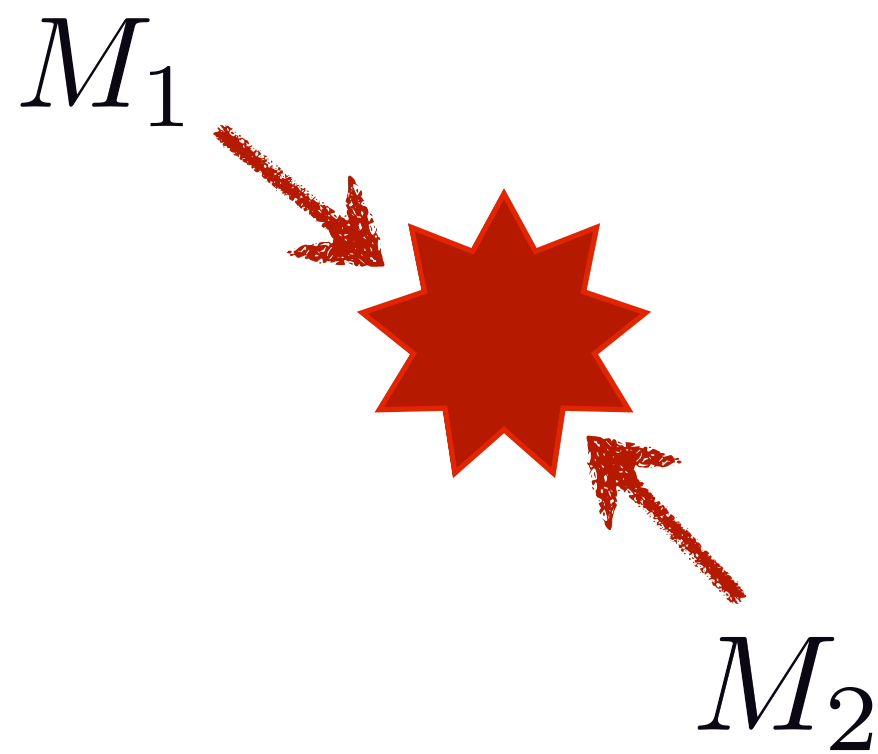

Solution...

Results: BDDbar system...

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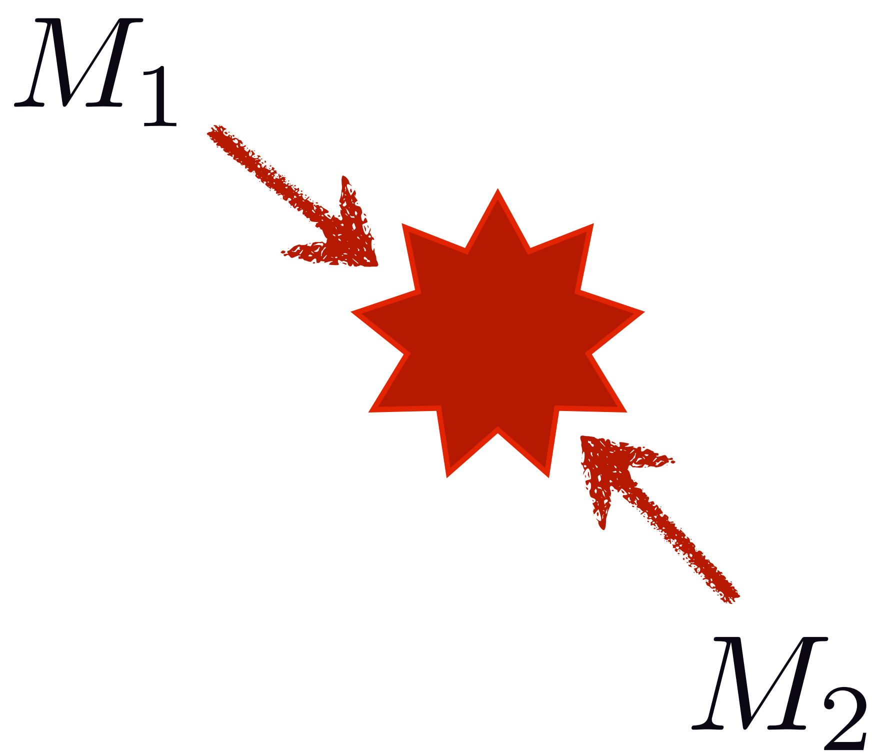
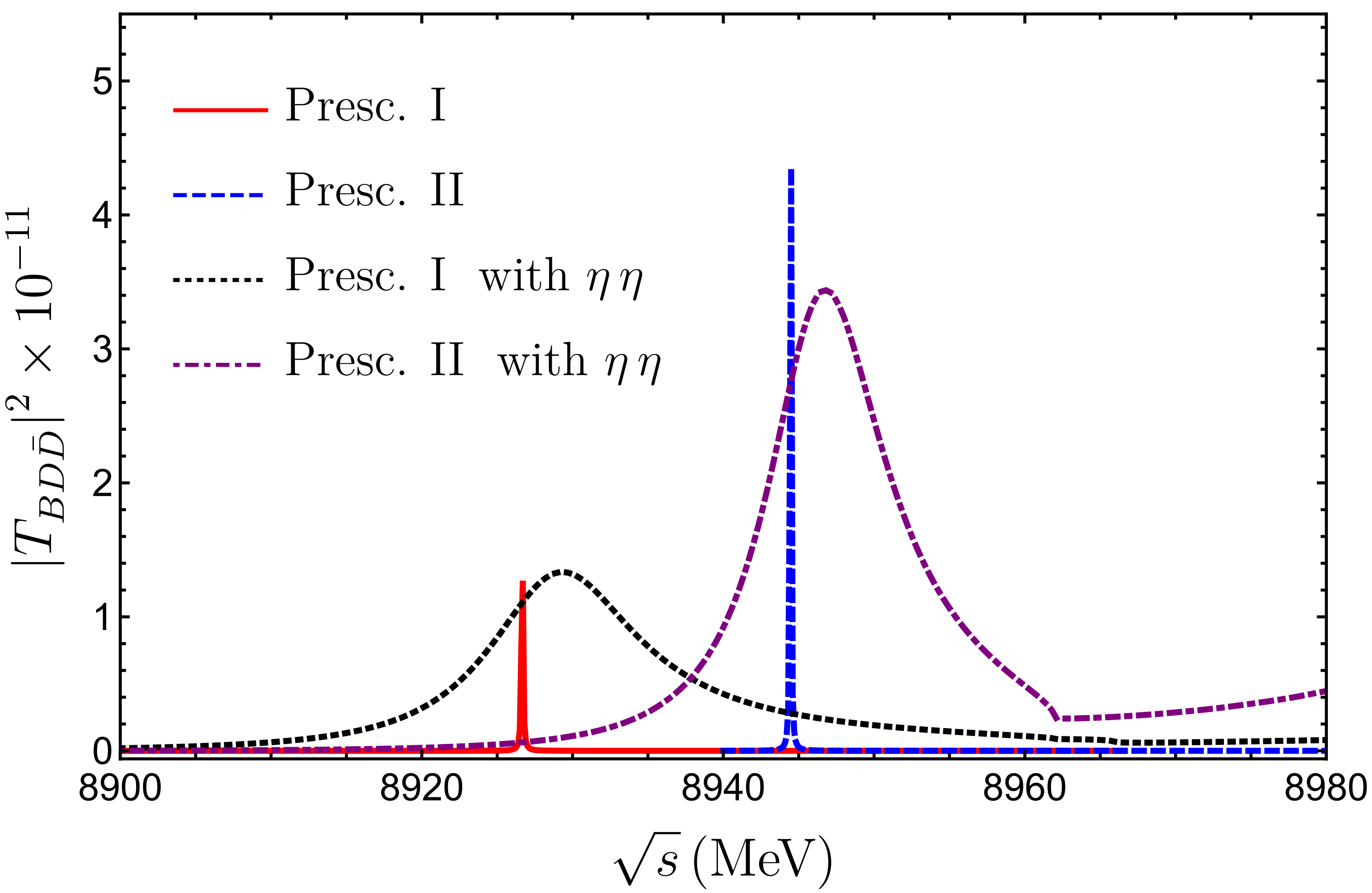


Solution...



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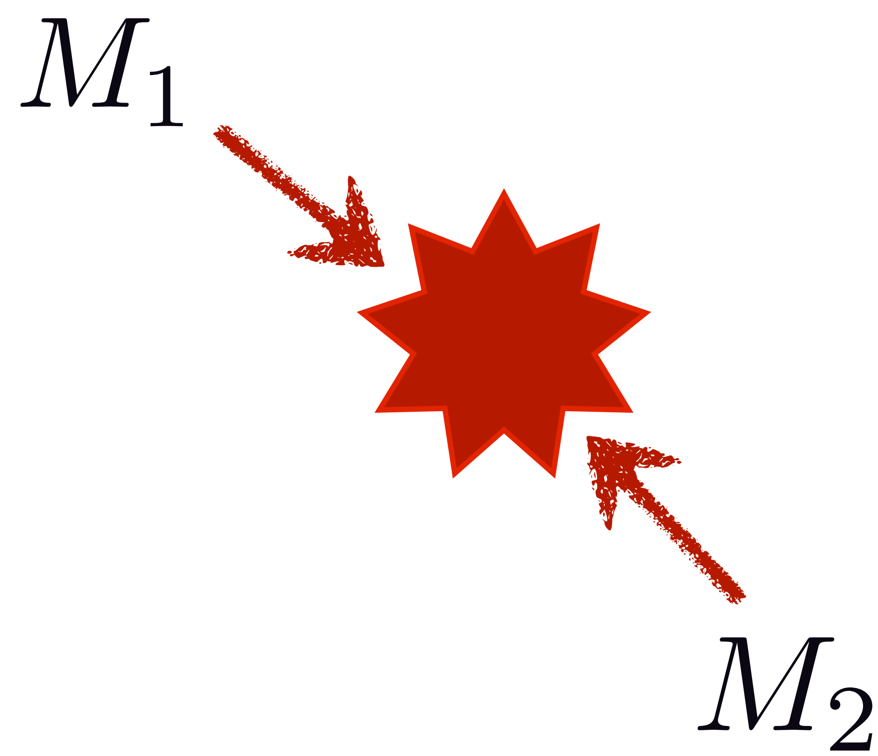
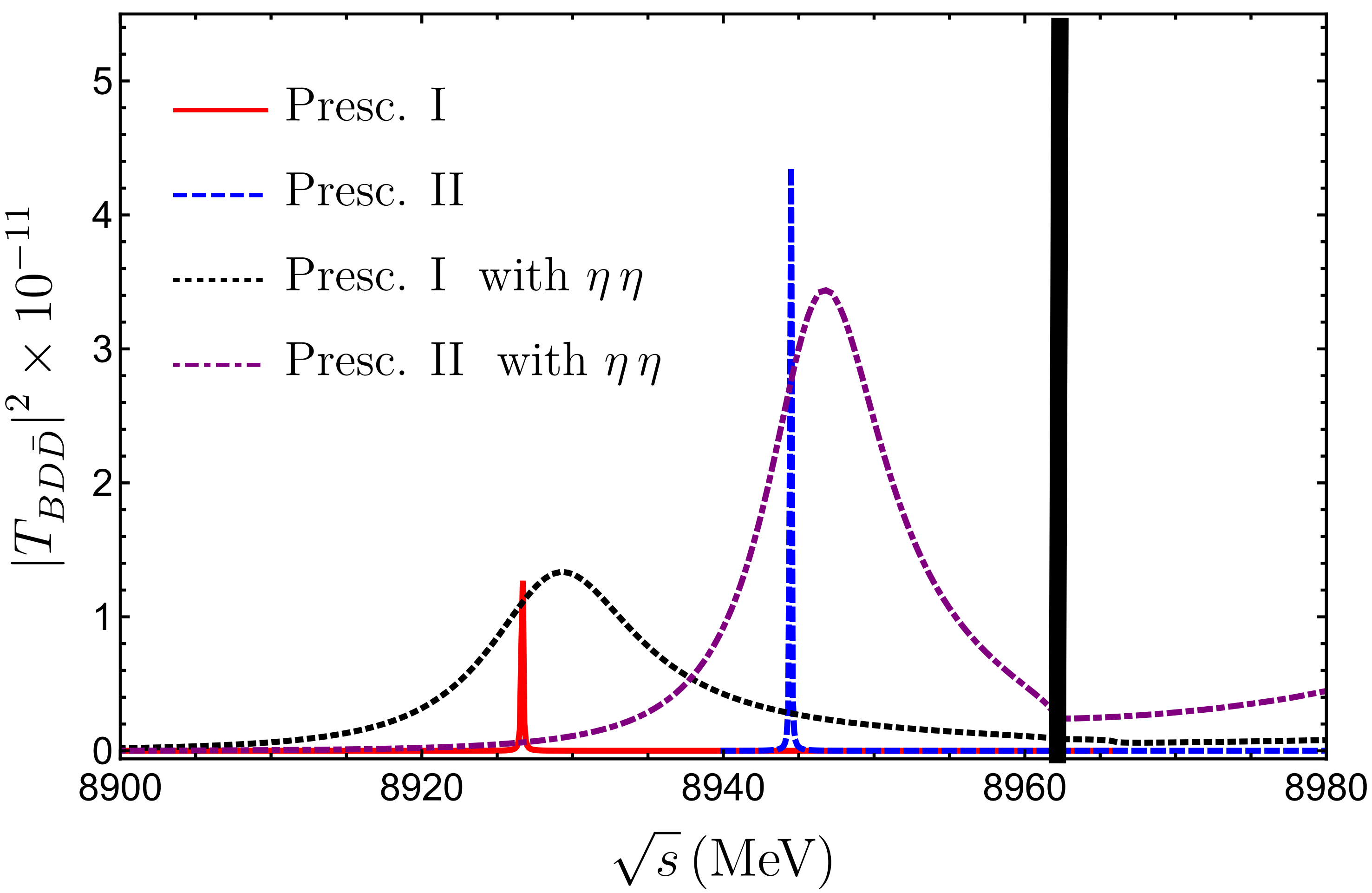


Solution...



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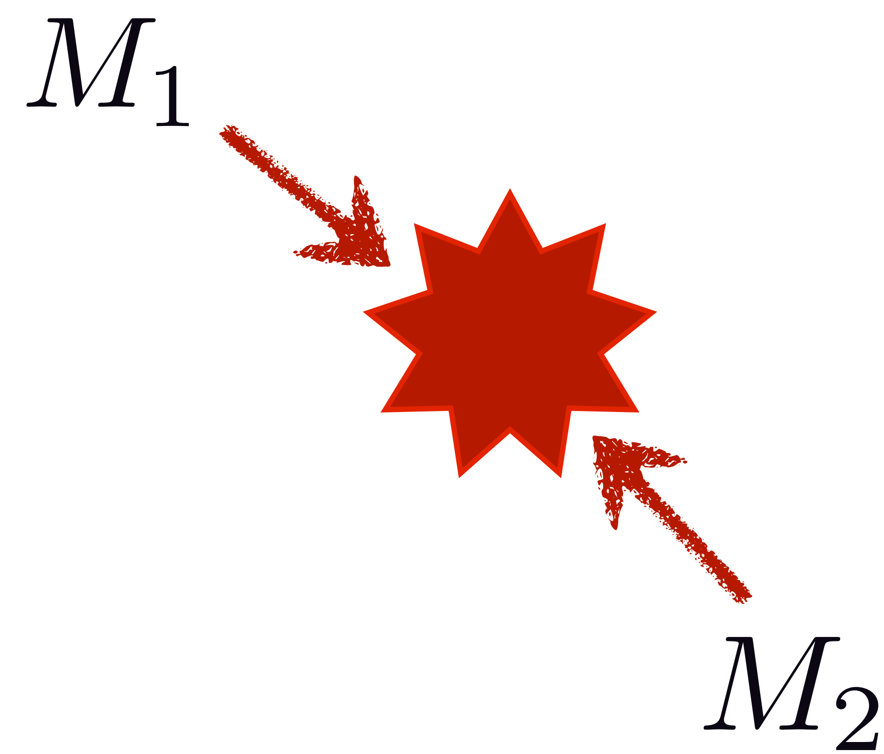
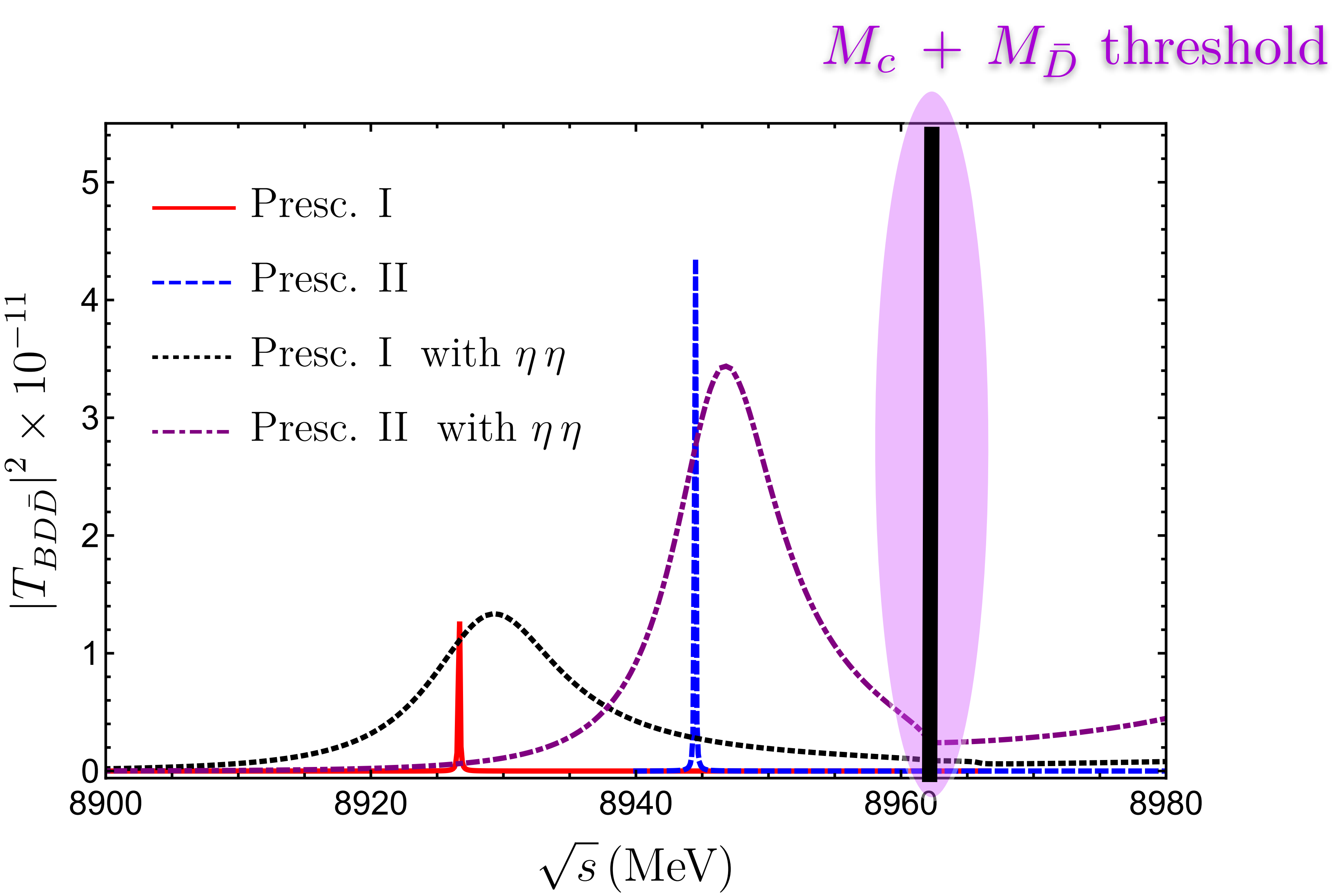


Solution...



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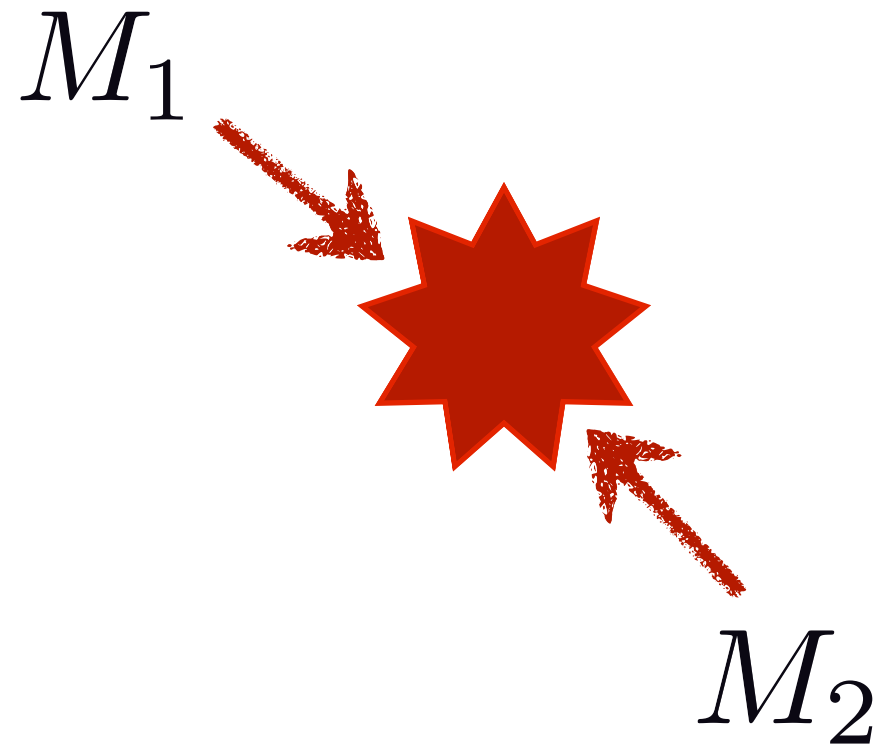
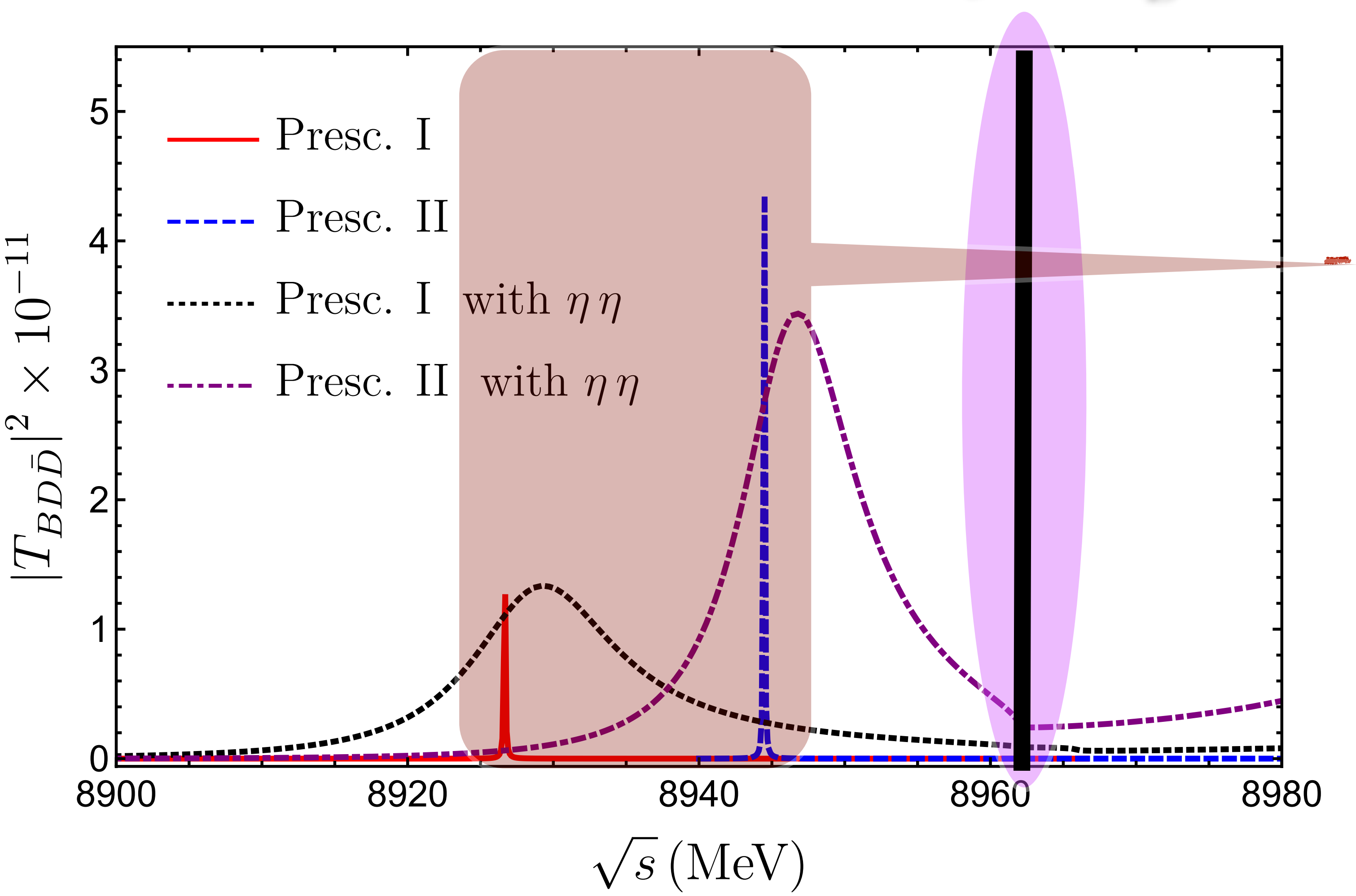


Solution...

$M_c + M_{\bar{D}}$ threshold



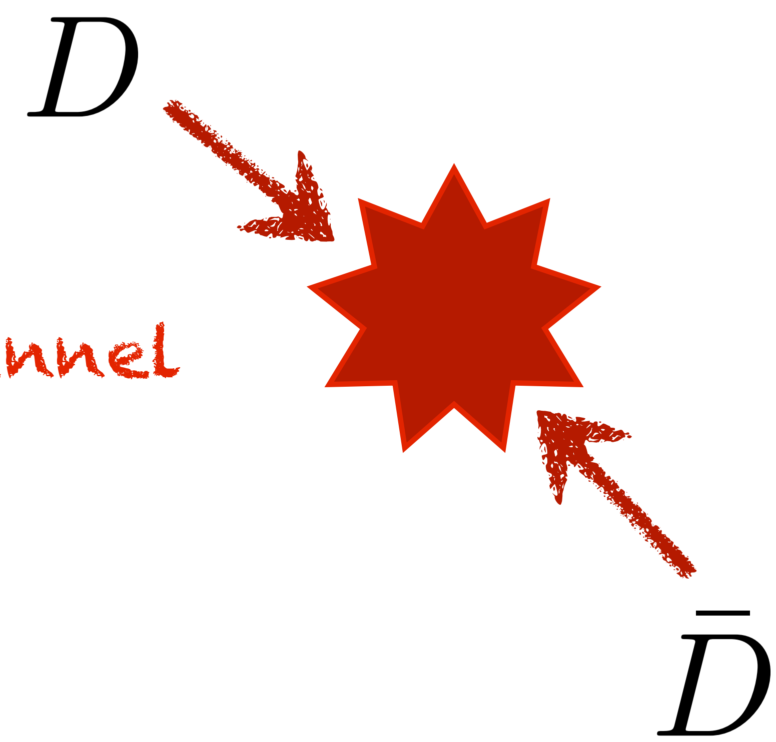
- Both solutions are below threshold

$\approx$ 8944 MeV

$\approx$ 8926 MeV

Results: BDDbar system...

$$T_{ij}^{\mathrm{FCA}}(s) = V_{ij}^{\mathrm{FCA}}(s) + \sum_k \tilde{V}_{ik}^{\mathrm{FCA}}(s) G_0 T_{kj}^{\mathrm{FCA}}(s)$$

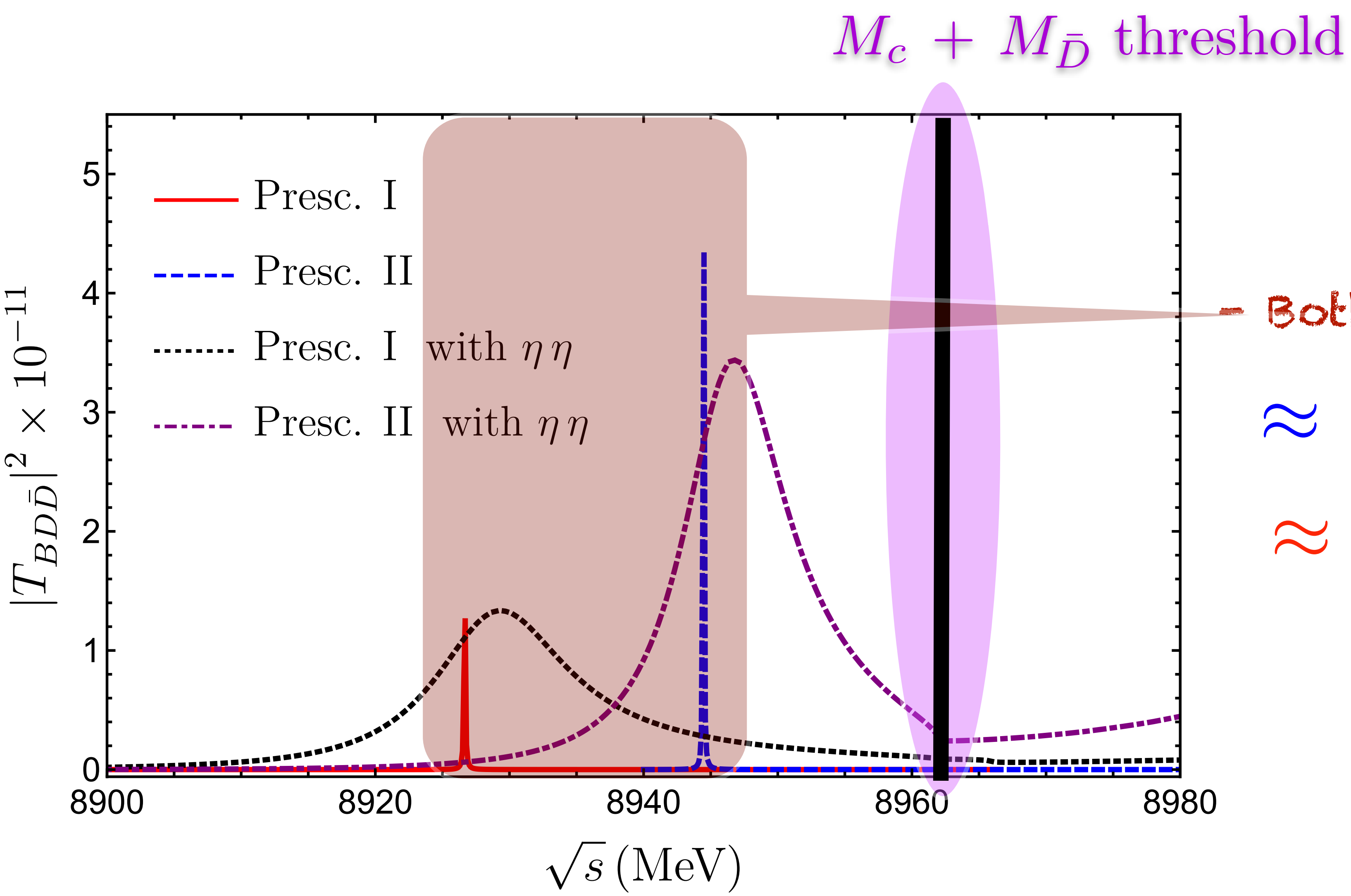


$$t_{ij}(s) = t_{D\bar{D}}(s)$$

Including the $\eta\,\eta$ channel

Phys. Rev. 76, 074016 (2007)

Solution...



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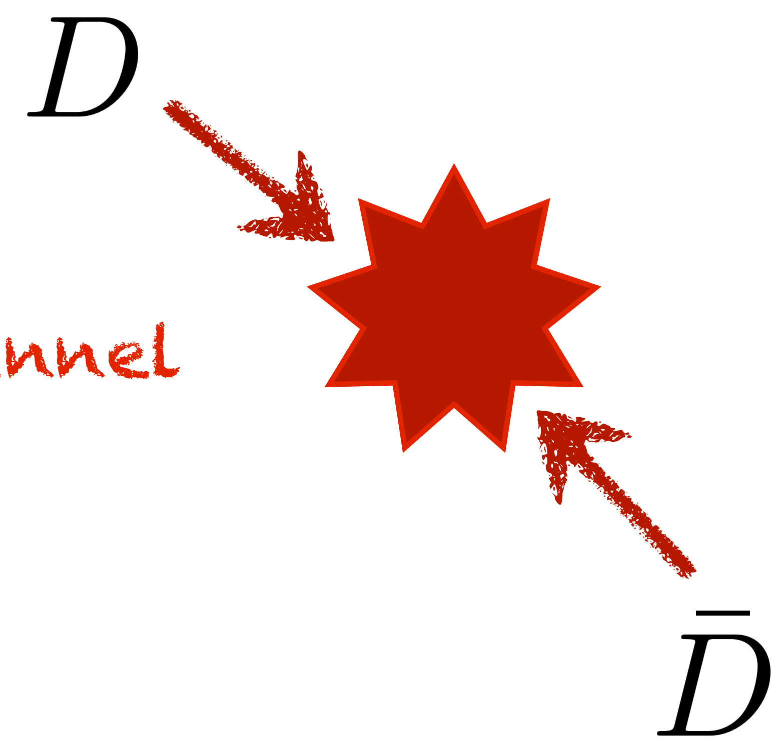


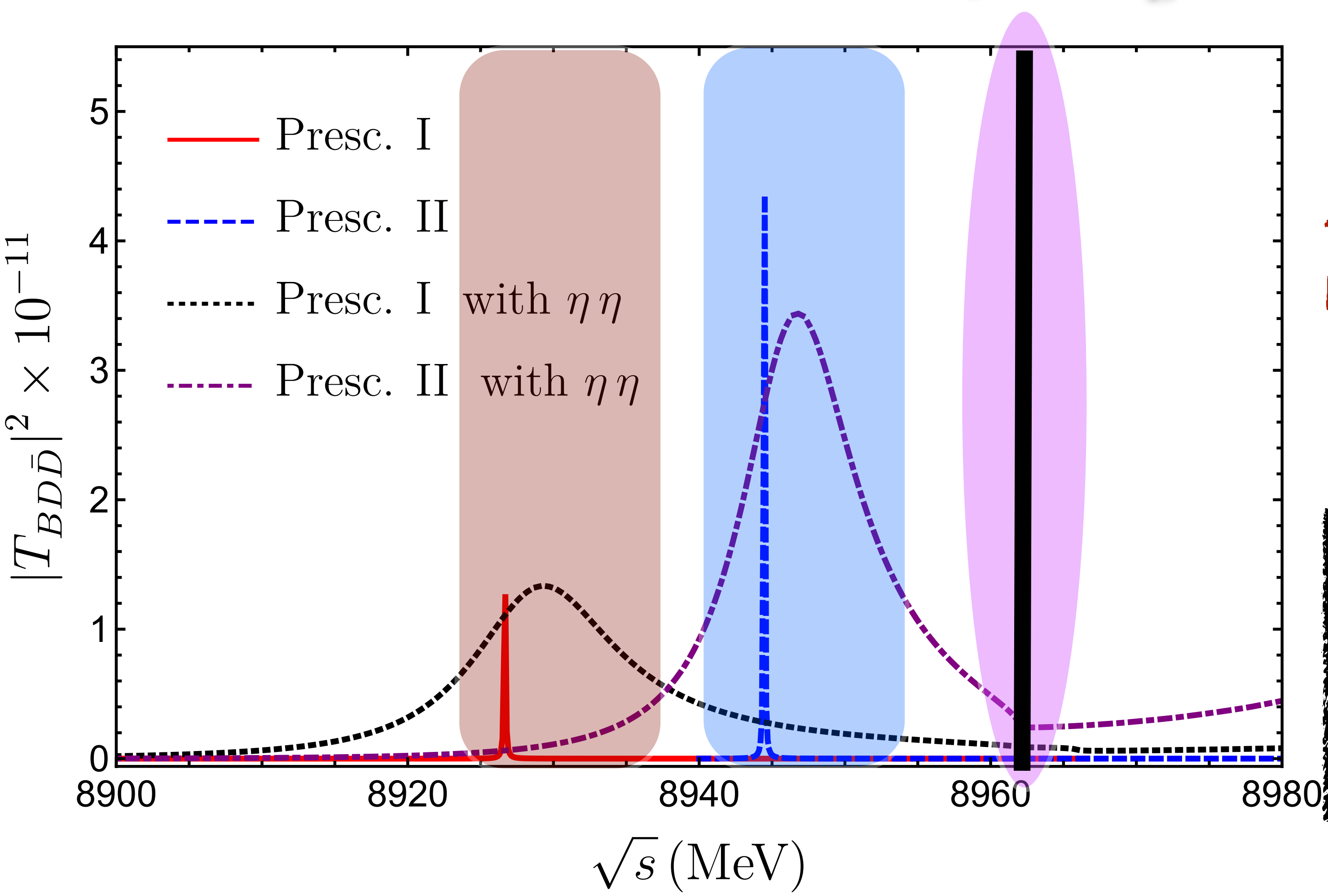
$$t_{ij}(s) = t_{D\bar{D}}(s)$$

Including the $\eta\,\eta$ channel

Phys. Rev. 76, 074016 (2007)

Solution...

$M_c + M_{\bar{D}}$ threshold



- Both solutions still are below threshold

$$\Gamma \approx 10\,\mathrm{MeV}$$

Taking into account our uncertainties

$$8925 \; - \; 8985\,\mathrm{MeV}$$

Results: BDDbar system...

What is the origin of these binding?

Tracking down the binding...

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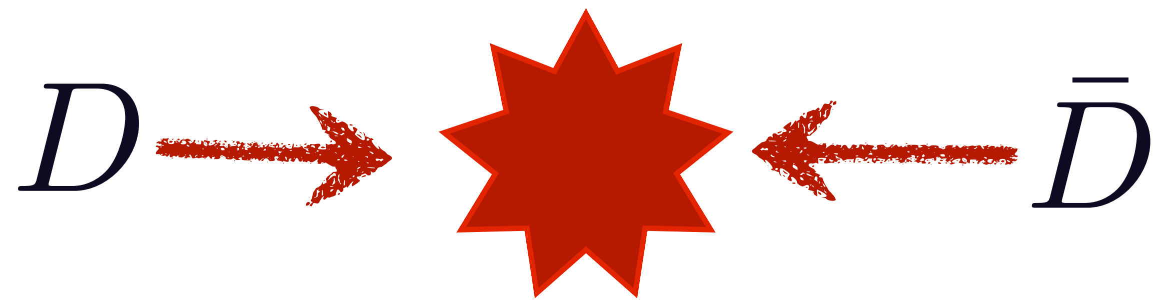
Tracking down the binding...



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Attractive for I=0 and I=1

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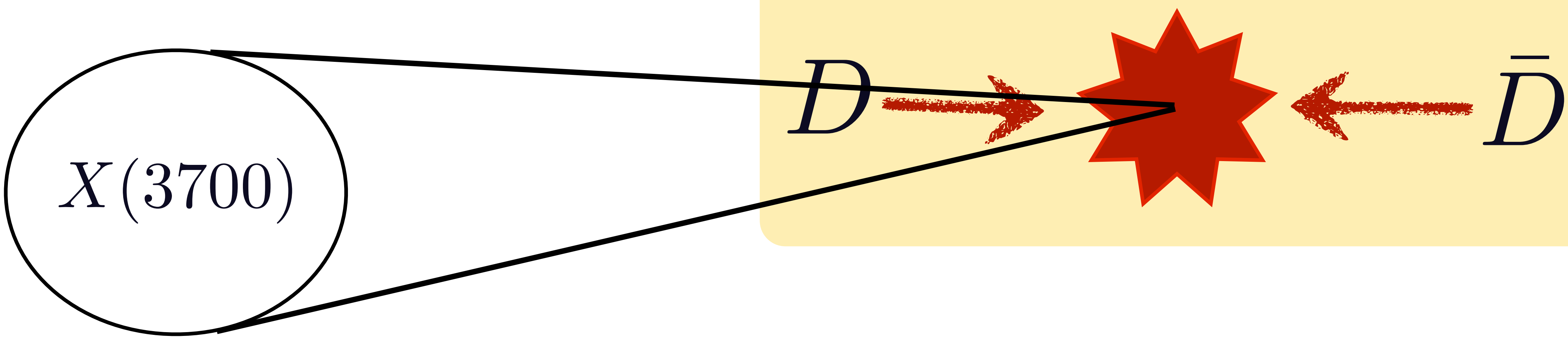

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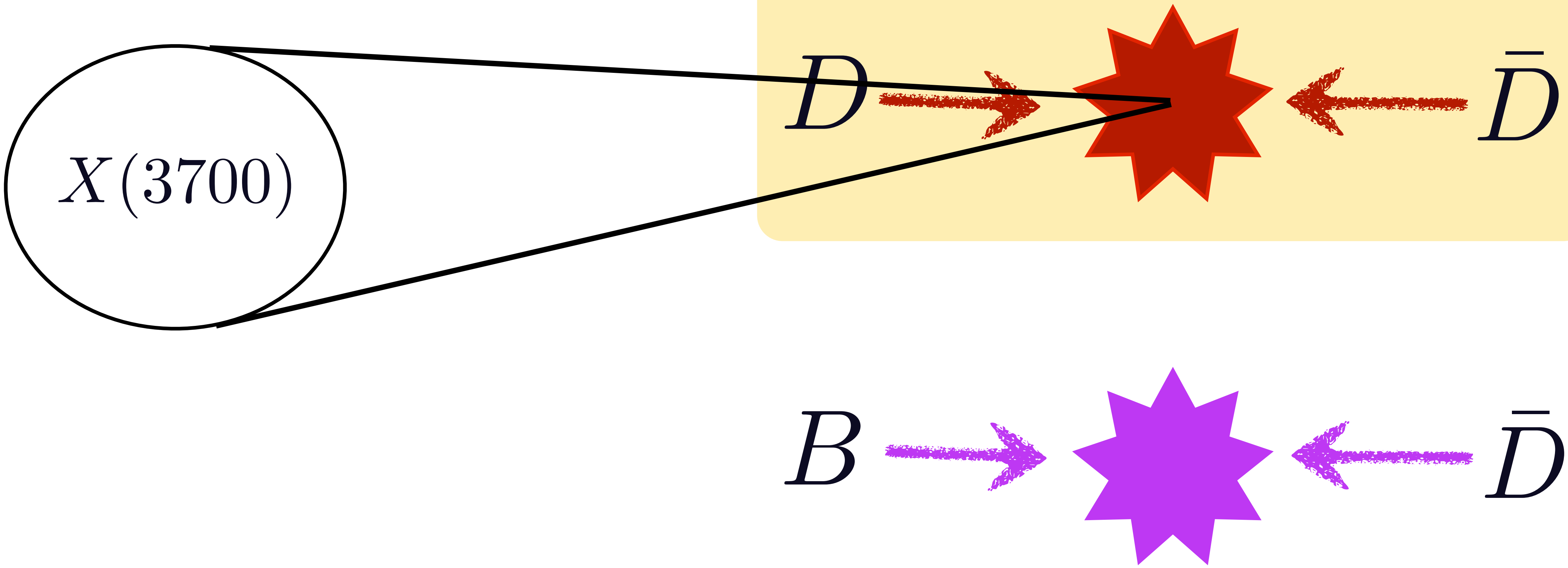

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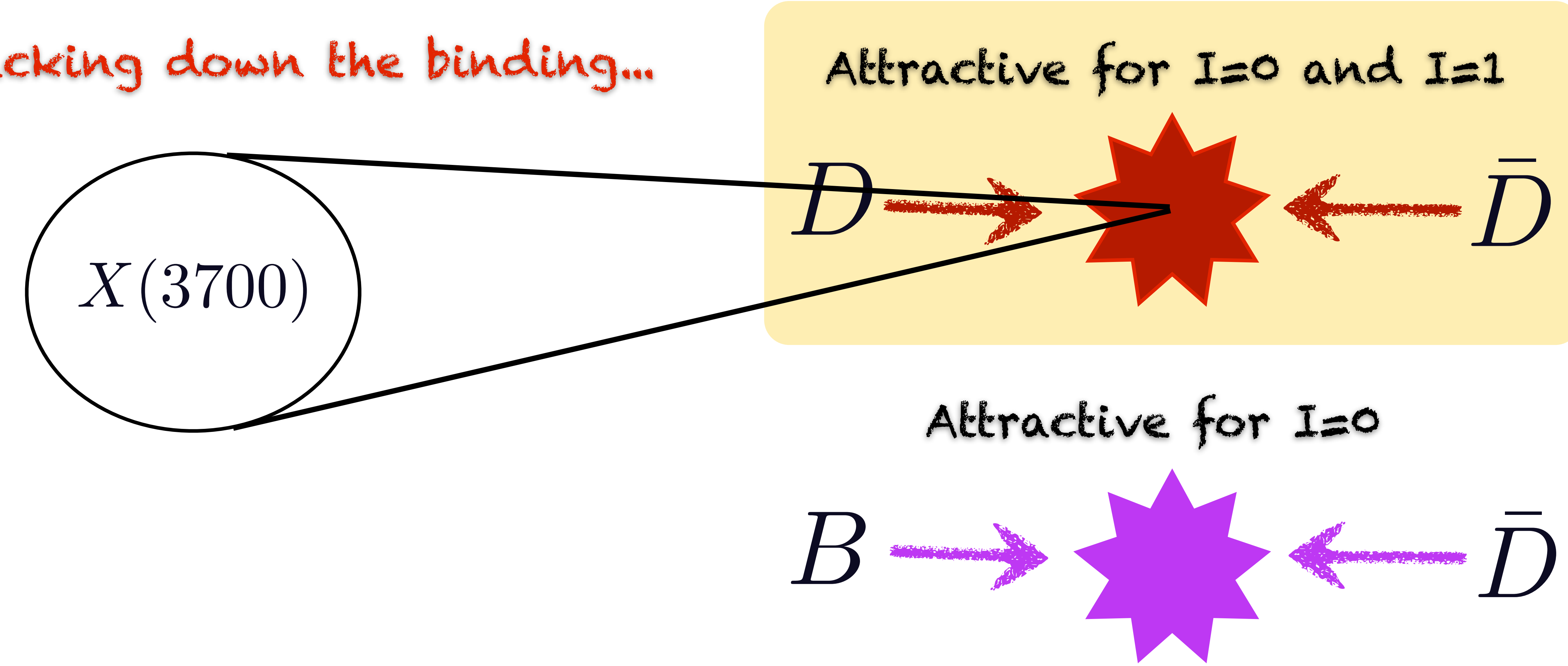

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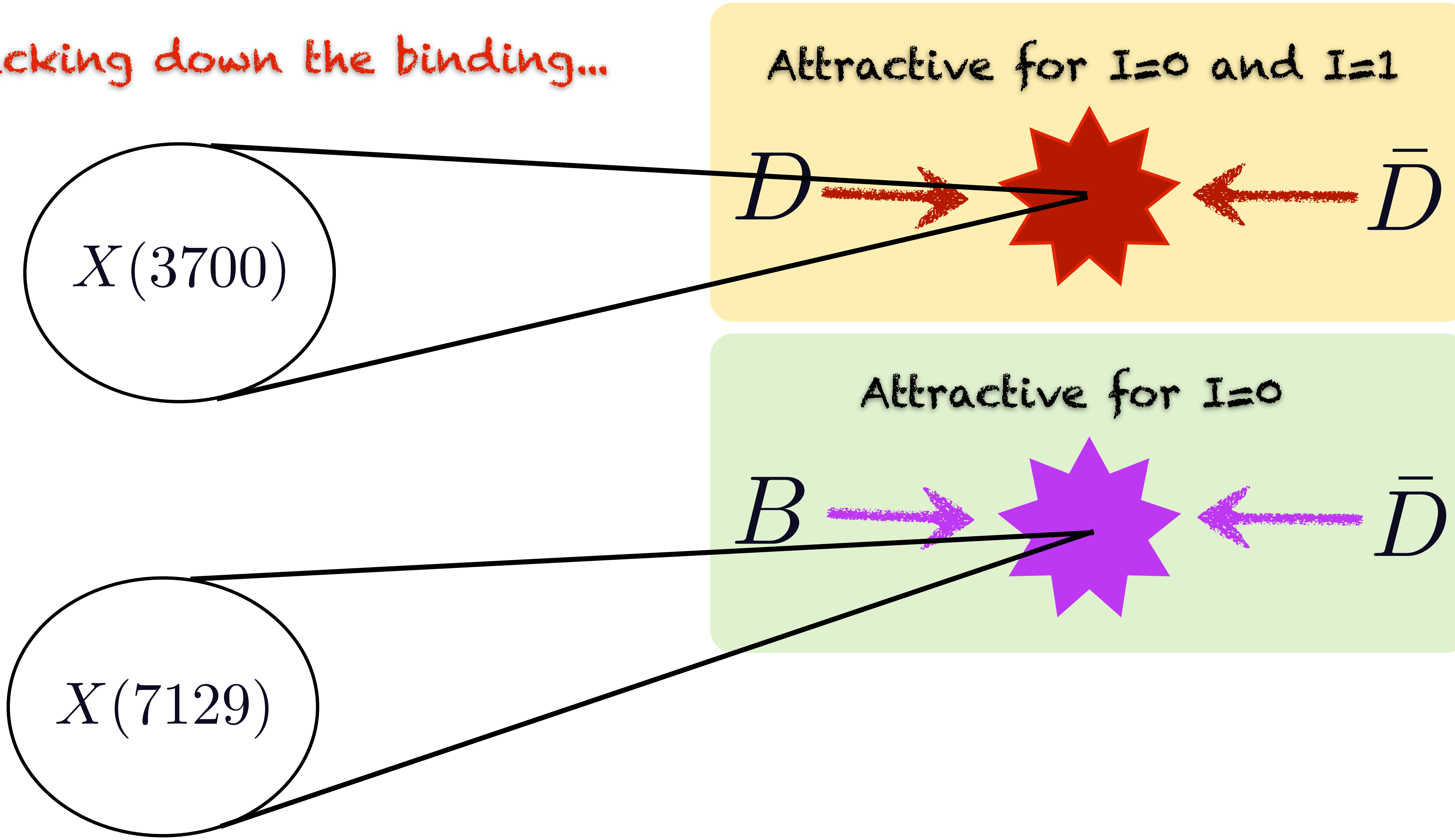

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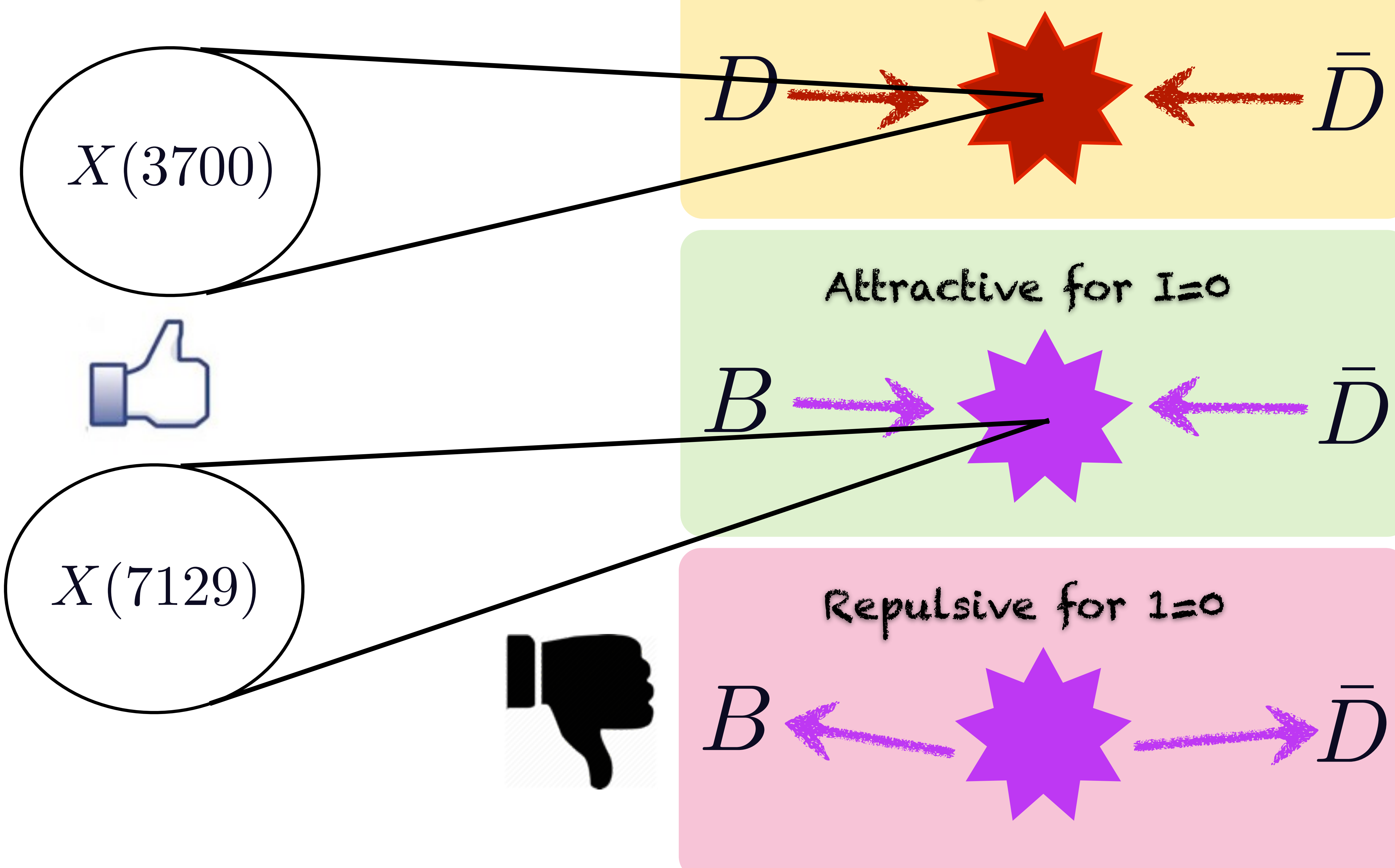

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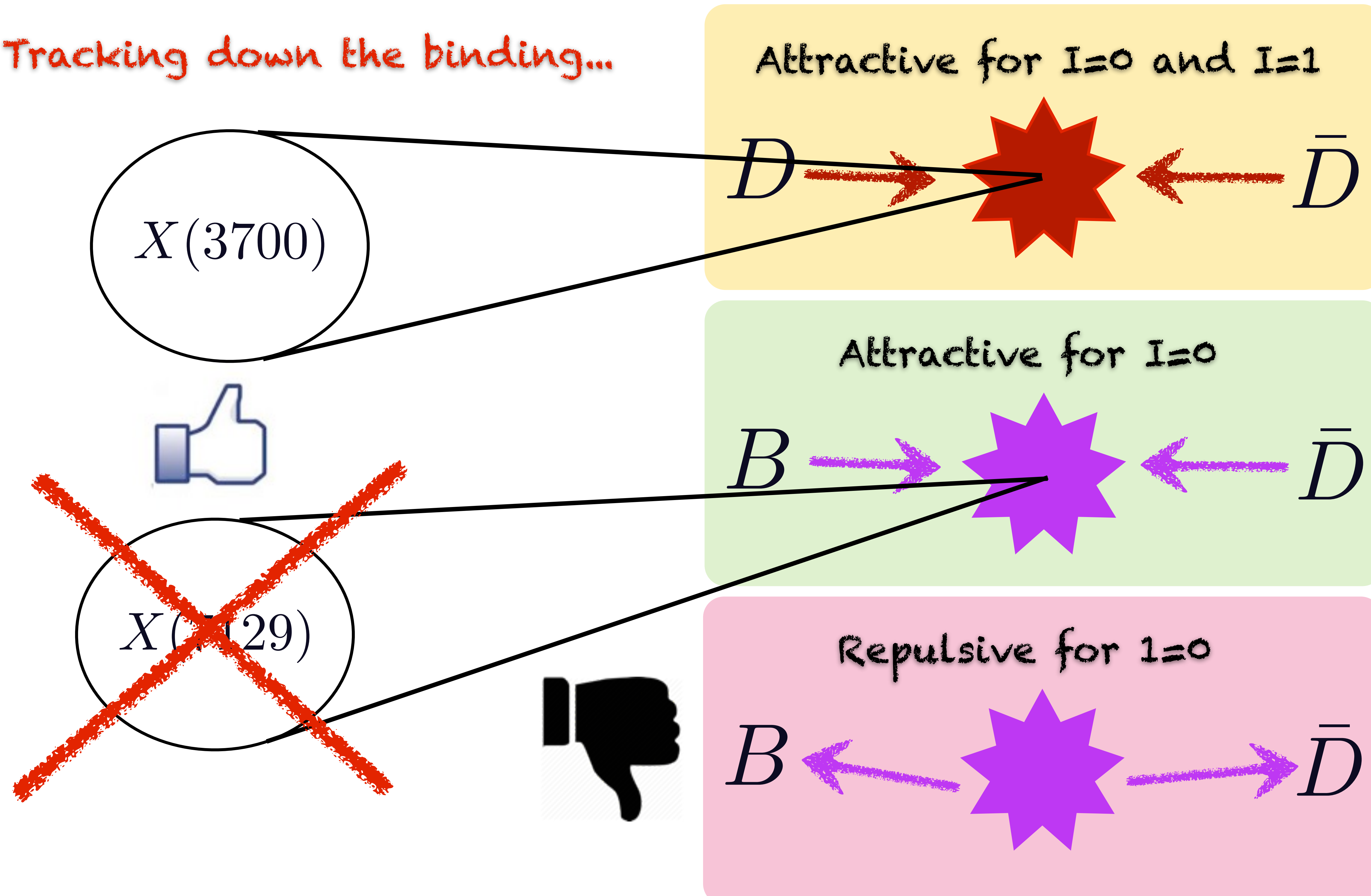

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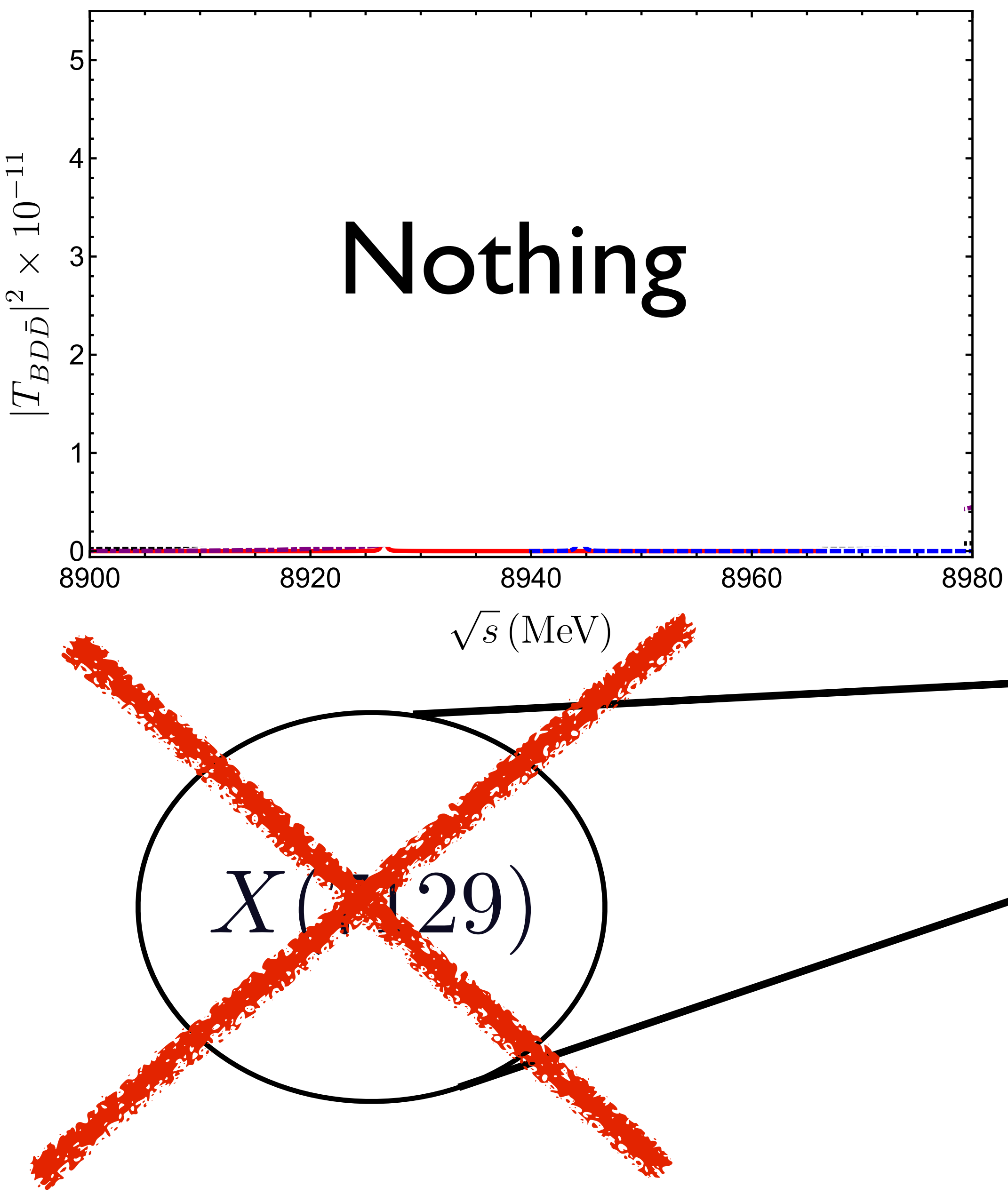

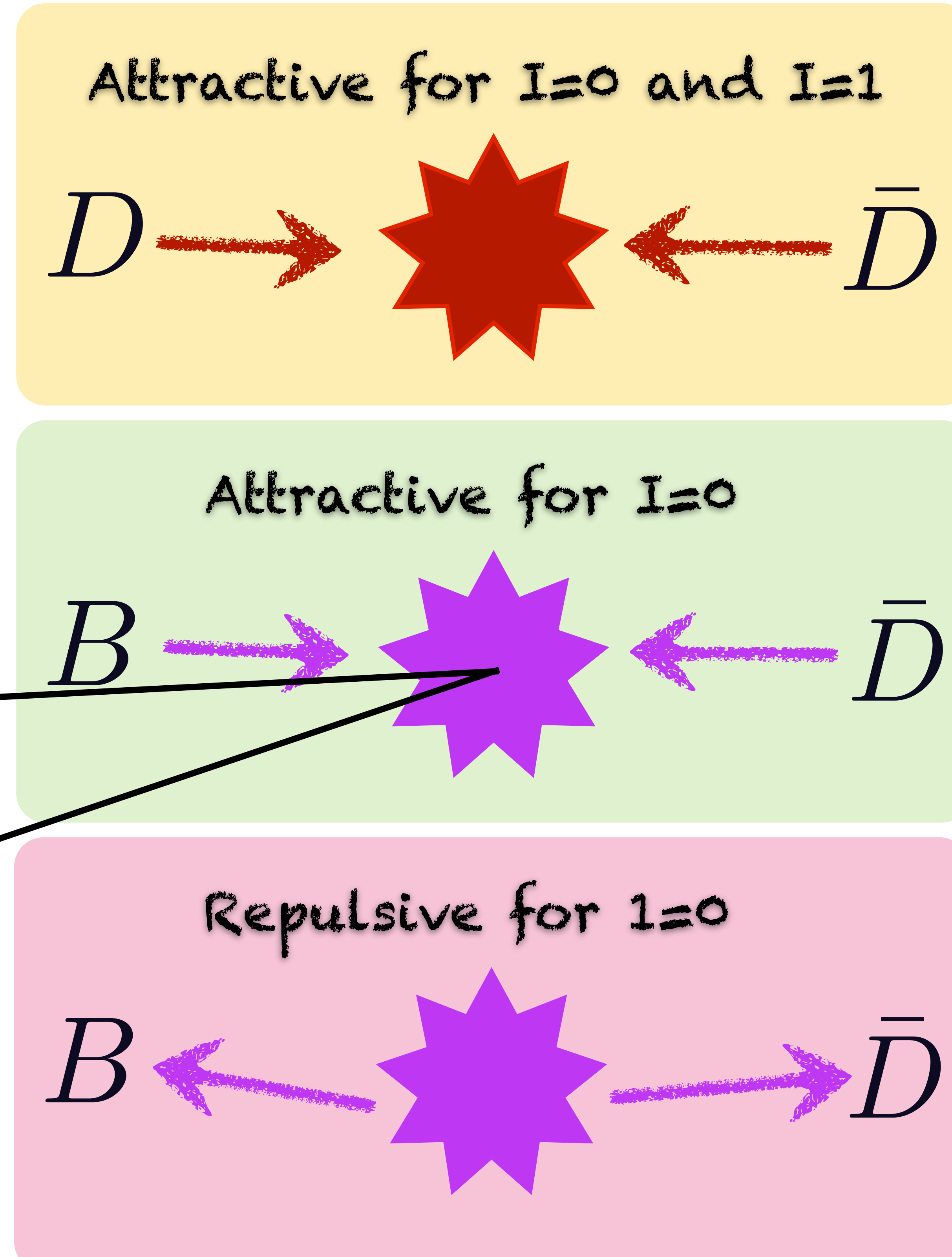

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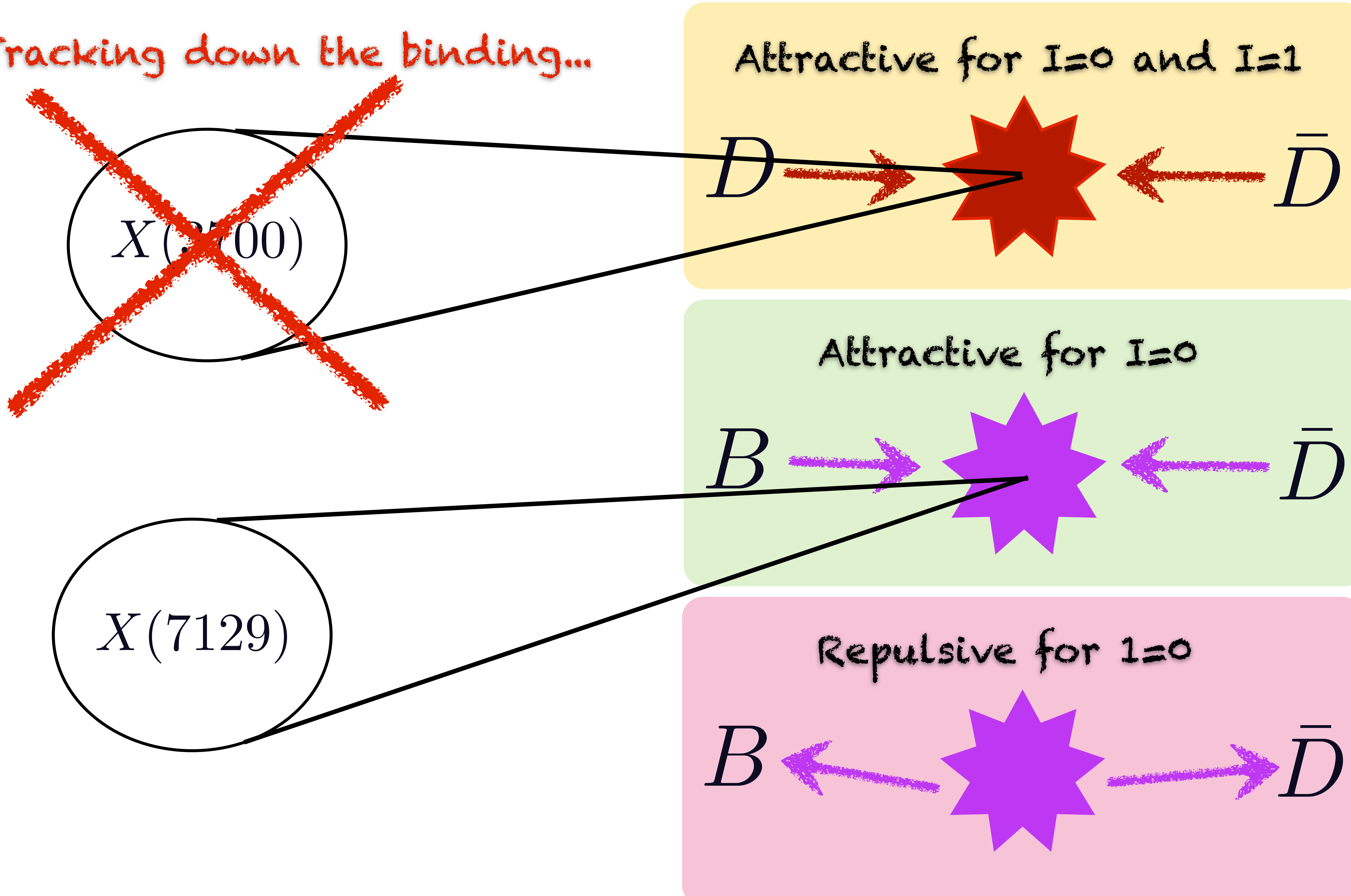

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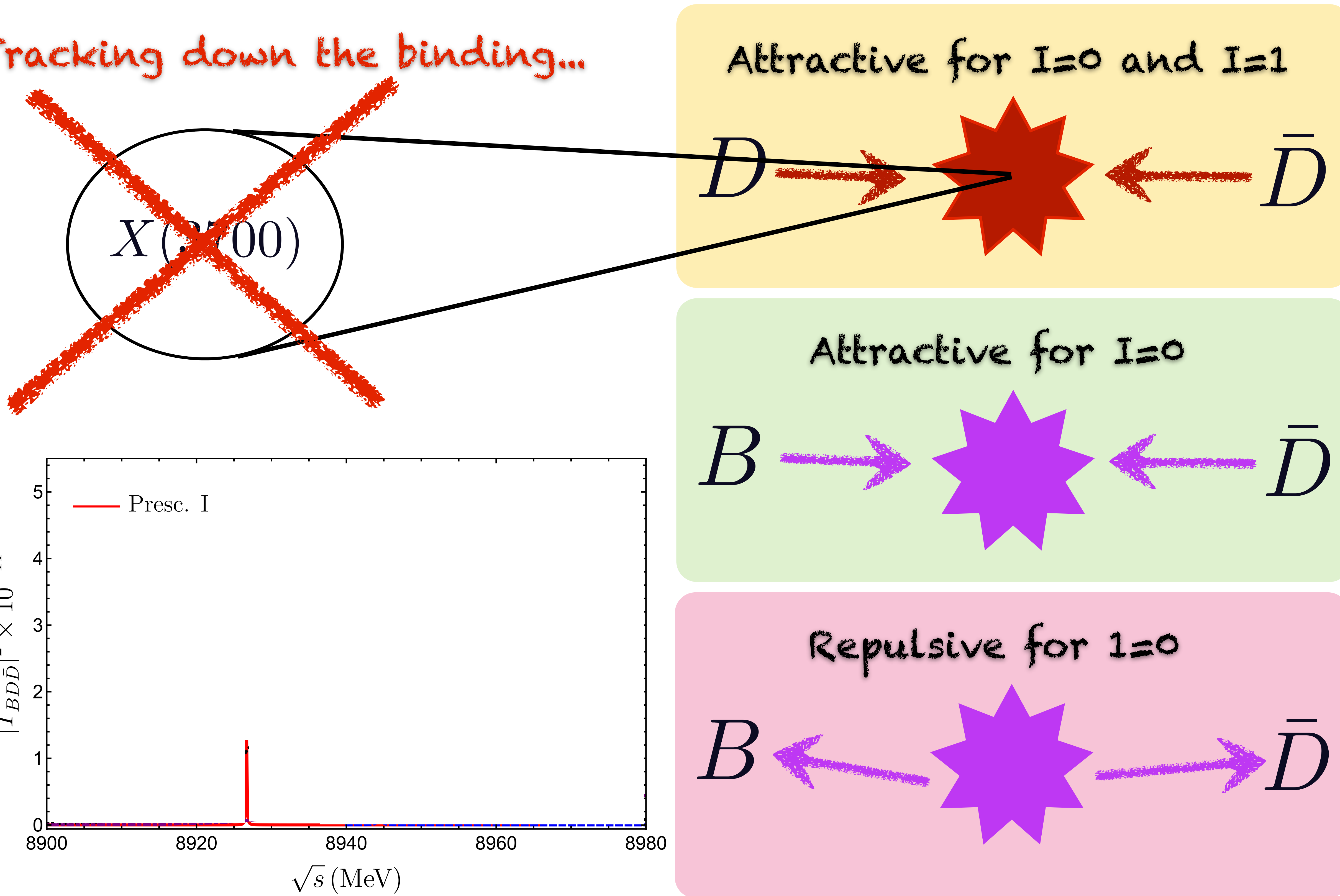

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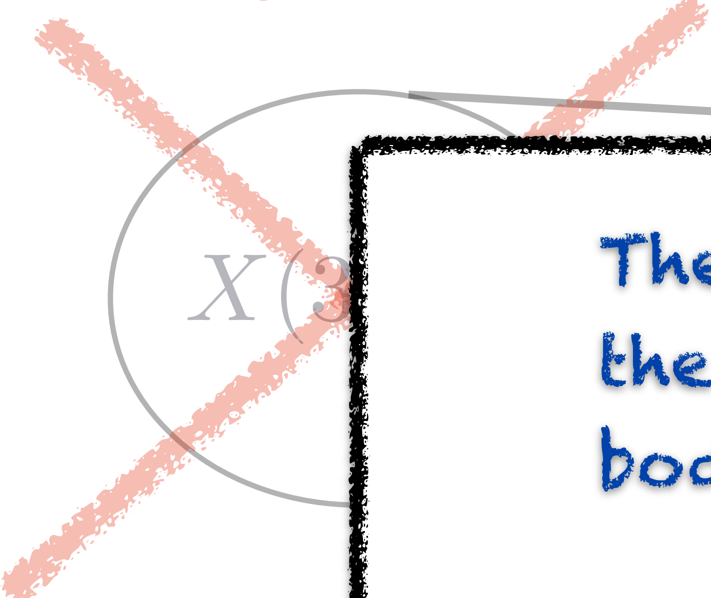

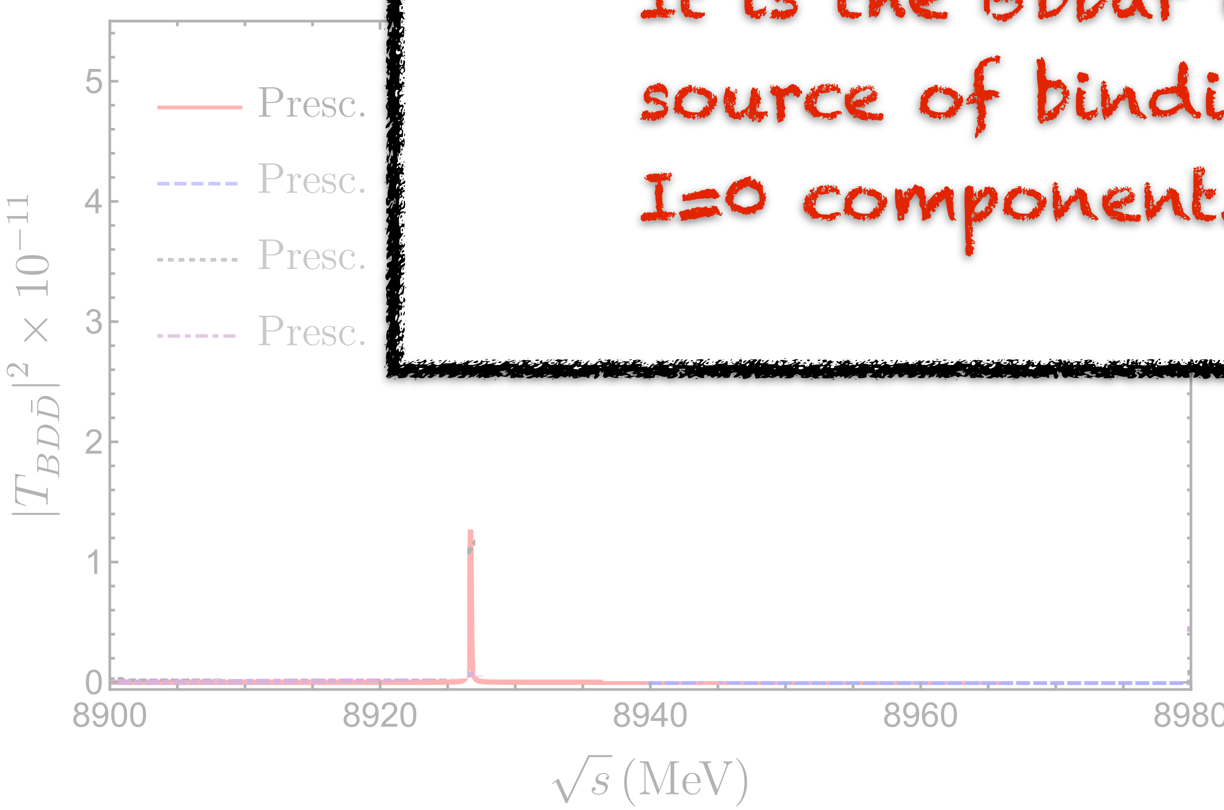

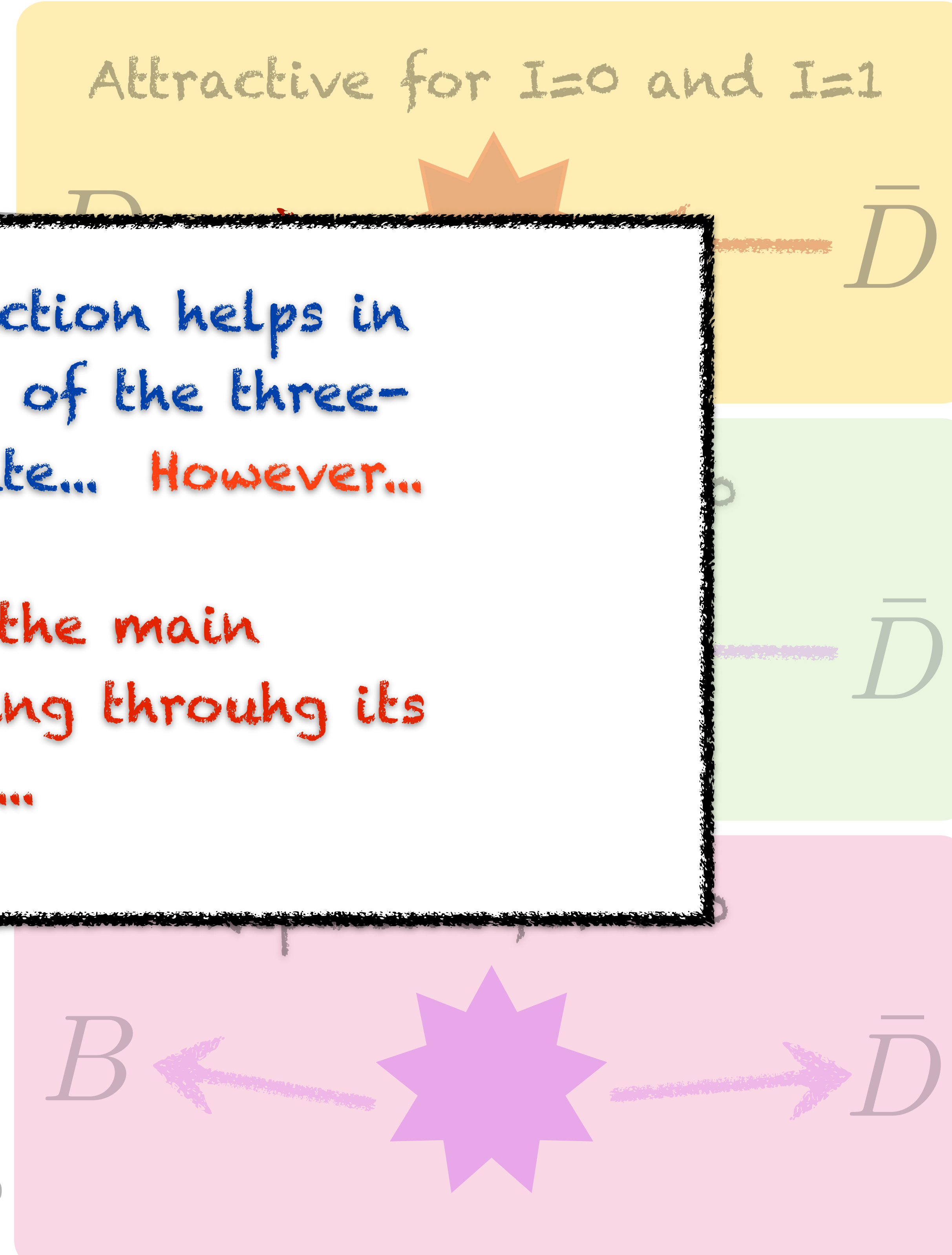

The DDbar attraction helps in the building up of the three-body bound state... However...

It is the BDbar the main source of binding throuhg its I=0 component...

Results: BDD system...

It is essentially exotic!

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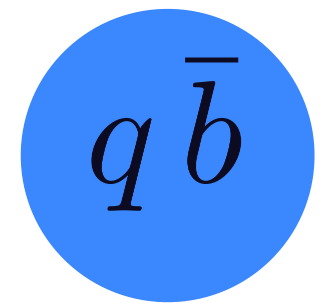
It is essentially exotic!



B meson

Results: BDD system...

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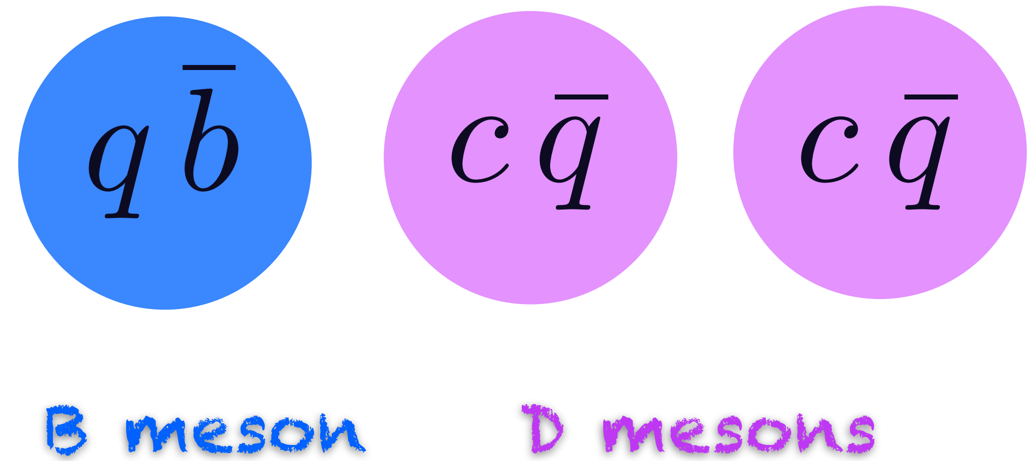

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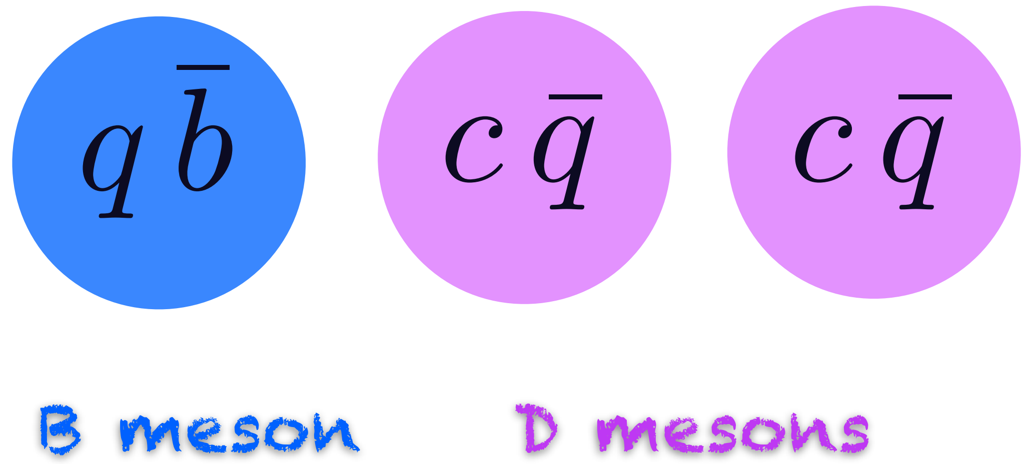

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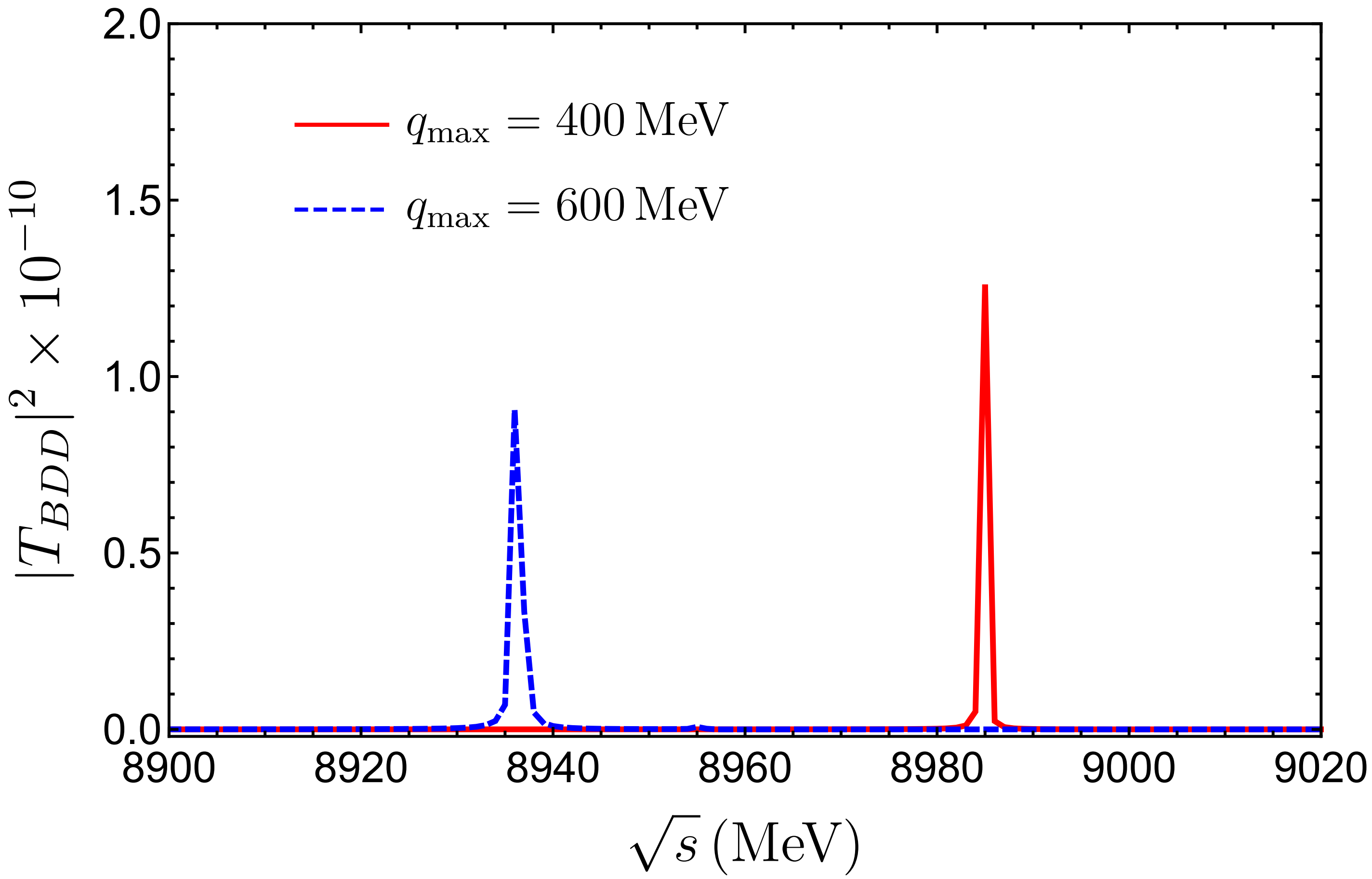

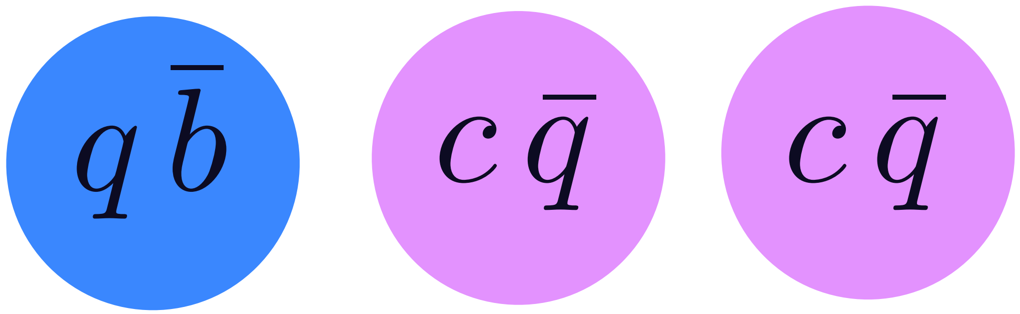

B meson

D mesons

Results: BDD system...

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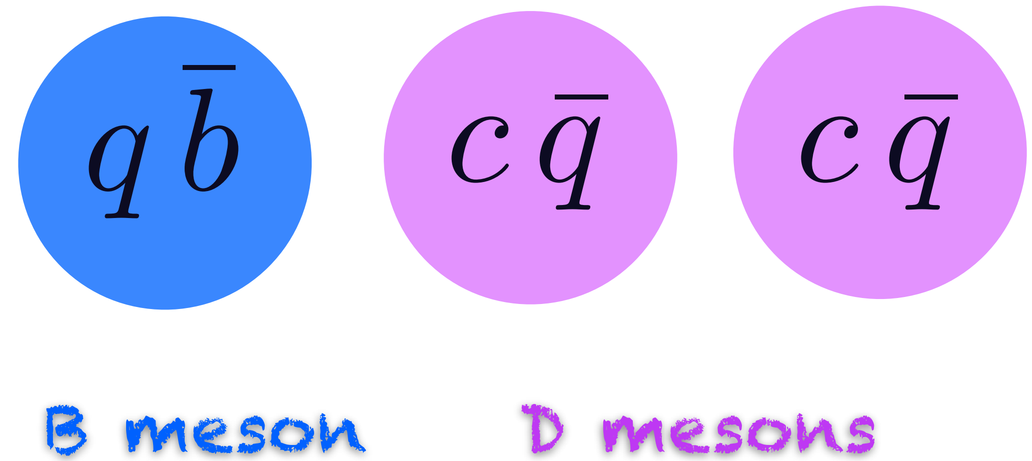

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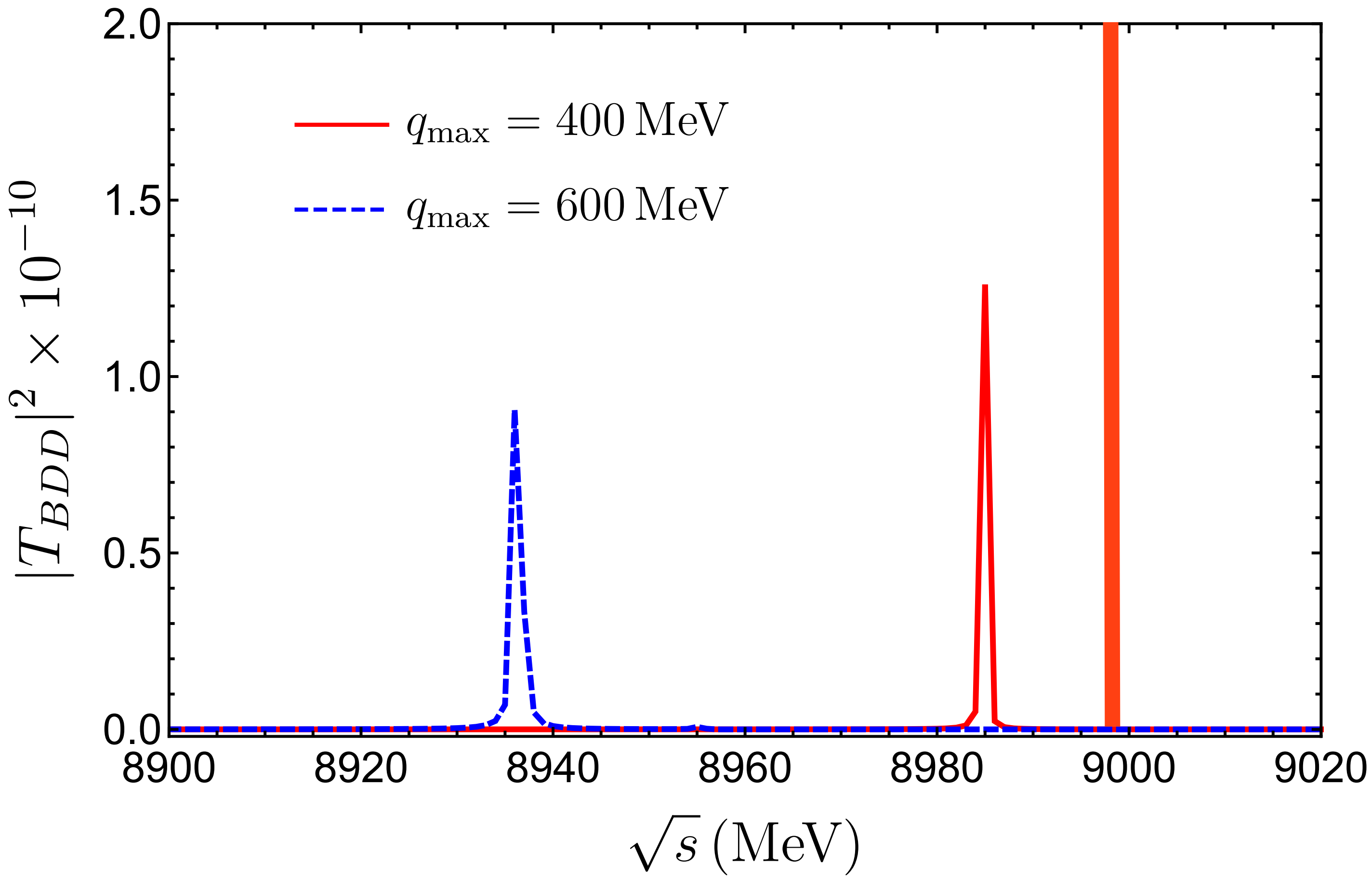

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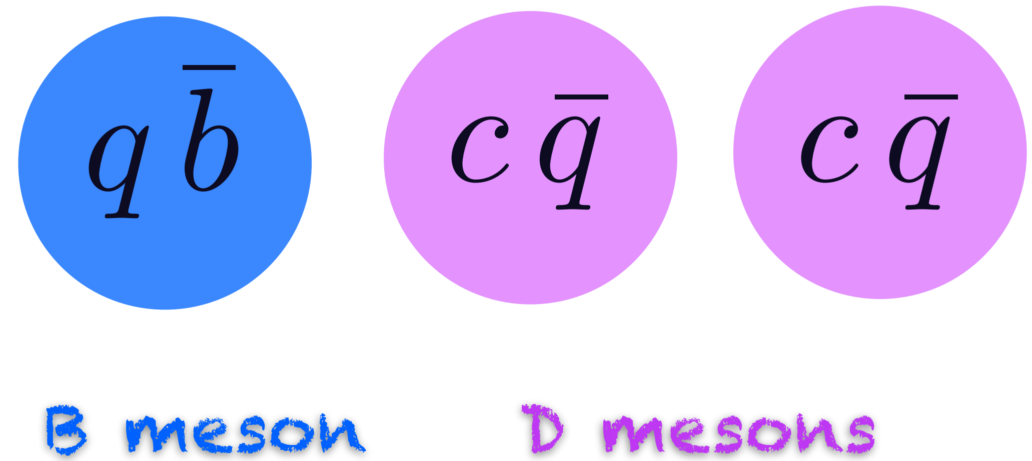
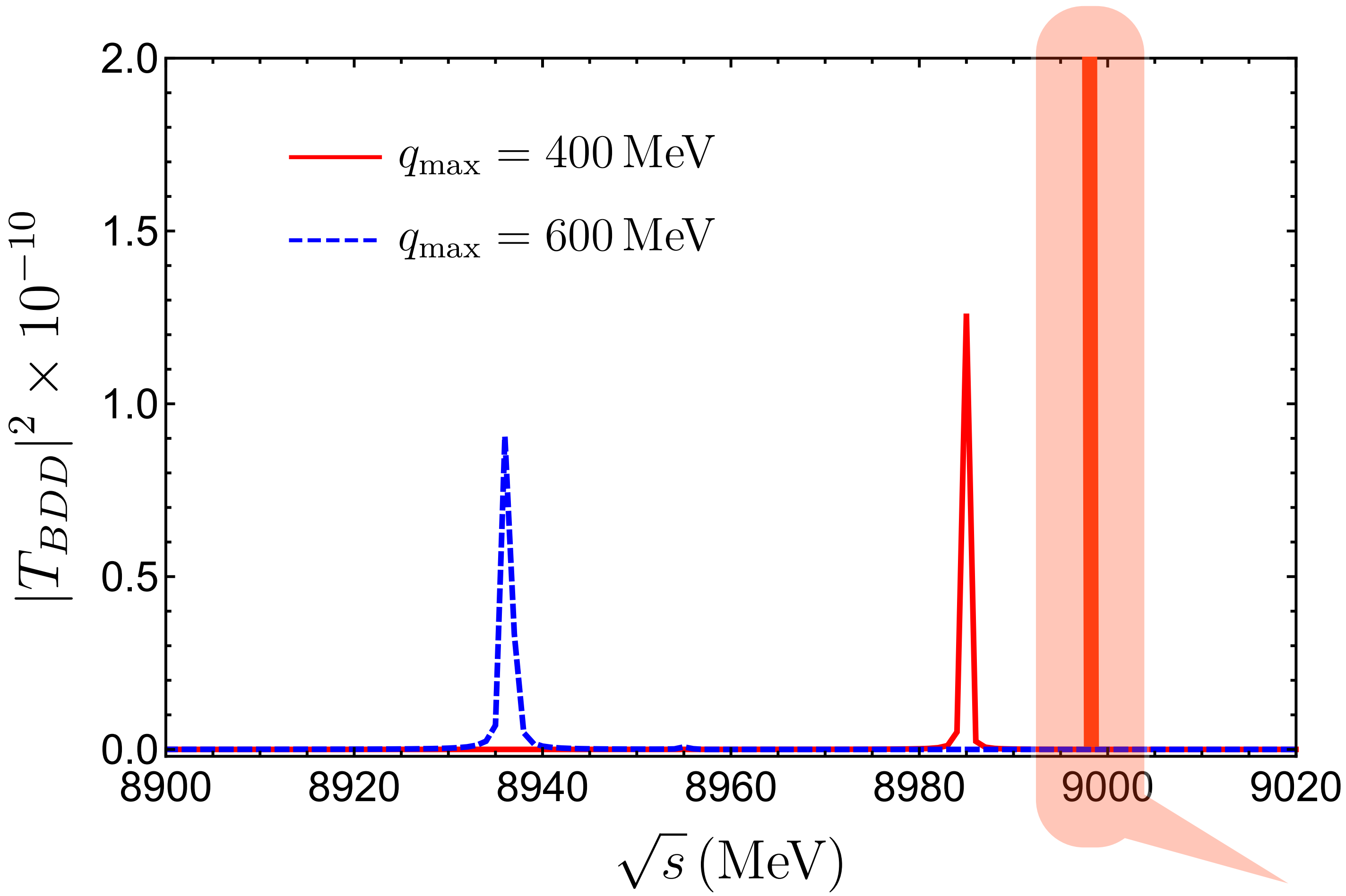


Prescription I



threshold = 8998 MeV

Results: BDD system...

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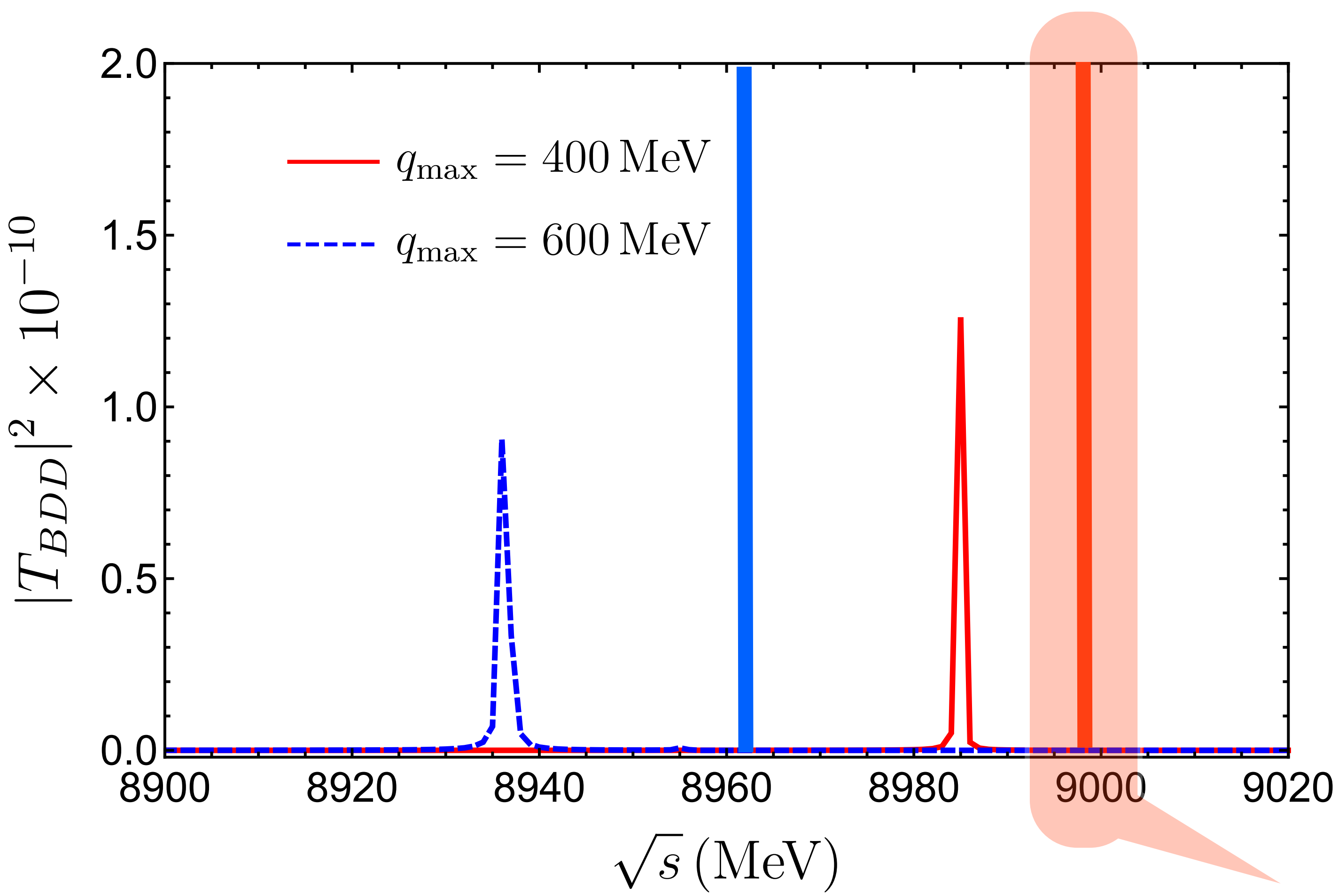
Prescription I



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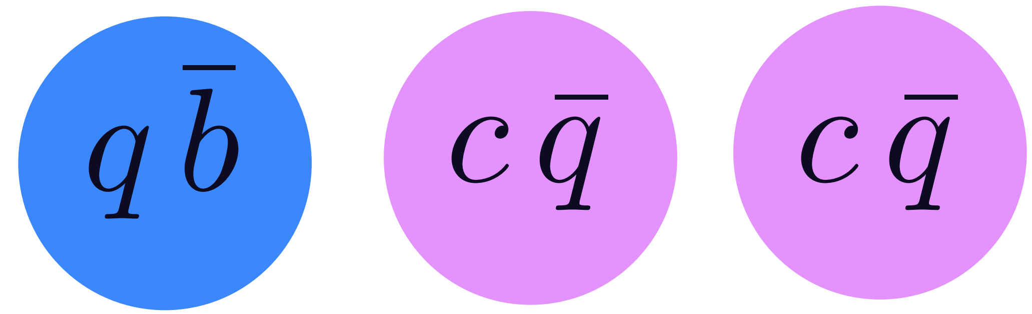

B meson D mesons

Results: BDD system...

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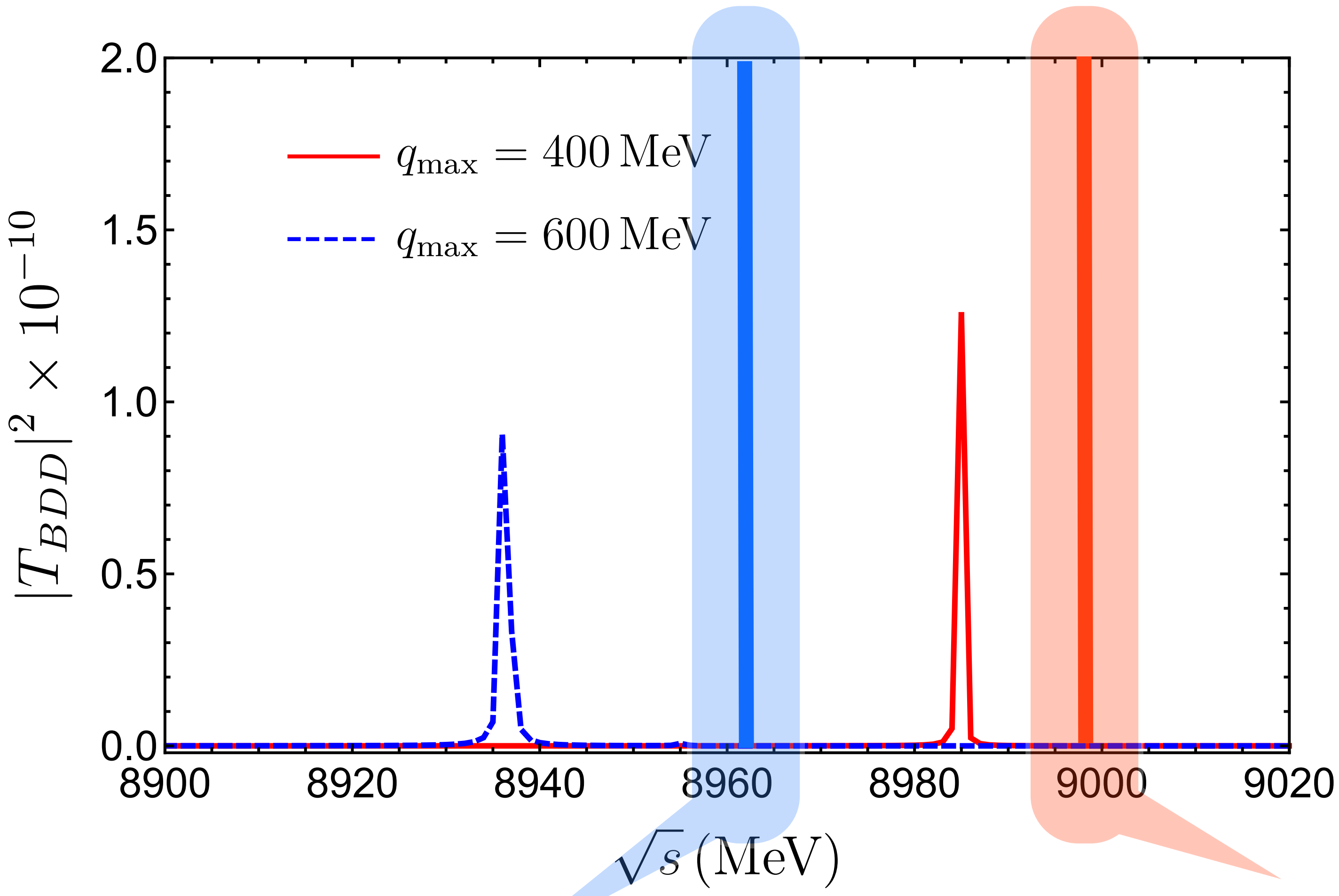
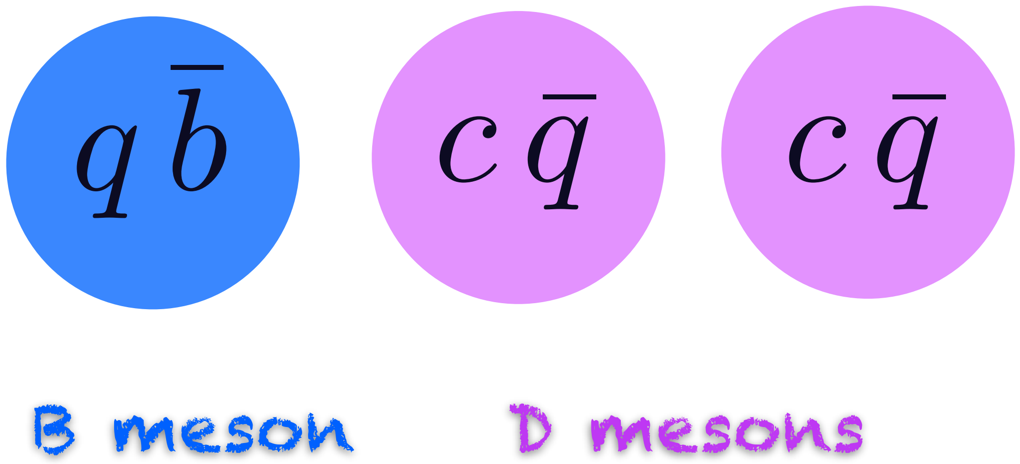
Prescription I



threshold = 8998 MeV

threshold = 8962 MeV



Results: BDD system...

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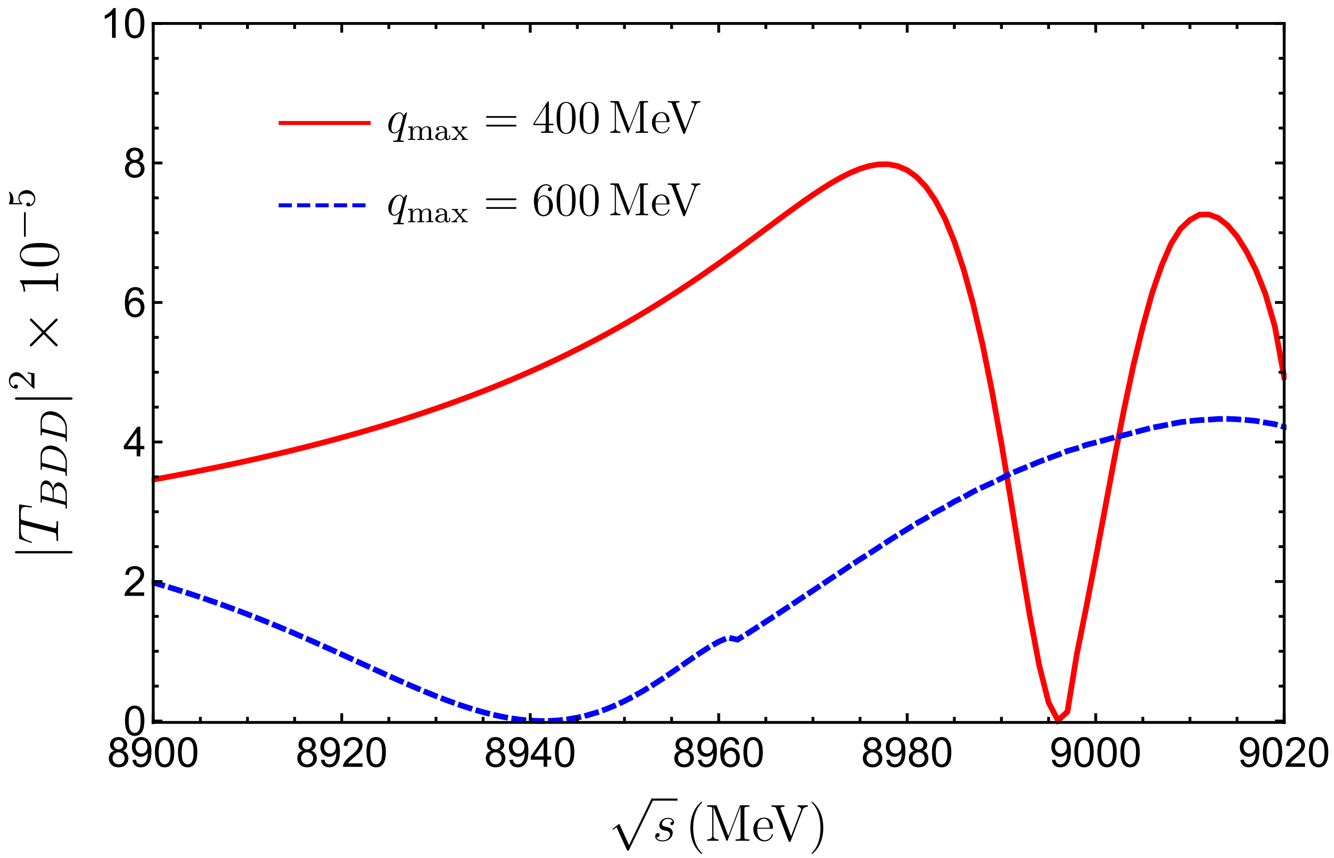
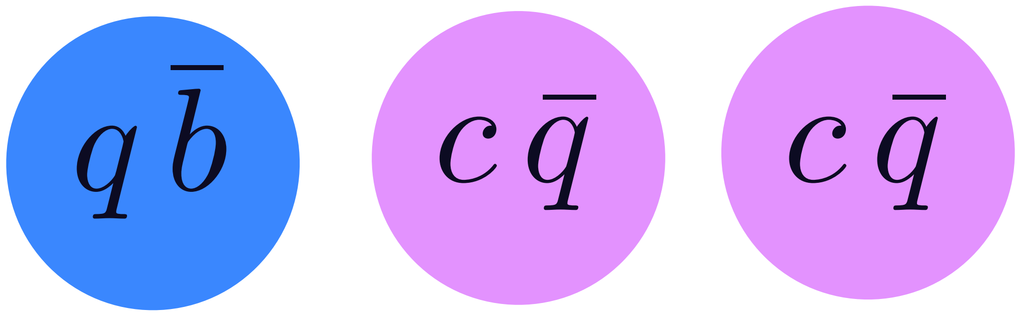
Prescription II





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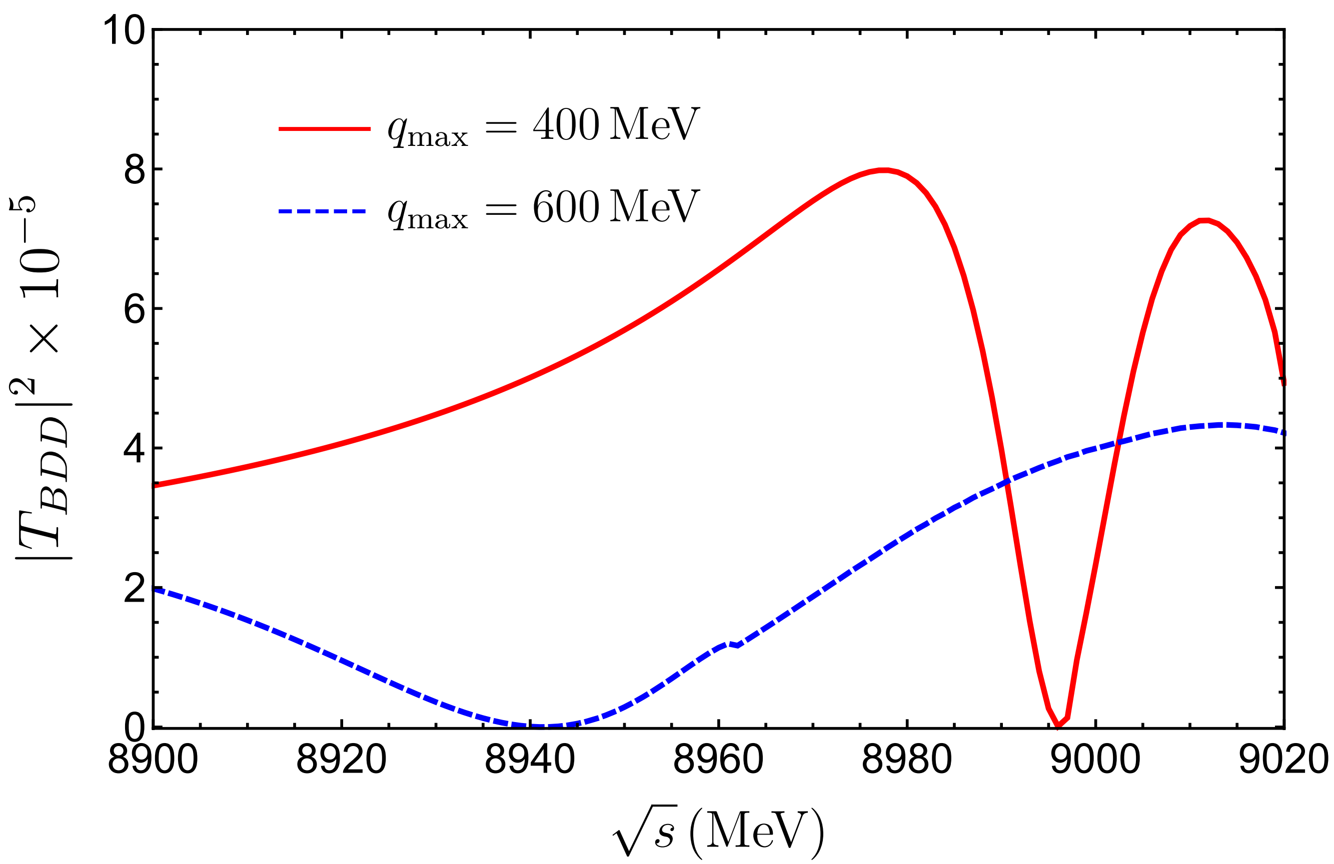
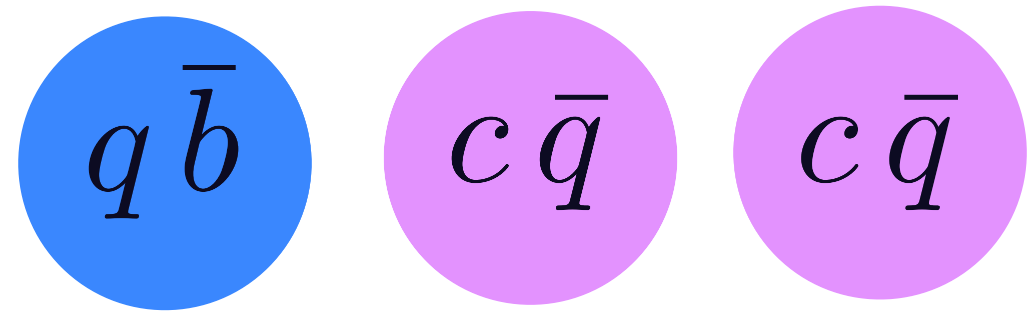


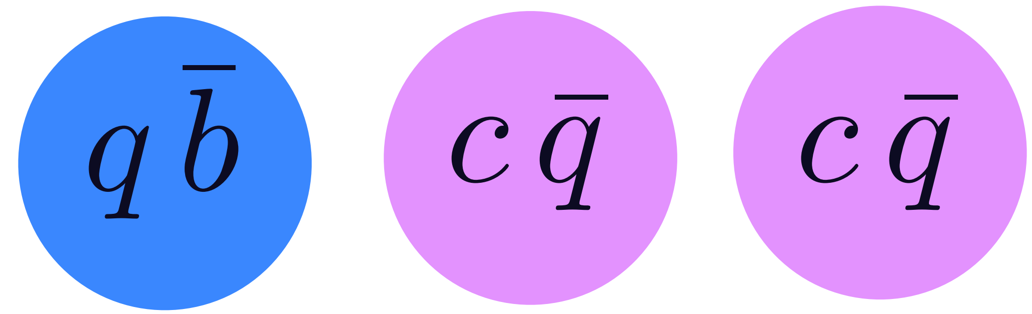


B meson D mesons

No BDD state signal!

Results: BDD system...

It is essentially exotic!



B meson D mesons

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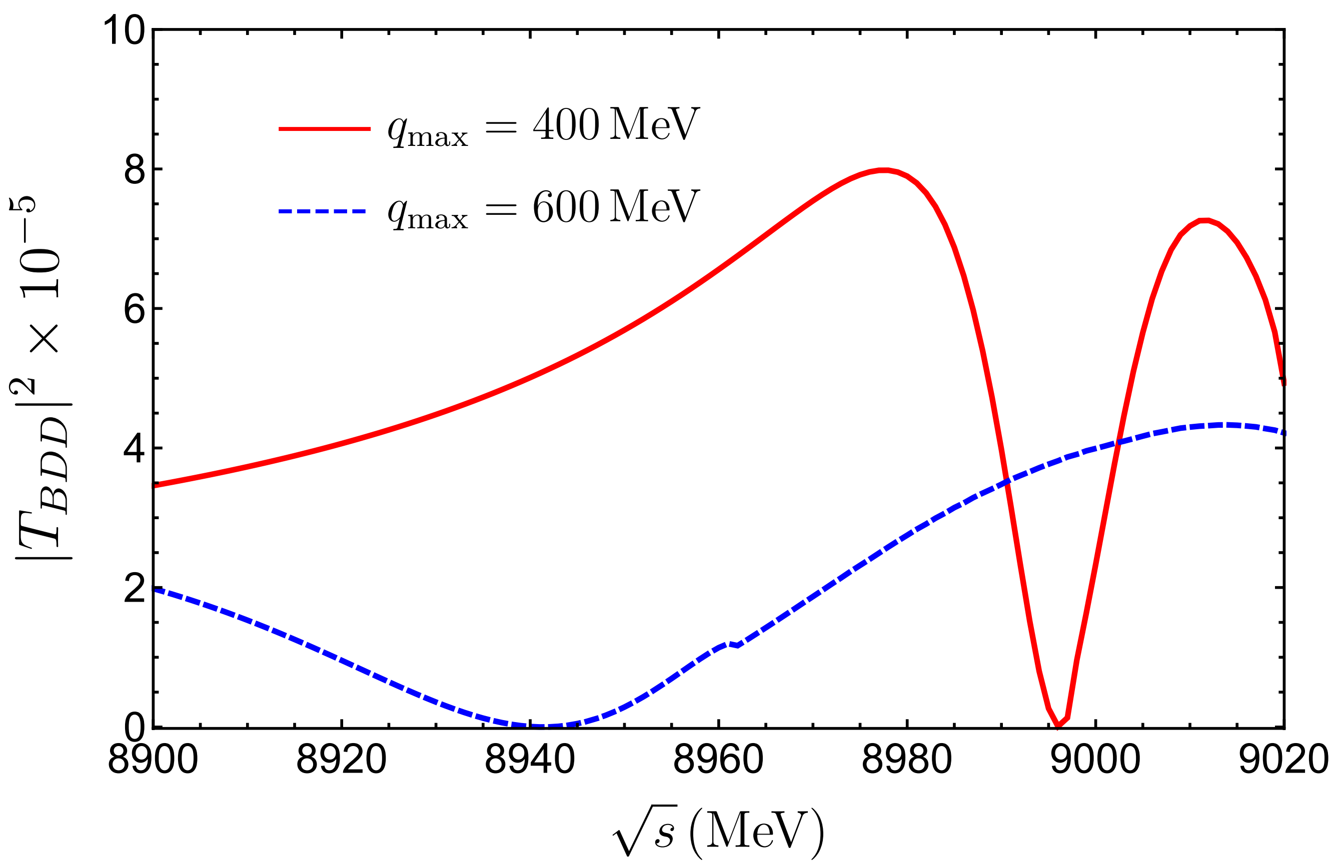
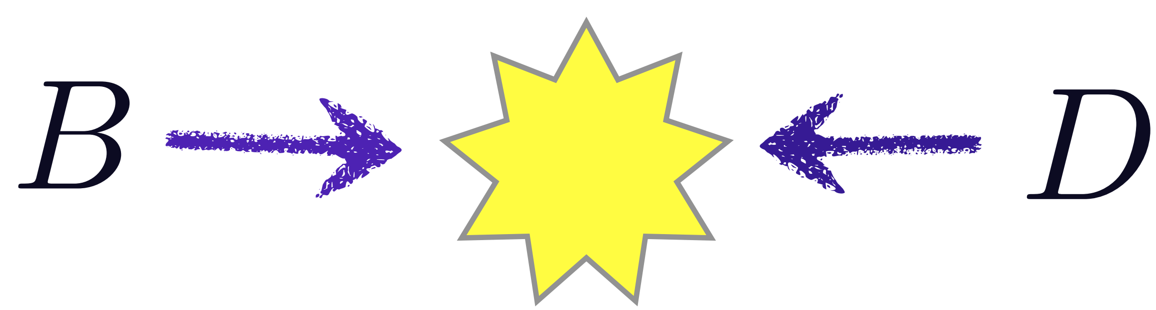


No BDD state signal!

Attractive



Results: BDD system...

It is essentially exotic!

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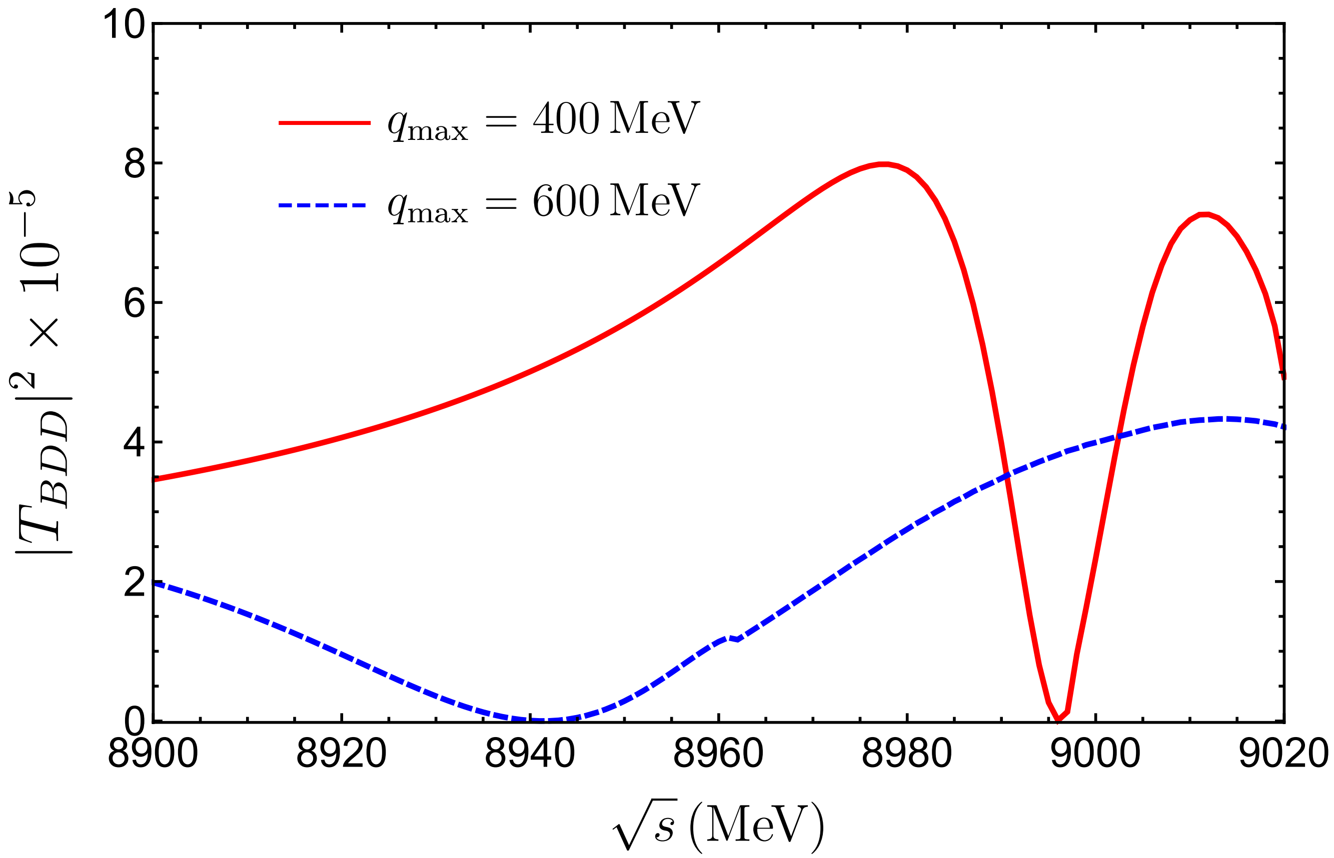
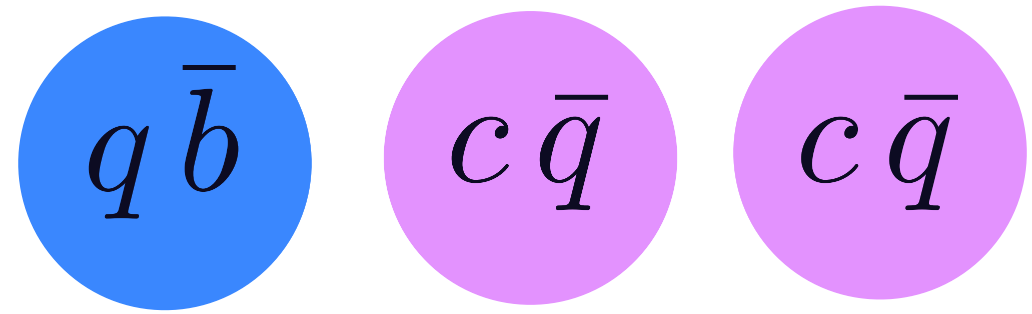
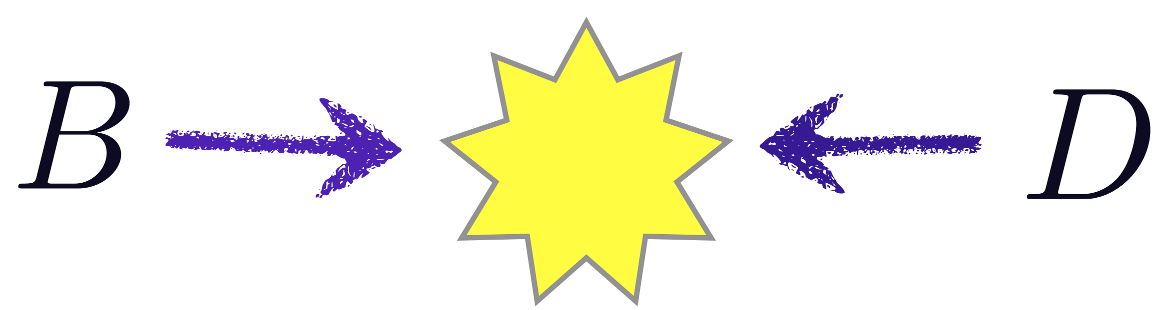




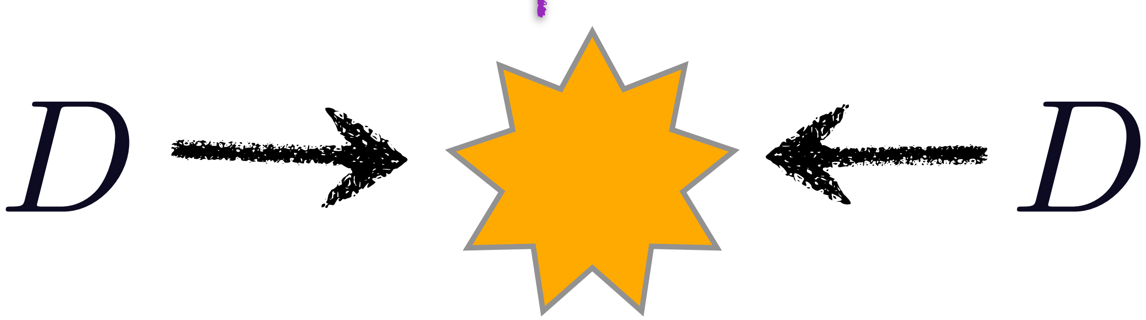
B meson D mesons

No BDD state signal!

Attractive



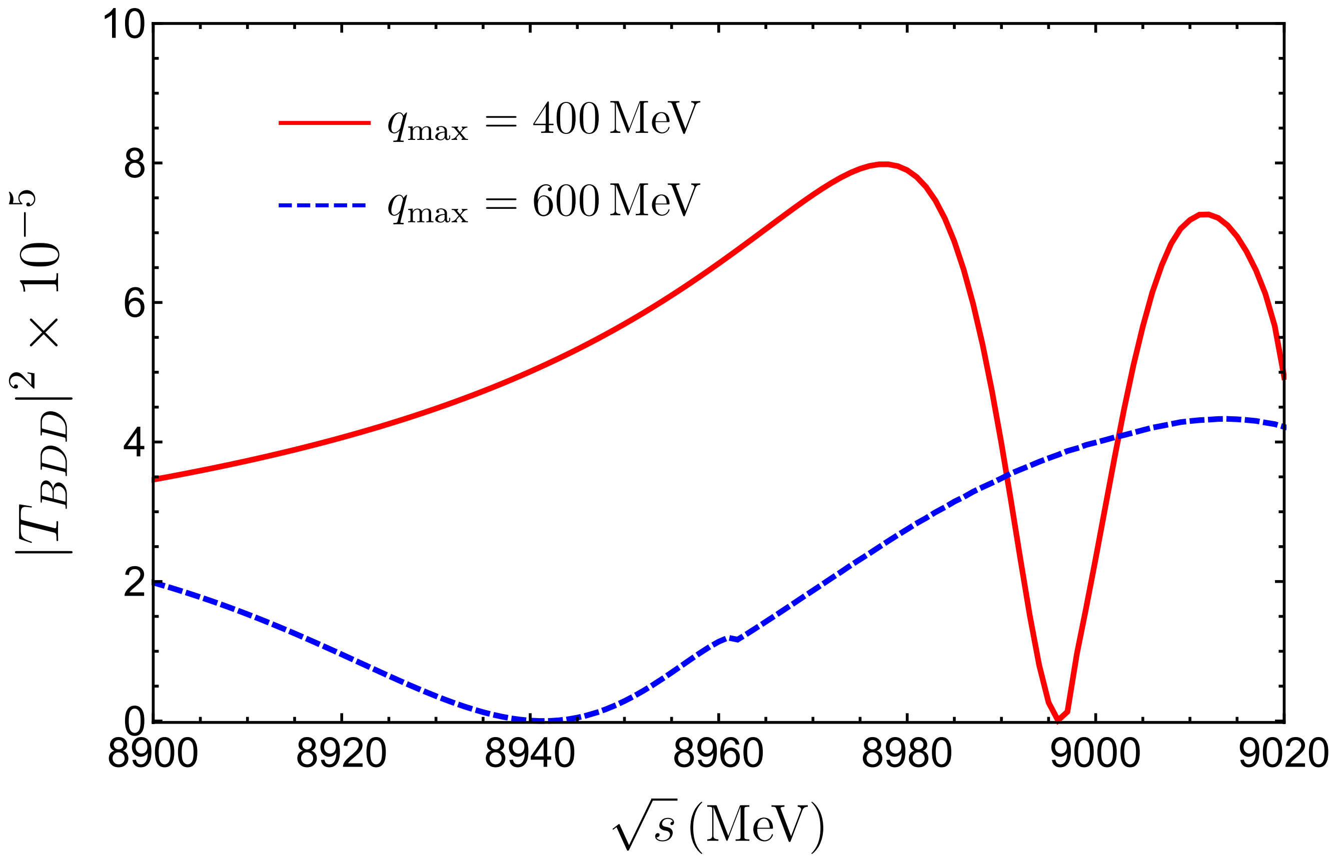
Repulsive

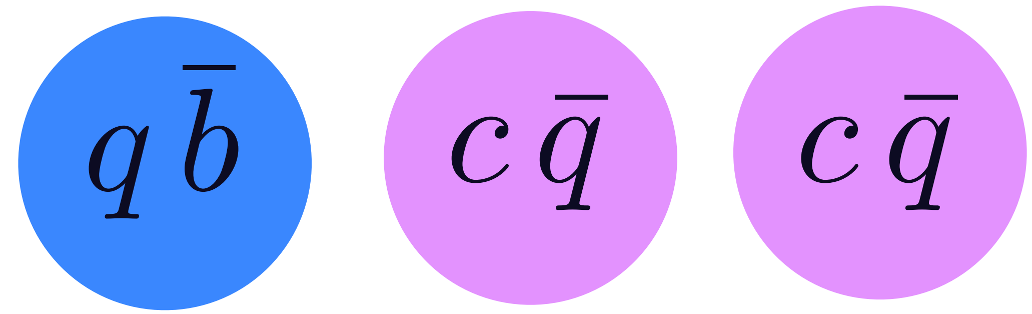


Results: BDD system...

It is essentially exotic!

Prescription II

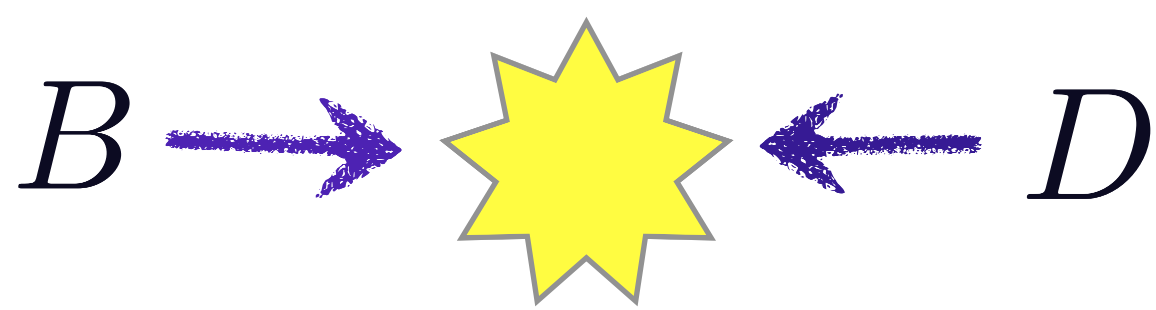




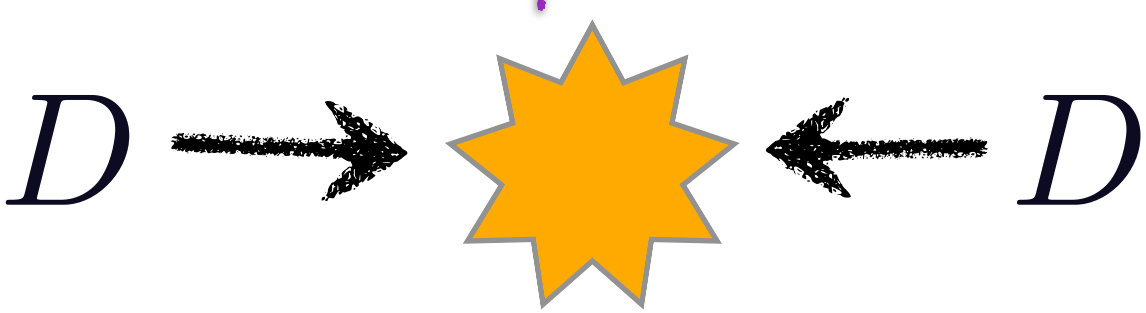
B meson D mesons

No BDD state signal!

Attractive

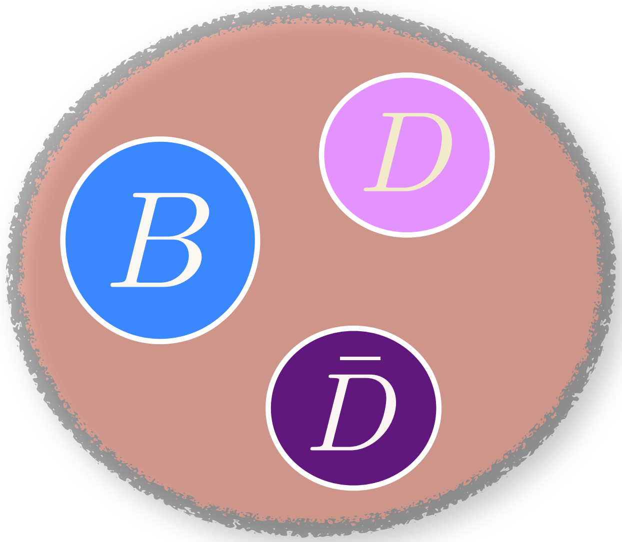


Repulsive



We can't arrive to a decisive conclusion!

Conclusions...



- We get a bound state

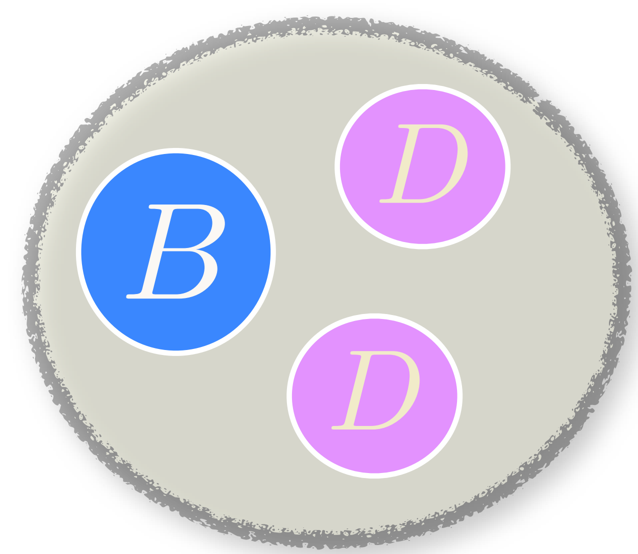
$$M = (8925 - 8985)\,\mathrm{MeV}$$

- Where the I=0 components for BDbar and DDbar interactions are the main sources of the binding...

- In this case, we have some clues of a bound state in the range.

$$M = (8935 - 8985)\,\mathrm{MeV}$$

- However, the results are not stable with the uncertainties of the model.



Thank you for your attention!!