The GlueX Experiment

Jefferson Lab Hall-D Experiment E12-06-102

Mapping the Spectrum of Light Quark Mesons and Gluonic Excitations with Linearly Polarized Photons

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The primary physics goal of the GlueX experiment is to search for particles in which the gluonic field binding the quarks and antiquarks has been excited. Theoretical predictions for these particles suggest that several families of these should exist. In addition, several of these families are expected to have underlying quantum numbers of the strong interaction that are not allowed for quark-antiquark systems (mesons) in which the gluonic field is not excited. GlueX will open the door on high-statistics searches for these "exotic hybrids" utilizing photon beams, and with the experiments nearly hermetic acceptance and high-multiplicity capabilities, will be able to carry out searches in nearly all the expected decay channels for exotic hybrids. In addition to the search for exotic hybrids, the GlueX experiment will be able to study the spectrum of normal mesons, where those consisting of a strange and an antistrange quark are of particular interest.

To carry out these studies, linearly-polarized photons will be generated using the coherent bremsstrahlung technique where the 12 GeV CEBAF electron beam hit a $20\,\mu m$ thick diamond radiator. The diamond is aligned such that the energy of the coherent photons will be in the 8.4 to $9.0\,GeV$ range, with a peak linear polarization of about $40\,\%$. The interacting electrons are detected in one of two tagging arrays, which allow the energy of the photon to be measured with high precision. The photon beam is then collimated about $80\,m$ down stream of the production target, passing through a $3.4\,mm$ diameter hole, and then proceeding into the liquid hydrogen target in the GlueX detector.

Charged particles produced by the interaction of the photon in the hydrogen target are tracked through a $\sim 2\,T$ solenoidal filed using two systems of drift chambers. Flight time is measured utilizing a scintillator-based start counter around the hydrogen target combined with time measurements from a down-stream time-of-flight wall. Photons from the interaction are detected using a pair of calorimeters. In the barrel region, a lead-scintillating-fiber calorimeter both detects photons and provides timing information on charged particles. Down stream, an array of lead-glass blocks is used to reconstruct the photons.

Because of the hermetic nature of the GlueX detector, exclusive final states are reconstructed by GlueX and classified by event topology using machine-learning algorithms. Individual topologies are then used as input to sophisticated amplitude analyses to identify which short-lived intermediate particles contribute to the signal, and ultimately identify and map out the exotic hybrids.

This first phase of the GlueX Experiment will run prior to the installation of a down-stream DIRC detector for kaon identification. It will start with somewhat reduced photon intensities and work to increase those intensities utilizing sophisticated triggering. These data will open the door on a number of exotic hybrid searches and establish the analysis techniques for GlueX.