CUSPS 101

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NRW-FAIR

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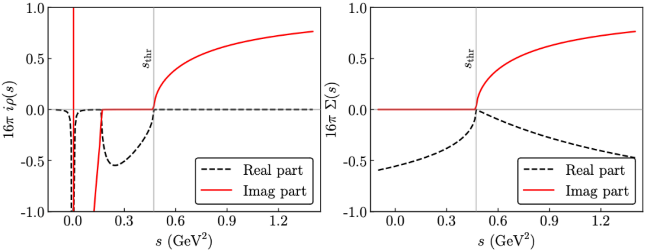
ILLUSTRATION: THE SCALAR LOOP



For $s > s_{\rm thr}$

PDG resonance review 2024

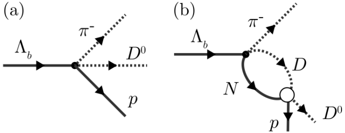
$$\Sigma_a(s) = \frac{1}{16\pi^2}\left[\frac{2q_a}{\sqrt{s}}\log\left|\frac{m_1^2+m_2^2-s+2\sqrt{s}q_a}{2m_1m_2}\right| - (m_1^2-m_2^2)\left(\frac{1}{s}-\frac{1}{(m_1+m_2)^2}\right)\log\frac{m_1}{m_2}\right] + i\rho_a(s)$$

with

$$\rho_a(s) = \frac{q_a}{8\pi\sqrt{s}} = \frac{\sqrt{(s-(m_1^2+m_2^2))}\sqrt{(s-(m_1^2-m_2^2))}}{16\pi s}$$

EFFECT IN COUPLED CHANNEL SCATTERING

S. Sakai, F. K. Guo and B. Kubis, PLB808(2020)135623



$$G_i^\Lambda = \int^\Lambda \frac{d^3\mathbf{q}}{(2\pi)^3} \frac{2\mu_i}{\mathbf{q}^2 - p_i^2 - i\epsilon}$$
$$= i\frac{\mu_i}{2\pi} p_i + \frac{\mu_i}{\pi^2}\Lambda \left[1 + \mathcal{O}\left(\frac{p_i^2}{\Lambda^2}\right)\right].$$

$$T^{\mathrm{NR}} = -\frac{2\pi}{\det} \begin{pmatrix} \frac{1}{\mu_1}\left(\frac{1}{a_{22}} + ip_2\right) & \frac{1}{a_{12}\sqrt{\mu_1\mu_2}} \\ \frac{1}{a_{12}\sqrt{\mu_1\mu_2}} & \frac{1}{\mu_2}\left(\frac{1}{a_{11}} + ip_1\right) \end{pmatrix}$$

with

$$\det = \frac{1}{a_{12}^2} - \left(\frac{1}{a_{11}} + ip_1\right)\left(\frac{1}{a_{22}} + ip_2\right),$$

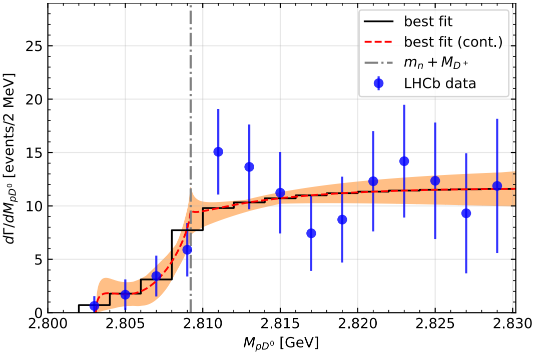
and $p_1 = \sqrt{2\mu_1 E}$ & $p_2 = \sqrt{2\mu_2(E-\delta)}$, $\delta = m_1^{(2)} + m_2^{(2)} - (m_1^{(1)} + m_2^{(1)}) > 0$

$\Longrightarrow$ at higher threshold p_2 switches from imag. to real

RESULTS

Fit function:

$$\mathcal{A}_1 = P_1\left(T_{11}^{\mathrm{NR}} + \frac{P_2}{P_1}T_{21}^{\mathrm{NR}}\right), \quad \text{and} \quad \mathcal{A}_2 = P_1\left(T_{12}^{\mathrm{NR}} + \frac{P_2}{P_1}T_{22}^{\mathrm{NR}}\right)$$



$a^{\mathrm{I}=0} = 0.79^{+0.61}_{-0.66}$ fm

and

$a^{\mathrm{I}=1} = 3.8^{+2.0}_{-1.4} - i2.7^{+2.7}_{-1.6}$ fm

FIRST STEPS TOWARDS YY