Grace Cooper, Mateo Gomez, Eliot Moser, Andrea Wainwright
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IceCube Neutrino Observatory

The IceCube Observatory is a laboratory made to observe neutrinos from the highest energy sources. Neutrinos are subatomic particles very similar to electrons but they have no charge and a very small mass. They're also one of the most abundant particles in the universe. Furthermore, neutrinos are an attractive prospect because of their ability to produce fluctuations in gravitational waves. Neutrinos stimulate interest in the scientific community largely because they are one of the few subatomic particles capable of moving throughout the universe in dense capacities. Because they have very little reaction with matter, they're very hard to detect, which is why this observatory was built.

The Ice Cube Neutrino observatory is based in the south pole, and has a very extensive layout. Since neutrinos are so small, researchers needed a large area to be able to drill underground and place their sensors. “Thousands of sensors are located deep under the Antarctic ice across a cubic kilometre” [2] with the goal of detecting these particles.According to Jim Madison, a physics professor and researcher brought on to the ice cube project, the observatory itself follows a strict procedure for detecting Neutrinos. First a hole is created using a heated metal pole. From there a cable is lowered into the hole measuring at exactly 2 kilometers deep. Attached to each cable are 60 light detectors. It takes the ice about a month to freeze back up in the shape of the hole. Neutrinos, due to their neutral charge, are only visible on these detectors’ radar systems when they make contact with another Neutrino. The collision of two Neutrinos creates a light which is then absorbed by the detectors and converted into an electrical current. The current travels to the surface through the cable and the observatory is notified by lights connected to the cable. Through detecting Neutrinos scientists are able to use the data collected to detect fluctuations in gravitational waves.also because they are located in the south pole, it allows the scientists to have better access to the neutrinos. Here's how, when the neutrinos interact with atoms inside the deep arctic ice detectors, they sometimes give off puffs of energy. John Conway, a physics professor at University of California, Davis said that “As neutrinos pass through [the ice] and interact, they produce charged particles, and the charged particles traveling through the ice give off light. That’s how they’re detected. It’s like having a telescope for neutrinos underground”[3]. The ice is an essential part of the experiment, the neutrinos need it so the people studying them can do their jobs.

The goal of this observatory is to detect the neutrinos from the highest energy sources in order to locate where they are coming from, so the high energy fields can be used for further study. Scientists are able to detect neutrinos because of their origins in

magnetic fields, however, the charge from the particle reads as multiple points in the magnetic field. Due to their different readings, scientists are not able to pinpoint exact locations. If scientists could figure out the location of the high energy neutrinos, it would allow for more advanced exploration of physics concepts in a high energy environment. This in turn could lead to new innovations in technology. As of 2015, there have been detections of 40 high energy neutrinos and 14 high energy neutrinos that they know "came from astrophysical objects"[1]. Scientists at IceCube have speculated that the high energy could be coming from black holes that consume the material around it, or from gamma ray bursts that release large amounts of energy. They don't know where the neutrinos are coming from, however they do know that it is not in the Milky Way galaxy. They know this because they haven't detected anything in our galaxy that requires that high amount of energy. Also because the neutrinos are not clustering in the shape of the Milky Way, which they would be doing if they originated from there. The Neutrino Observatory uses advanced technology to interpret Neutrinos coming from high energy sources in order to discover more about the universe and potentially study what these areas are and where they are located.

Neutrinos are much more than small particles floating around in space, it's believed they had a huge part to play in the creation of this universe. They also are far more common than a person might think, according to Fermilab, "About 100 trillion neutrinos pass through your body every second without interacting with any of the particles in your body" [4]. Many scientists believe this is because they have no charge, which is what makes it so difficult to find and understand them. They could help us further understand the processes that go on within the sun as well as understand the start of the universe or the big bang. are detected and studied is just as important as to why they're being studied. This observatory has been in the process of being made for decades, up until the 90s, many scientists believed neutrons had no weight at all, and instead they actually have a very small mass. It's important to keep learning about the universe around our planet and our planet itself.

Bibliography:

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How the detect them
Why it's important
How can this data help
What does the data mean