$\pi N \rightarrow \pi N$ elastic scattering at finite density

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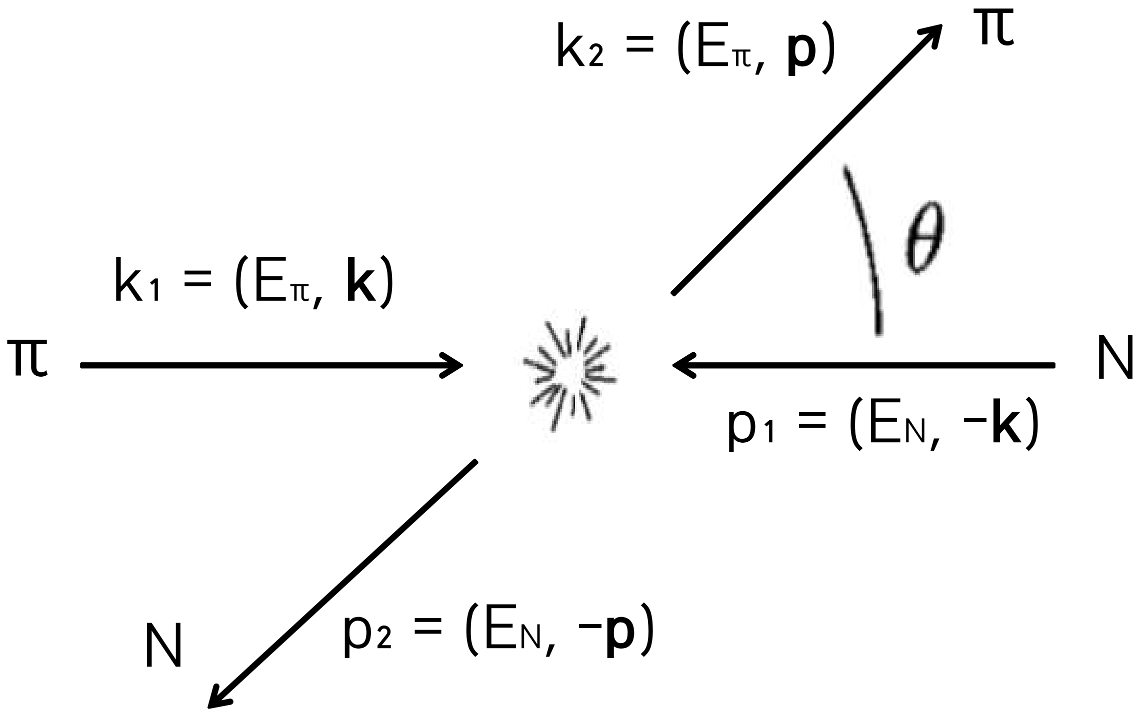
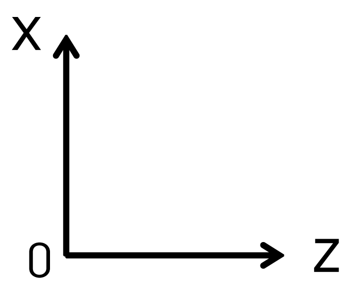
목　차

1. Introduction : πN→πN elastic scattering at finite density

○ πN→πN elastic scattering in center-of-mass frame





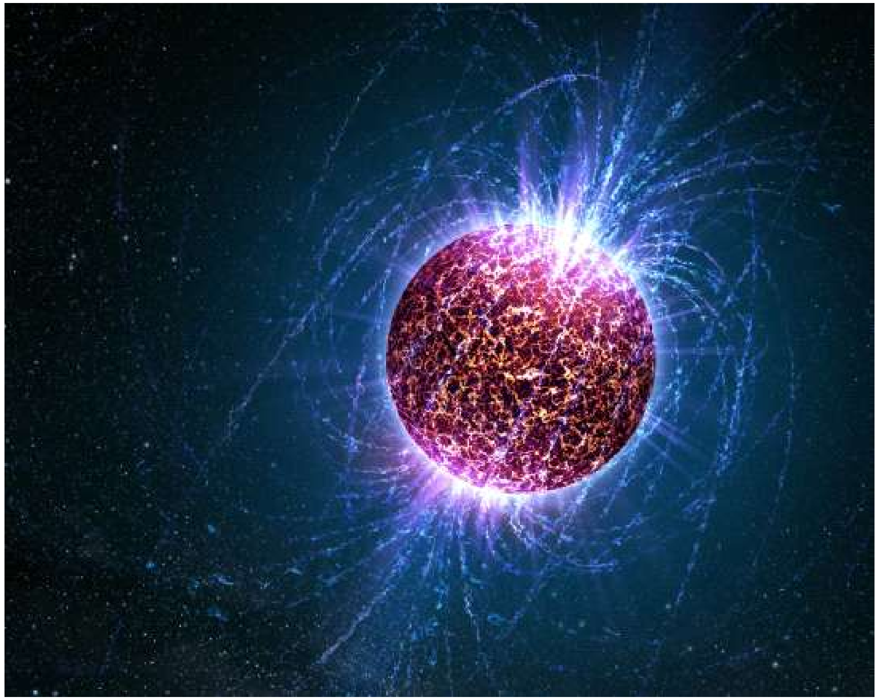
k = (0, 0, k)
p = (psinθ, 0, pcosθ)

$$E_N = \sqrt{M_N^2 + |\vec{k}|^2}$$

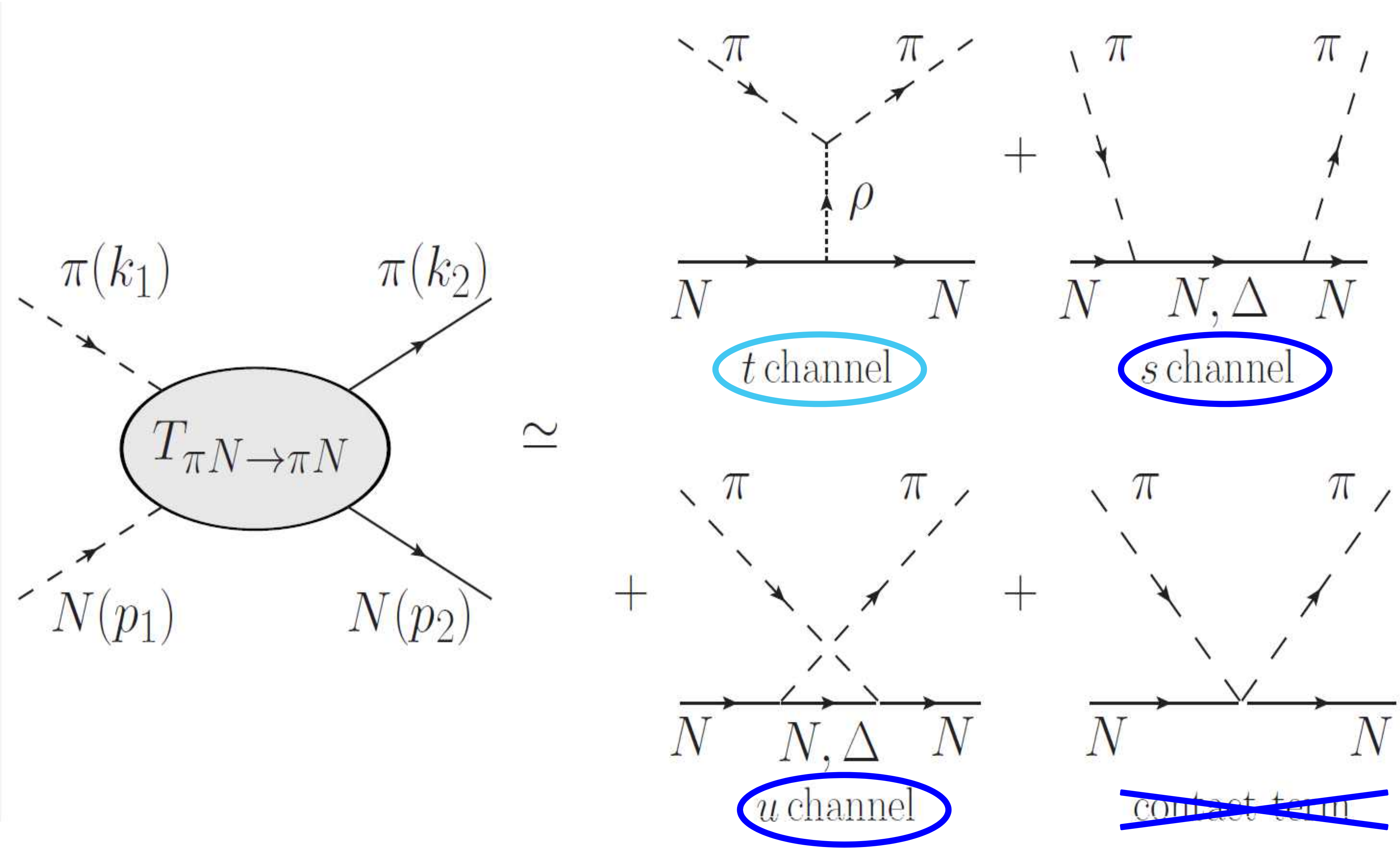
$$E_\pi = \sqrt{M_\pi^2 + |\vec{k}|^2}$$

1. Introduction : πN→πN elastic scattering at finite density

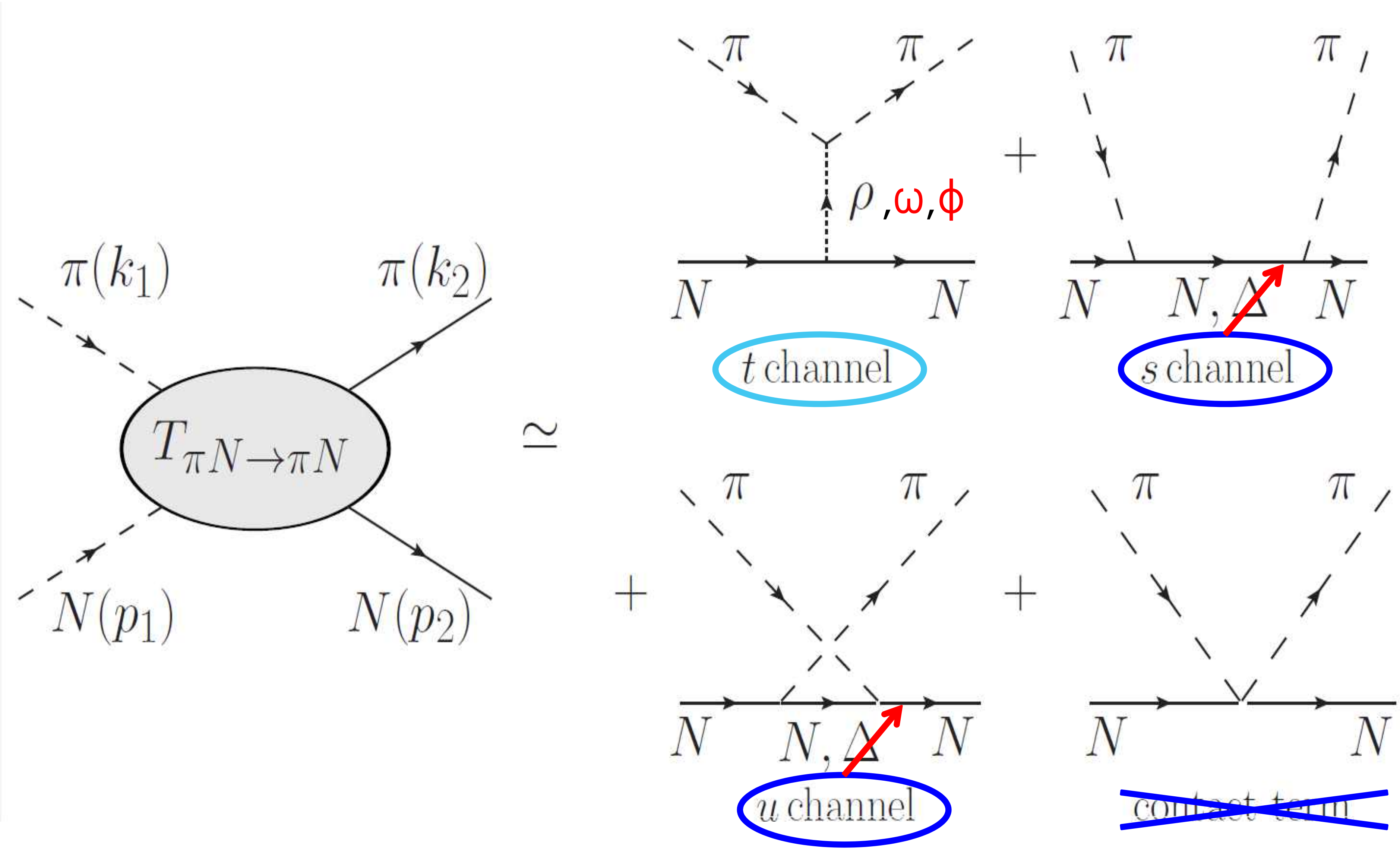
$$M_N, M_\pi \rightarrow M_N(\rho), M_\pi(\rho)$$



2. Amplitude calculation : πN→πN elastic scattering



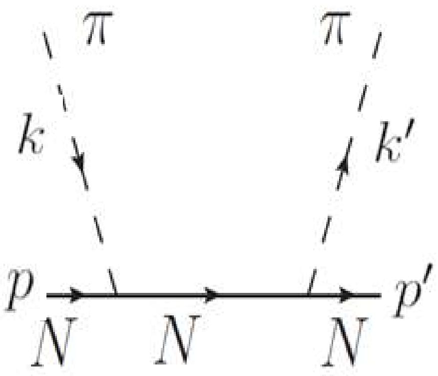
2. Amplitude calculation : πN→πN elastic scattering



2. Amplitude calculation : πN→πN elastic scattering

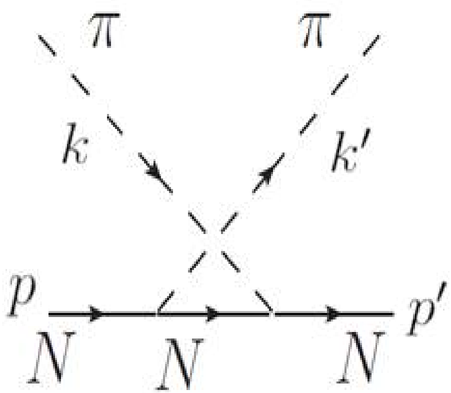
$$\mathcal{L}_{\pi NN} = \frac{g_{\pi NN}}{2f_\pi}\bar{N}\gamma^5 \partial\!\!\!/ \pi N$$

○ S-channel



$$\mathcal{M}_s = -\frac{g^2_{\pi NN}}{4f^2_\pi}\bar{u}(p')\gamma_5 k\!\!\!/' \frac{p\!\!\!/ + k\!\!\!/ + m_N}{(p+k)^2 - m_N^2}\gamma_5 k\!\!\!/ u(p)$$

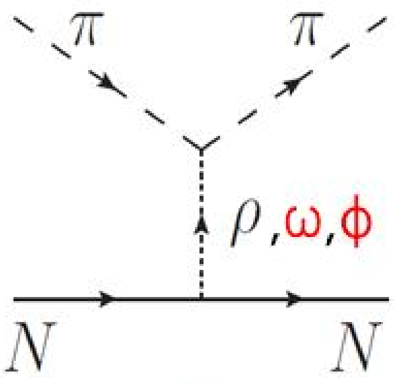
○ U-channel



$$\mathcal{M}_u = -\frac{g^2_{\pi NN}}{4f^2_\pi}\bar{u}(p')\gamma_5 k\!\!\!/ \frac{p\!\!\!/ - k\!\!\!/' + m_N}{(p-k')^2 - m_N^2}\gamma_5 k\!\!\!/' u(p)$$

2. Amplitude calculation : πN→πN elastic scattering

○ T-channel



$$\mathcal{L}_{\rho\pi\pi} = -ig_{\rho\pi\pi}\rho_\mu(\boldsymbol{\pi}\cdot\partial^\mu\boldsymbol{\pi} - \partial^\mu\boldsymbol{\pi}\cdot\boldsymbol{\pi})$$

$$\mathcal{L}_{\rho NN} = -ig_{\rho NN}\bar{N}[\rho^\mu\gamma_\mu - \frac{\kappa_{\rho NN}}{2M_N}\partial^\nu\rho^\mu\sigma_{\mu\nu}]N + H.c.$$

⋮

2. Amplitude calculation : πN→πN elastic scattering

○ Form factor

- s, u channel

$$F_x(q^2) = \frac{\Lambda^4}{\Lambda^4+(x-M_x^2)^2}, \quad x = s, u$$

(Λ = cut-off mass, M_x = exchange particle mass)

- t channel

$$F_B(q^2) = \frac{\Lambda^4}{\Lambda^4+(t-M_B^2)^2}, \quad B = \rho, \omega, \phi$$

3. Cross-section calculation

- Differential Cross-Section (DCS)

$$\left(\frac{\partial\sigma}{\partial\Omega}\right)_{CM} = \frac{1}{2E_A 2E_B|v_A - v_B|}\frac{|p_1|}{(2\pi)^2 4E_{CM}}\left|\mathcal{M}(p_A, p_B \rightarrow p_1, p_2)\right|^2$$

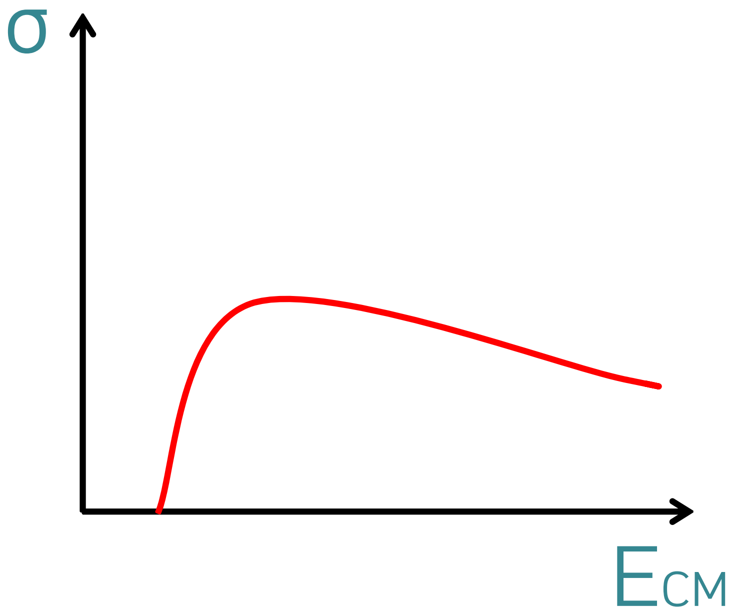
$$\Rightarrow \frac{1}{64\pi^2}\frac{p}{k}\frac{1}{E_{CM}^2}\frac{1}{2}\sum_{spins}|\mathcal{M}|^2$$

- Total Cross-Section (TCS)

$$\sigma^{total} = 2\pi \int_0^{\pi} \left(\frac{\partial\sigma}{\partial\Omega}\right)_{CM} sin\theta \, d\theta$$

3. Cross-section calculation

○ πN→πN elastic scattering at finite density



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