The A' Experiment (APEX)

Spokespersons: Rouven Essig (Stony Brook), Philip Schuster (SLAC), Natalia Toro (SLAC), Bogdan Wojtsekhowski (JLab)

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The Standard Model describes all known matter, and its interactions through the strong, weak, and electromagnetic forces mediated by vector bosons of the Standard Model. New forces beyond the Standard Model could have escaped detection only if their mediators are either heavier than O(TeV) or quite weakly coupled. The latter possibility can arise through a simple and generic mechanism called kinetic mixing, in which a new vector particle A' (the *dark photon*) mixes via quantum loops with the Standard Model photon. Through this mechanism, dark photons obtain a small coupling to electrically charged particles. Dark photons have received considerable attention over the last decade both as being one of the very few ways in which new forces can couple to the Standard Model and as a possible mediator between Standard Model and dark matter particles.

The A' EXperiment (APEX) is designed to search for dark photons. A' bosons can be produced by radiation off an electron beam, and could appear as narrow resonances with small production cross-section in the QED e^+e^- spectrum. We plan to search for an A' using the CEBAF electron beam at energies of 1–4 GeV incident on $0.5 - 10\%$ radiation length multi-foil tungsten and tantalum targets, and measure the resulting e^+e^- pairs using the High Resolution Spectrometers and a new septum magnet in Hall A at Jefferson Lab. With a 33-day run, APEX will explore the region 50 MeV $< m_{A'} <$ 550 MeV with couplings as low as $\alpha'/\alpha \gtrsim 10^{-7}$, where α' is the dark photon's fine structure constant.

APEX had a test run in June 2010. The test run allowed us to demonstrate the detector performance necessary for the full APEX run. A small amount of physics-quality data was also collected, allowing the APEX collaboration to publish a (now highly cited) search for A's in a narrow mass window in *PRL*. The full run will allow us to explore a much wider mass range to much lower sensitivity. This will provide unprecedented sensitivity to dark photons in a parameter region compatible with dark photons being a mediator of dark matter interactions as well as if the Standard Model hypercharge gauge force is part of a Grand Unified Theory.