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The KamLAND Experiment: Measuring Terrestrial and Solar Neutrinos

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Since the 1950's, physicists have used nuclear reactors to study the properties of antineutrinos. In 1956, one of the first such experiments, Project Poltergeist, proved the existence of antineutrinos. The initial experiments were only a few meters away from the reactor core, the source of electron antineutrinos. Over the years the experiments steadily increased their baselines, with the goal to test and ultimately establish neutrino disappearance. That goal was reached in 2002, when the KamLAND Collaboration, using a one kton liquid scintillator detector, reported the first observation of electron antineutrino disappearance from 53 Japanese reactors at an effective baseline of $\sim$180 km. KamLAND has since observed distortions in the antineutrino energy spectrum, a telltale sign of neutrino oscillation. The experiment has also measured a key neutrino oscillation parameter, the solar mass-splitting, to unprecedented levels. Reactors, however, are not the only source of antineutrinos on Earth. Radioactive decays in the Earth also produce antineutrinos and the heat released in that process may be the driving force for mantle convection, which is responsible for terrestrial phenomena such as plate tectonics. KamLAND is sensitive to geologically produced electron antineutrinos from the ^{238}U and ^{232}Th decay chains. Earth composition models predict that these are responsible for the majority of the radiogenic heat; detection of geoneutrinos from these two decays allows the models to be directly tested for the first time. I will discuss how KamLAND's measurements have further solidified the case for neutrino oscillation and the exciting recent investigation of geoneutrinos. I will conclude with an outlook on the next, low-background phase of the experiment that aims to measure the flux of solar ^{7}Be neutrinos.