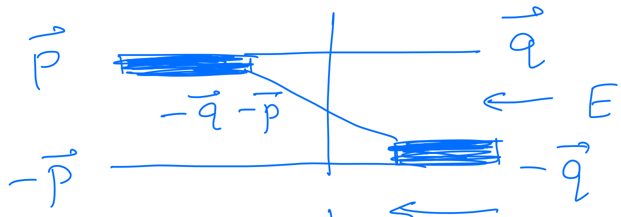
Exercise 4

1.



$$\frac{1}{E-H_0}$$

$$= \frac{1}{E - \frac{p^2}{2M} - \frac{(\vec{p}+\vec{q})^2}{2M} - \frac{q^2}{2M}}$$

$$= \frac{M}{\boxed{ME - p^2 - q^2 - \vec{p}\cdot\vec{q}}}$$

2.

$$\frac{1}{2}\int_{-1}^{1} \frac{d(\cos\theta)}{ME - p^2 - q^2 - pq\cos\theta}$$

$$= \frac{1}{pq}\,\frac{1}{2}\int_{-1}^{1}\frac{dx}{a-x}$$

where $a = \frac{ME - p^2 - q^2}{pq}$

$$= \frac{1}{pq}\,\frac{1}{2}\ln\left(\frac{a+1}{a-1}\right) = Q_0(a)$$

3.

$\frac{ME - p^2 - q^2}{pq} - 1$: singularity

Consider $ME - p^2 - q^2 - \vec{p}\cdot\vec{q}$

$$= \frac{3k^2}{4} - MB \cancel{- p^2 - q^2 - (\vec{p}\cdot\vec{q})}$$

To find first k for which there is 3B singularity I set this to 0

$$\Rightarrow \text{ If } \frac{3k^2}{4} - MB = 0 \quad \text{i.e. } E = 0$$

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4. $$\tau(q;E) = \frac{1}{-\gamma + \sqrt{\frac{3q^2}{4} - ME}}$$

$$= \frac{\gamma + \sqrt{\frac{3q^2}{4} - ME}}{-MB + \left(\frac{3q^2}{4} - ME\right)}$$

$$= \frac{1}{M} \frac{\gamma + \sqrt{\frac{3q^2}{4} - ME}}{-E - B + \frac{3q^2}{4M}}$$

$E < -B$ no singularity

$0 > E > -B$ simple pole when $q = k$

since $E + B = \frac{3k^2}{4M}$

Neutron-deuteron state can go on shell.