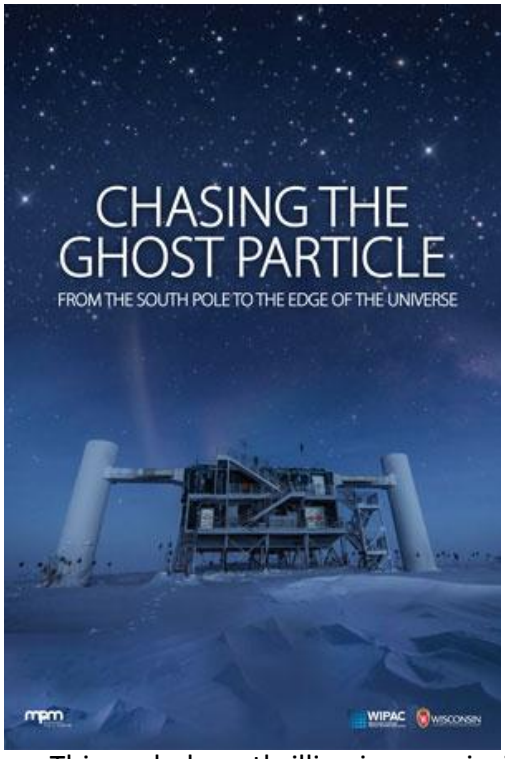

Chasing the Ghost Particle – From the South Pole to the Edge of the Universe: Teacher's Guide

Target Audience: Ages 12+ (Grade 6 – Adult)
Length: 30 minutes + Live Portion (50 minutes total)
Trailer: http://www.mpm.edu/plan-visit/theater-planetarium/chasing-ghost-particle
Expanded Description: IceCube, the biggest and strangest detector in the world, lies deep in the ice at the heart of Antarctica waiting for mysterious messengers from the cosmos. Scientists use tiny and elusive particles called neutrinos to explore the most extreme places in the universe. These ghostly neutrinos give us an exclusive way to study powerful cosmic engines like exploding stars and black holes.

This show gives stunning simulations of the most energetic places in our universe and the galaxies around us. This preludes a thrilling journey inside IceCube, where scientists look for traces of neutrino collisions in the ice. From one of the most remote locations on Earth to the unexplored regions of the cosmos, *Chasing the Ghost Particle: From the South Pole to the Edge of the Universe* will take you on a journey you won't forget.

General Concepts:

- Neutrinos are neutral, weakly interacting subatomic particles
- Neutrinos are formed in the most extreme environments of space, such as supernovae, gamma ray bursts, and black holes. These highly abundant cosmic messengers carry information that can be used to study these astronomical events
- Neutrinos rarely interact with anything since they are extremely small and fast. This makes them difficult to detect, which is how they became referred to as "ghost particles"
- Traditional telescopes study the universe around us by observing various forms of light with mirrors and lenses. These forms of light include radio waves, gamma rays, and x-rays, which give us information about astronomical phenomena
- Advances in technology have led to new telescopes that dramatically changed our view of the universe
- The IceCube Neutrino Observatory is a new type of telescope buried in one cubic kilometer of ice at the South Pole. This observatory attempts to detect rare, high-energy neutrinos
- Most neutrinos pass through IceCube without any interaction. However, if a neutrino collides with the nucleus of an atom in the ice, a muon is created. This muon then interacts with ice molecules producing blue light called Cherenkov radiation

- The Cherenkov radiation is then detected and recorded by extremely sensitive light sensors called Digital Optical Modules (DOMs)
- Exploration will not cease as long as there are curious people willing to develop creative new tools to help understand the universe

Vocabulary:

Active Galactic Nuclei (AGN)
Atom
Black Hole
Cherenkov Radiation
Cosmic Ray
Digital Optical Modules (DOMs)
Gamma Ray
Hypernova
IceCube
Light Year
Muon
Neutrino
Neutron Star
Nucleus
Radio Wave
Supernova
Photons
X-ray