Neutrino Astronomy and Astroparticle Physics with IceCube

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The IceCube Neutrino Observatory is the world's largest neutrino detector and is the first high energy neutrino telescope to explore this new window on the Universe. Soon after completion of the cubic kilometre, 86 string array in late 2010, the first evidence for astrophysical neutrinos began to emerge as an addition to and beyond the high energy tail of atmospheric neutrinos produced by cosmic ray interactions. Once the astrophysical neutrino flux was revealed, the search to identify the astrophysical sources began – by analysing if the neutrinos self-cluster in the sky, or if they correlate with known astrophysical objects. To date, the blazar TXS 0506+056 is the one object identified as a source, with other objects showing correlations not quite yet at discovery level significance. In this talk we will review the evidence for sources of the observed IceCube astrophysical neutrinos and discuss other particle astrophysics results obtained – including the first direct observation of a Glashow resonance interaction event at 6.3 PeV. Plans for the next generation detector – IceCube-Gen2 – which will significantly expand the size of the detector and astrophysical capabilities over the coming decades will also be discussed.