## TOP3 (Igor, Vitaliy): Baryon resonances: present status and understanding of resonance-vector meson couplings

+ Victor, Andrew

- Inverse Pion Electroproduction, $\pi^- p \rightarrow e+e-n$
- $\pi N \rightarrow$ 2pN and $\rho N$ component.
- $\pi N \rightarrow K^0 \Lambda$
- $\pi^- p \rightarrow n\gamma$ for Neutron EM couplings.
- $\eta N$ production
- omega-meson dynamics
- **why new (and what) data on $\pi N$ are needed**

Introduction (Igor)

- Spectroscopy of Baryons.
- SAID for Baryon Spectroscopy.
- pN Elastic Scattering.
- pN inElastic Scattering.
- Pion Photoproduction.
- Pion Electroproduction.

## TOP1 (Beatrice, Stefan, Bengt) Electromagnetic Transition Form Factors of baryon resonances

Time-Like (TL) electromagnetic form factors:

- Introduction, Beatrice or anybody
  - Non-resonant Bremsstrahlung → TL electromagnetic nucleon form factors in the unphysical region
  - Charged current emission → meson form factors:
  - Baryonic resonance Dalitz decays → Time-Like electromagnetic transition Form Factors
- Experimental status and methods (data and projects) in SL and TL regions
  - Nucleon, Beatrice
    - Space-Like region: Rosenbluth / polarization methods
    - Time-Like region pbarp→$e^+e^-$, $e^+e^-$→pbarp, ISR technique, ideas to access the unphysical region:
  - Baryonic Transitions:
    - Space-Like: photo and electro-excitation of baryonic resonances. What are the baryonic resonances with the largest radiative decays? Are the behavior of the form factors with $q^2$ very different

        - Time-Like: Dalitz decay of baryonic resonances: what are the experimental results?
        - specificities of pp reactions, $\pi^-$p reactions, can we think of pbarp reactions?

- The concept of form factors and the link between TL and SL regions
    - what are the known constraints (charge, magnetic moments, radiative decays) Teresa?
    - asymptotic behavior of form factors for nucleon and transition (useful for very large $q^2$ only?) Teresa?
    - how powerful are dispersion relations? What is needed as an input for dispersive treatments (and other approaches)? Close relation to coupling of resonances to nucleon + $2\pi$ Stefan. How well do we know this (Igor)?
    - Interpretation of form factors: Space-Like: relation of FF to transverse spatial distributions? Time-like: higher sensitivity to the hadron spectrum, and the hadronic decays into $e^+e^-$ Stefan?
    - the problem of the non-physical region : how to define a form factor for a broad resonance? and for an off-shell proton? Bengt
- How to build models for the TL region:
    - analytical continuation of SL form factor models (constrained on data): what are the theoretical uncertainties? Does it give a valid constraint in the (time-like) region of the vector meson poles? Teresa?
    - coupling of baryons to photons.
        - Validity of Vector Dominance Models? VDM and pion cloud, is there a double counting? Hendrik
        - Can we learn something from meson form factors comparison to models? Stefan
        - how to understand the presence in models of a structure not corresponding to a physical vector meson mass Beatrice (Iachello form factor), Teresa (her model), Hendrik (general comments)
        - Can the coupling of baryons to photons be calculated on the lattice? Hartmut?
- From form factors to dilepton production (models) and vice versa (experiment)
    - resonance models: the problem of Dalitz decay width - constraints from radiative decay width- why are there still difference between calculations, even for point-like case (constant form factor)? Piotr or Beatrice
    - Baryonic transition form factor models and/or baryon coupling to vector mesons: what is the best approach ? Can the baryon coupling approach work for small $q^2$? Hendrik, Burkhard?
    - One Boson Exchange models: how to deal with gauge invariance, is it a crucial problem? (Burhard). Are calculations including many resonances feasible?

- What is the sensitivity of data and calculations to the form factors? Burkhard, Piotr. The problem of non-resonant contribution: how can one experimentally extract a transition form factor Bengt
- Is the concept of electromagnetic form factors useful for in-medium calculations of dielectron production? Bengt
- Will someone use the Rapp/Wambach model and predict the reaction $\pi$+N to dilepton+N? Hendrik?

## TOP2 (Volker, Burkhard, Charles) Dielectron and photon radiation from dense nuclear matter

- What are the effects of baryons on photon and dilepton spectra and $v_2$?
  - Does it make sense to study this also at HADES energies?
- What are the higher moments of spectrum anisotropy for photons (i.e. $v_n$)? Can they tell us anything more?
- What are the effects of dynamics on photon momentum anisotropies? Can we constrain the dynamics (hydro vs "fireball(s)")?
  - Dynamics
    - Fluctuating initial states
    - Viscosities
- How can we constrain off-shell effects on dilepton spectra?
- Can we learn from dilepton $v_2$, and $v_n$?
- Pre-equilibrium photons?
- Photons and dileptons from baryon resonances
  - How does a resonance with $M>>M_0$ + Gamma shine?
  - Does it make sense to talk about a resonance and a form factor in that case?
  - How are these things treated in transport and in the spectral function approach. Similar, different?
- What needs to be done to declare success? What are the essential cross sections/ form factors to be measured? What controls on the dynamics need to be verified?

## TOP4 (Teresa, Olaf) Theoretical developments in the context of electromagnetic decays of baryonic resonances

Hendrik, Gilberto, Gernot, David

- What are the prospects for lattice QCD to constrain model calculations of medium effects in dense and hot matter? (David)
  - How can lattice QCD incorporate decay channels of mesons and baryons?

- What can calculations within the Dyson-Schwinger formalism or other covariant formalisms add to the understanding of the electromagnetic coupling of baryons, and their behavior in dense matter? (Gernot & Gilberto)
  - How to bridge timelike and space like regions in those formalisms?
- What is the role of models in the calculations of emissivity of baryons and mesons? (Hendrik, Gernot & Gilberto)
  - What is the role of resonance approaches and how to constrain non-resonance effects in the medium?
  - Finally, and to unify ideas into a specific goal and conclusion "Interplay of lattice QCD and models"
  - How can lattice QCD constrain calculations of the emissivity of baryons and mesons? How can lattice QCD data be incorporated into model calculations? (ALL)