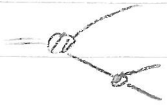
Notes on three-body decays:

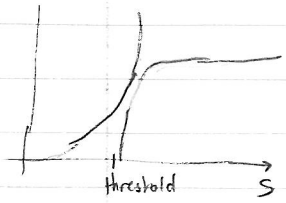
e.g: 

LEVELS OF APPROX

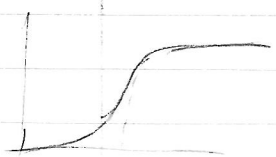
Crude: Below threshold, neglect width in denominator $\frac{1}{M^2 - m^2 + i\epsilon}$ (off-shell)

Above threshold, use on-shell (two-body) process.

two curves don't join perfectly.



Better: For narrow widths, neglect real part of $\Sigma'(p^2)$ and use Breit-Wigner form. (Valid for all Q^2)



Best: For large widths, retain full M^2 dependence: (Valid across all Q^2)

$$\frac{1}{M^2 - m^2 - \Sigma(M^2)}$$

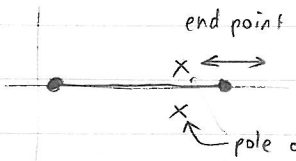
[Be sure to apply pinch technique to remove gauge dependence from Σ].

Comments:

- Useful to parametrize amplitude in a way that is consistent with unitarity.

  Γ in numerator, Γ in denominator.

- Understand result (behavior near threshold) by investigating analytic structure.



NEARBY POLE saturates amplitude,

- limit $\Gamma \to 0$ gives narrow width approximation

- Explore issue of double counting with

  $e^- N \to e^- N \gamma^*$, $\gamma^* \to e^+ e^-$