Project Findings

The data from the Austral winter 1997 has been analysed. The searches made, and results, are summarised below.

Atmospheric neutrinos The successful search for atmospheric neutrinos has been reported in a publication to Nature. Over 300 atmospheric neutrinos were found at a rate consistent with expectations. The energy range of these events makes them the highest energy neutrinos detected by any experiment. These neutrinos are being used to verify the correct operation and understanding of the detector, paving the way for other physics analyses. A detailed publication on this analysis is being prepared for submission.

Diffuse sources A search for a source of diffuse extra-terrestrial muon-neutrinos (for example from the sum of all active galaxies in the universe) has led to the best limits on such fluxes of any existing neutrino detector (e.g. Baikal) or previous detector (e.g. Frejus). The 90% confidence level limit for an assumed E^{-2} spectrum is $\Phi_{90}E^2 < 0.9 \times 10^{-6}$ GeV^{-1} cm^{-1} s^{-1} sr^{-1}, which is sufficient to rule out many of the early model predictions (1990-1996) of neutrino production in active galaxies. A comparable limit $\Phi_{90}E^2 < 7.3 \times 10^{-6}$ GeV^{-1} cm^{-1} s^{-1} sr^{-1} has been set for electron-neutrinos.

Point sources Searches have been made for cosmic objects that may be emitting neutrinos in numbers sufficient to stand out above the atmospheric neutrino background. Some active galaxies have been observed in high energy gamma-rays, and these have been searched for neutrino emission, the detection of which would confirm the hadronic nature of the acceleration mechanisms in these objects. No significant excess of events from any of these sources has been seen, leading to upper limits on the flux of neutrinos. In the case of Markarian 501, a source observed in gamma-rays, the neutrino flux limit is only a factor 10 above the level of the observed gamma-ray flux.

Gamma-ray bursts The origin of the gamma-ray emissions from gamma-ray bursts (GRBs) is still unknown. The gamma-rays from these energetic objects are detected by earth orbiting satellites, and detecting neutrinos in time and spatial coincidence with these objects would signify a hadronic acceleration mechanism is at work. The AMANDA B10 data has been searched for evidence of neutrino emissions in spatial and temporal coincidence with the BATSE observations. No significant excess of events has been found, and limits have been placed on the fluxes of neutrinos from these objects.

Supernovae The expected burst of low energy neutrinos from a stellar collapse can be detected by the AMANDA detector, by looking for a brief increase in the counting rates of the detector optical modules caused by the interaction of these low energy neutrinos with the ice in the detector. The AMANDA B10 detector can monitor 70% of the galaxy at 90% efficiency. A 90% confidence level upper limit of < 4.3 such collapses per year for our galaxy is found.

WIMPs Weakly Interacting Massive Particles (WIMPs), predicted by supersymmetric extensions of the standard model, are a candidate for the cold dark matter thought to exist in the universe. Such particles will become gravitationally trapped in the earth's centre, where they will annihilate with each other producing neutrinos. The AMANDA B10 data has been searched for an excess of events from the earth's centre. No such excess events have been found, and limits have therefore been placed on some supersymmetric models.

Monopoles The existence of magnetic monopoles was suggested by Dirac in 1931. These are also predicted by grand unification theories, where monopole masses in the range $10^8 - 10^{17}$GeV are predicted. A relativistic monopole would appear in the AMANDA detector as a track with a brightness 8300 times that of a minimum ionising muon, and thus very bright track-like events are searched for. An upper limit on the flux of monopoles has been placed at a level $\Phi < 0.62 \times 10^{-16}$ cm^{-1} s^{-1} sr^{-1}.