PR12-13-003: *An initial study of mesons and baryons containing strange quarks with GlueX*

M.R. Pennington, P. Guo

GlueX is the flagship experiment in Hall D. It has been approved for 120 days of initial running by a previous PAC. The aim of this experiment is to take a large dataset on meson and baryon photoproduction with sufficient statistics and well understood systematics to allow clean Amplitude Analyses of a whole range of hadronic final states essential for revealing, and unambiguously determining, signals for mesons with *unusual* quantum numbers and those with other *unusual* properties. These may prove that excitations, for which gluons are essential to their quantum numbers, do indeed exist. Other states may have multi-quark or molecular structures.

PAC 39 previously received a proposal to explore the strange sector, for which the installation of kaon identification hardware and level-three (software) trigger were proposed. This proposal was conditionally approved, pending a final design of the kaon ID system. The current proposal focuses on those parts of the GlueX program that can be addressed with the baseline hardware.

Initially, GlueX will likely focus on the lightest "exotic" hybrid mesons, like those with $J^{PC} = 1^{-+}$, which lattice calculations have confirmed should be well within the mass range accessible to photoproduction in the GlueX energy region. While there already exist hints of such *unusual* states in isovector systems, to be claimed as hybrids they should come in appropriate flavor multiplets to be confirmed by the identification of their companion strange isodoublets. This proposal for Phase IV of the GlueX experiment addresses these.

Moreover, the discovery by e^+e^- colliders of the X, Y, Z mesons in the charmonium, and even bottomonium sectors, has led to the expectation that there may be partners with hidden strangeness (like the $Y(2175)$ seen by BaBar, Belle and BES). These too may be in the mass region accessible to GlueX. Exploration of strange decays may be critical to determining their quantum numbers, exposing their dynamics and structure, and revealing whether there exist even more surprises in spectroscopy. Moreover the identification of strange baryons, especially Ξ^*'s above 1.6 GeV may well be essential to an understanding of N^*'s and Δ^*'s extracted from 6 GeV results with CLAS.

The present proposal builds on that presented to PAC39 by exploring the scope for kaon identification using only the baseline equipment of GlueX. The proposal notes that the capability for kaon/pion separation is limited over the full momentum range, without dedicated hardware. Nevertheless an order of magnitude increase in statistics may provide data on channels with strangeness with meaningful numbers of events for Amplitude Analyses. At the same time the identification of hybrids with 0^{+-} and 2^{+-} quantum numbers may well require increased statistics compared to that needed for the 1^{-+} states. Consequently, this proposal is for a further 200 days of running at an average intensity of $5.\,10^7$ tagged photons that simulations show should produce 10^4 events per 10 MeV mass bin of the photoproduced system. Such running in Phase IV of GlueX will generate a factor of 10 more statistics on multi-pion production than in earlier Phases. The increased statistics will allow sensitivity to very small photo-produced signals for spectroscopy studies.

Clearly, supplementing the existing time-of-flight detector with a forward Cherenkov particle identification system would enable kaon identification to high momenta. This proposal does not obviate the need for such a dedicated system. Nevertheless, these studies of what may be achieved without such hardware are impressive. The GlueX program cannot achieve its goals of definitively establishing *unusual* hadrons, identifying their quantum numbers, exposing their nature and structure without a resolution of their flavor composition, whether for mesons or baryons. Thus the case for this proposal is irrefutable.