

HONORS 135 - Ideas in Honors - Week 5

Modern Experiments

Demo: Visit ATLAS lab

Overview: Different frontiers of HEP - cosmic, energy, intensity. Talk about neutrino experiments at Fermilab. Talk about modern high energy experiments PHENIX, STAR, ATLAS, ALICE, LHCb, and what each is trying to measure. Brief mention of cosmic experiments.

Class plan:

- 10min. Review material from last week. Accelerators, the LHC. Also review methods of detection: Cherenkov, scintillation, PMTs, drift, silicon. Now, how do you detect particles in real life?
- 10min. Discussion:
You have a collision, particles shoot every where. Design a detector. Have students draw detector configurations using colored markers representing various kinds of detectors.
- 30min Slides to cover categories of detectors.
 - Detector geometry - how it is important. What are you looking for? Something forward? Transverse? High momentum? Rare?
 - HEP frontiers: Energy (colliders), Intensity (neutrino), Cosmic (dark matter)
 - Collider detectors: begin with example of particle traverse CMS
 - * PHENIX - Heavy ion detector used for studying jets. Back to back distribution. Can measure parton distribution function. Operates at RHIC, in Brookhaven NY
 - * ALICE - Heavy ion detector at LHC. Study quark gluon plasma. When heavy ions collide, overlap in elliptical shape. Flow, thermalized, quarks unbound, subseconds after big bang, photons pass straight through, other particles not.
 - * LHCb - study B physics. Forward detector. Study CP violation, anti matter/matter
 - * ATLAS - General purpose detector, has bending magnets, central detector, calorimeters, muon detectors. Inner detector for

tracking. Calorimeters measure energy. Muon detectors detect muons that make it all the way out. Magnets bend tracks to measure momentum and charge for particle ID.

- * CMS - Similar to ATLAS, together discovered Higgs. Also search for super symmetry, dark matter, heavy ion, etc.

– Neutrino detectors:

- * MINOS - neutrinos produced by Fermilab MI. Measured near beam in Chicago and 735 km away in Minnesota Soudan mine. Detectors are steel-scintillator sampling calorimeters made out of alternating planes of magnetized steel and plastic scintillators.
- * MiniBooNE - Fermilab, 800 tons of mineral oil and lined with 1,280 photomultiplier tubes
- * IceCube - Antarctica, 2,450 meter deep strings of detectors look for cosmic high energy neutrinos. Gamma ray bursts coincident with neutrinos
- * Super-Kamiokande - Japan, 1km Mozumi Mine. Discovered neutrino oscillations. 11,146 PMTs look for Cherenkov in water from electrons excited by neutrinos.

– Dark matter detectors:

- * LUX - Large Underground Xenon experiment (LUX) 370 kg liquid xenon, Homestake Mine, South Dakota, 1 mile deep. Two phases, two sets of detectors. Dark matter exclusion data results. Look for WIMPS, nuclear recoils, photon and electron production.
- * SNOLAB - 2 km in Sudbury, Ontario, hide from backgrounds. Hosts many experiments like DEAP (scintillation in 7 kg liquid argon)
- * PandaX - 18-km tunnel under 2400m, similar to LUX.

- 30min. Visit ATLAS lab.

References:

- Boris Kayser: <http://indico.cern.ch/event/318553/>