Group Meeting 10.10

Calculations of three-body observables in ^{8}B breakup

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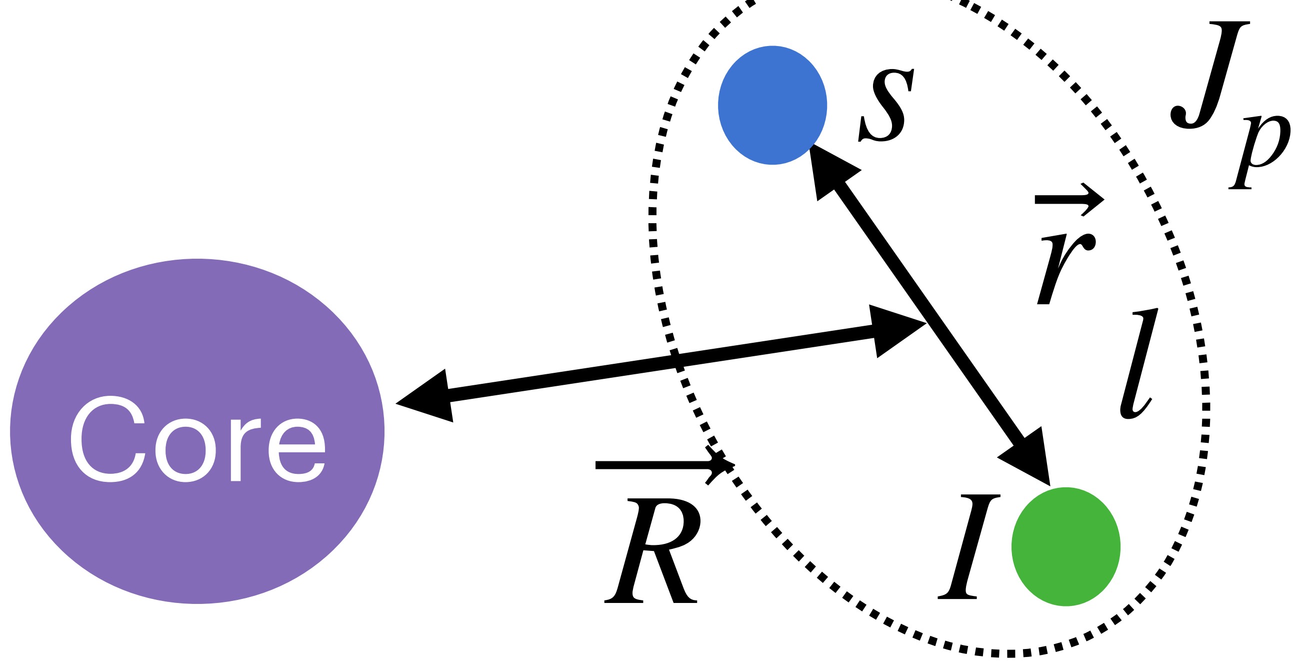
Overview

In CDCC calculation, the bin state wave function:

$$\hat{\phi}_{\alpha}^{M'}(\vec{r}) = \left[\left[Y_l(\hat{r}) \otimes \mathcal{X}_s\right]_j \otimes \mathcal{X}_I\right]_{J_p' M'} u_\alpha(r)/r \,.$$

The radial function u_α are square integrable and are a superposition:



$$u_\alpha(r) = \sqrt{\frac{2}{\pi N_\alpha}} \int_{k_{i-1}}^{k_i} g_\alpha(k) f_\alpha(k, r) dk$$

Overview

The coupled equations solution generates the scattering amplitudes

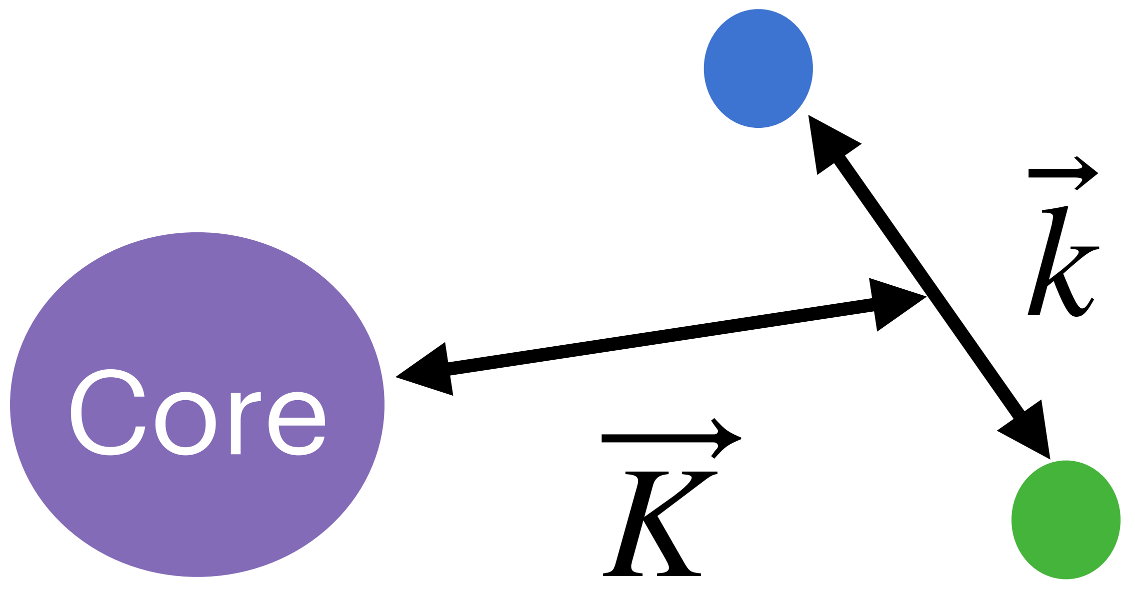
$$\hat{\mathscr{F}}_{M'M}\left(\overrightarrow{K}_\alpha\right) = \frac{4\pi}{K_0}\sqrt{\frac{K_\alpha}{K_0}}\sum_{LL'J}\left(L0J_pM \mid JM\right)\left(L'M - M'J'_{p'}M' \mid JM\right)$$

$$\times \exp\left(i\left[\sigma_L + \sigma_{L'}\right]\right)\frac{1}{2i}\hat{\mathscr{S}}^J_{LJ_p:L'J_p{}'}\left(K_\alpha\right)Y^0_L\left(\hat{K}_0\right)Y^{M-M'}_{L'}\left(\hat{K}_\alpha\right).$$

But it's two body scattering amplitudes. And the inelastic cross section:

$$\frac{d\sigma(\alpha)}{d\Omega_K} = \frac{1}{2J_p+1}\sum_{MM'}\left|\hat{\mathscr{F}}_{M'M}\left(\overrightarrow{K}_\alpha\right)\right|^2.$$

Three-body observables



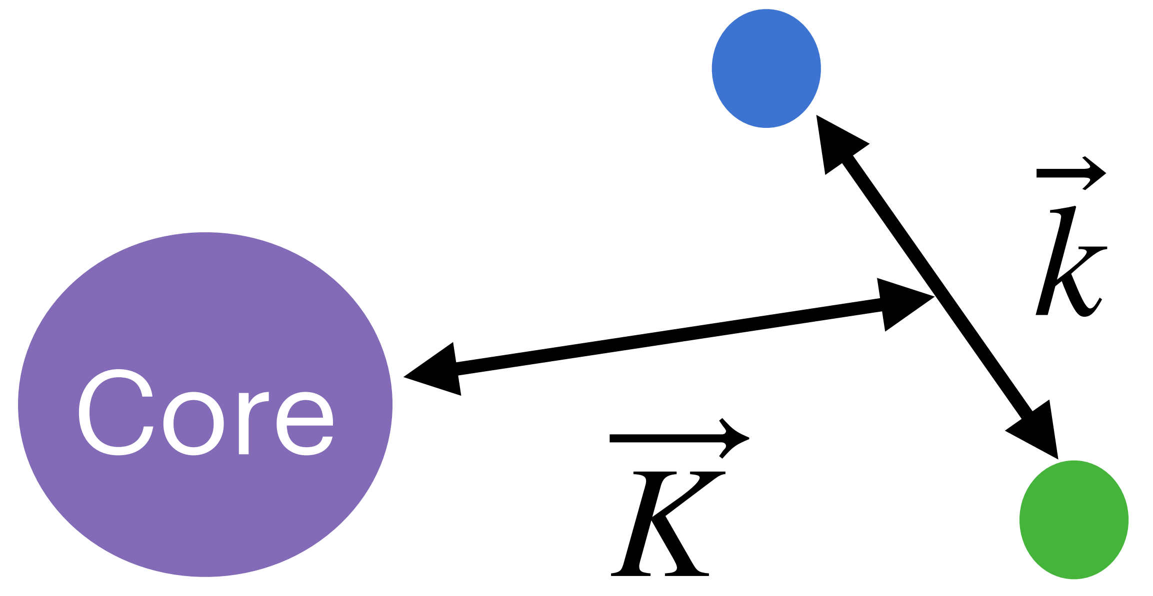
The breakup T-matrix can be given by CDCC wave function,

$$T_{\mu\sigma:M}(\vec{k}, \vec{K}) = \left\langle \phi^{(-)}_{\vec{k}\mu\sigma}(\vec{r}) e^{i\vec{K}\cdot\vec{R}} \,\middle|\, U(\vec{r}, \vec{R}) \,\middle|\, \Psi^{CD}_{\vec{K}_0 M}(\vec{r}, \vec{R}) \right\rangle$$

$$T_{\mu\sigma:M}(\vec{k}, \vec{K}) = \sum_{\alpha, M'} \left\langle \phi^{(-)}_{\vec{k}\mu\sigma} \,\middle|\, \hat{\phi}^{M'}_{\alpha} \right\rangle \left\langle \hat{\phi}^{M'}_{\alpha} e^{i\vec{K}\cdot\vec{R}} \,\middle|\, U(\vec{r}, \vec{R}) \,\middle|\, \Psi^{CD}_{\vec{K}_0 M}(\vec{r}, \vec{R}) \right\rangle,$$

$$\left\langle \phi^{(-)}_{\vec{k}\mu\sigma} \,\middle|\, \hat{\phi}^{M'}_{\alpha} \right\rangle = \frac{(2\pi)^{3/2}}{k\sqrt{N_\alpha}} \sum_{\nu} (-i)^l (l\nu s\sigma \mid jm) \left(jmI\mu \mid J'_p M' \right) \exp\left[i\bar{\delta}_\alpha(k) \right] g_\alpha(k) Y^{\nu}_{l}(\hat{k}),$$

Three-body observables



So they get the T-matrix with $\vec{k}$ index ,

$$T_{\mu\sigma:M}(\vec{k},\vec{K}) = \frac{(2\pi)^{3/2}}{k}\sum_{\alpha\nu}(-i)^l(l\nu s\sigma \mid jm)\left(jmI\mu \mid J_p'M'\right)$$
$$\times \exp\left[i\bar{\delta}_\alpha(k)\right] Y_l^\nu(\hat{k})g_\alpha(k)T_{M'M}(\alpha,\vec{K})$$

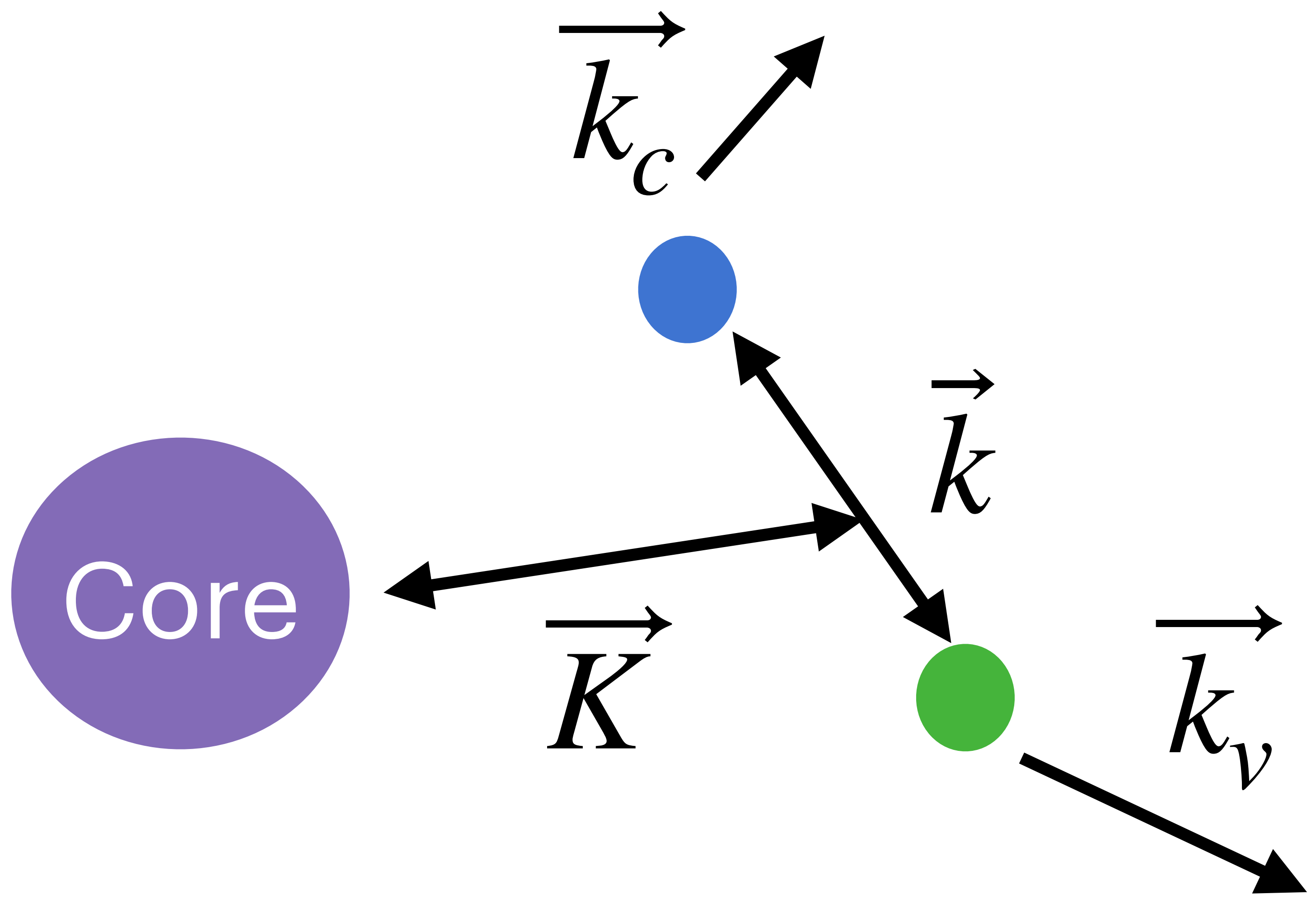
And the three-body observables can be given by

$$\frac{d^3\sigma}{d\Omega_c d\Omega_v dE_c} = \frac{2\pi\mu_{pt}}{\hbar^2 K_0}\frac{1}{\left(2J_p+1\right)}\sum_{\mu\sigma M}\left|T_{\mu\sigma:M}(\vec{k},\vec{K})\right|^2 \rho\left(E_c,\Omega_c,\Omega_v\right)$$

Three-body observables

$$\frac{d^3\sigma}{d\Omega_c d\Omega_v dE_c} = \frac{2\pi\mu_{pt}}{\hbar^2 K_0} \frac{1}{\left(2J_p + 1\right)} \sum_{\mu\sigma M} \left| T_{\mu\sigma:M}(\vec{k}, \vec{K}) \right|^2 \rho\left(E_c, \Omega_c, \Omega_v\right)$$

where $\rho\left(E_c, \Omega_c, \Omega_v\right) = \frac{m_c m_v \hbar k_c \hbar k_v}{(2\pi\hbar)^6} [\frac{m_t}{m_v + m_t + m_v\left(\vec{k}_c - \vec{K}_{tot}\right) \cdot \vec{k}_v / k_v^2}].$



$$\vec{K} = \vec{k}_c + \vec{k}_v - \frac{m_p}{m_p + m_t}\vec{K}_{tot}, \quad \vec{k} = \frac{m_c}{m_p}\vec{k}_v - \frac{m_v}{m_p}\vec{k}_c$$