N* Focus Session
Threshold Resonances

- $S_{11} (1535) \sim \eta N$ thresh (1487 MeV)
- $P_{11} (1440) \sim \pi\pi N$ thresh (1317 MeV)
- $\Lambda(1405) \sim K N$ thresh (1433 MeV)
- Each reaction S-wave, ~attractive
- How to decide if qqq or mes-bar molec?
  - EM form factor (e.g. $A_{1/2}(Q^2)$ for $S_{11}(1535)$ flat $\Rightarrow$ small (qqq)
  - Siggi Krewald (Effective Langrangian with coupled channels with microscopic nonres)
    - Can put in qqq or molec
    - Search for pole, better fit with or without res
  - Juan Nieves (chiral coup chan Lagrangian )
    - Can scat. data be fit with no qqq mechanism?
  - David Roberts, Frank Lee (quenched lattice QCD)
    - Can mass be calculated with qqq only?
present

• Effective Lagrangian, K-matrix, CMB tentatively identify these states as qqq (same as some quark models)
  – Need better data for $\gamma N \rightarrow \pi N, \pi \pi N; \pi N \rightarrow \pi \pi N$
  – Coupled channel has excellent flexibility
  – Is EM form factor a signal?

• Chiral Lagrangian fits data with molec.
  – Chiral effects important close to threshold
  – Only S-wave fit to total cross section
  – Use of coupled channels clever

• Lattice unclear
  – State of art has chiral symmetry in quenched calc.
  – Previous calcs had Roper, $\Lambda(1405)$ mass $\sim 400$ MeV high, but very recent Kentucky calc (Frank Lee) has sudden change in mass at $m_\pi < 400$ GeV (Baysian!)
  – But is it true mass?
    • Z graphs as with $a_0$?
    • Coupling to $\pi N, \pi \pi N$?
future

- Effective Lagrangian
  - More data is coming
    - $pp \rightarrow pp\pi^+\pi^-$ (WASA, Sweden)
    - $\pi N \rightarrow \pi \pi N$ (BNL)
    - $\gamma N \rightarrow \pi \pi N$ (CLAS, Bonn)
  - Better constraints, use of symmetries
- Chiral Lagrangian
  - Hard to extend
- Lattice QCD
  - Must continue to analyze Ky results
  - $qqqq\bar{q}$ interp. op. “few years away”
  - Full QCD “few years away” (harder)
  - Full scattering simulation “at least 10 years away” Lütcher