

Title: A New View of the Universe from the Earth's South Pole

Speakers: Naoko Kurahashi Neilson

Date: October 06, 2021 - 7:00 PM

URL: <https://pirsa.org/21100053>

Abstract: The universe has been studied using light since the dawn of astronomy.

But deep down in the dark glacial ice of the South Pole, Antarctica, a very different kind of telescope is getting a new view of the universe. Operated by a team of more than 300 physicists from 12 countries, the IceCube Neutrino Observatory captures the universe in high-energy neutrinos.

Neutrinos are particles a lot like light (photons), but with one remarkable property that makes them a powerful medium for studying the universe. Physicist Naoko Kurahashi Neilson has travelled to the snow-swept IceCube Neutrino Observatory to study these elusive particles. In her October 6 Perimeter Public Lecture webcast, she will share more about the insights neutrinos can offer and what it's like conducting research in one of the least habitable places on Earth.

Kurahashi Neilson is an associate professor at Drexel University and the recipient of a CAREER award from the National Science Foundation. Symmetry magazine featured her among 10 early-career experimentalists of note in 2019.

After her undergraduate degree from University of California, Berkeley, Kurahashi Neilson obtained her PhD at Stanford University while "listening" for extremely high-energy neutrinos in the ocean in the Bahamas. She now lives outside Philadelphia with her husband and three young children, and is devoted to STEM outreach, particularly aimed at middle- and high-school girls.

A New View of the Universe from the Earth's South Pole



Naoko Kurahashi Neilson



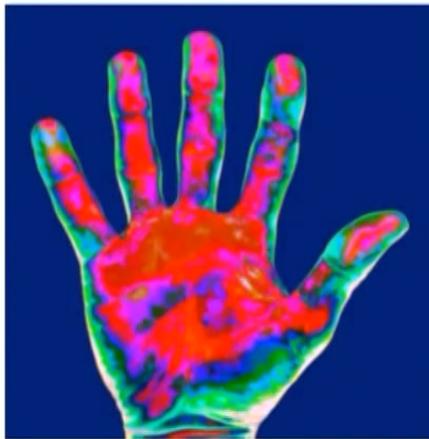
If you don't know what a hand is....



MRI image



X-ray image



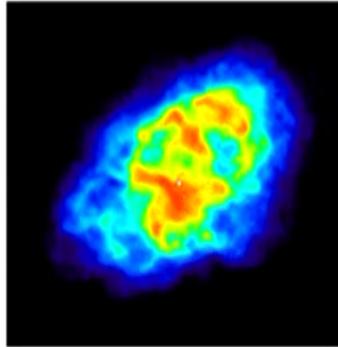
Infrared image



Optical image

The Crab Nebula

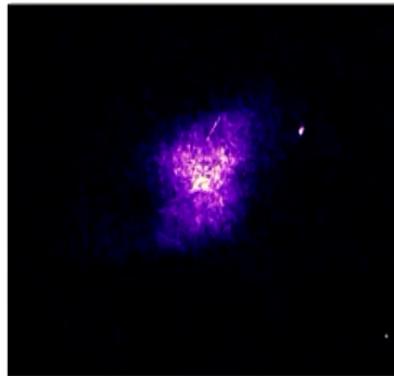
Star with gas cloud around it



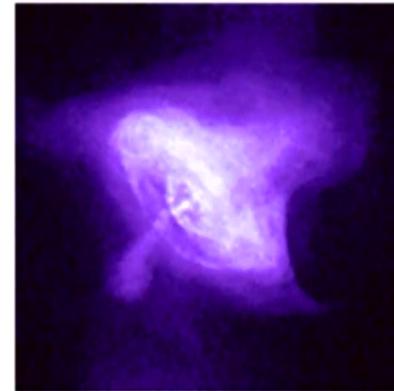
Radio image



Ultraviolet image



Optical image



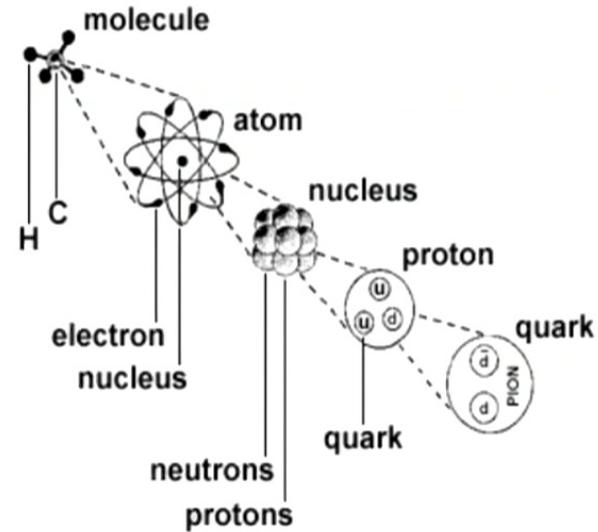
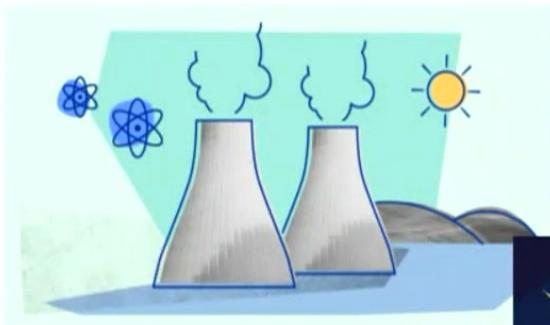
X-ray image



What are neutrinos?



- Elementary particle
- “Invisible” or “ghost” particle
 - No Electromagnetic Charge
 - Rarely Interact

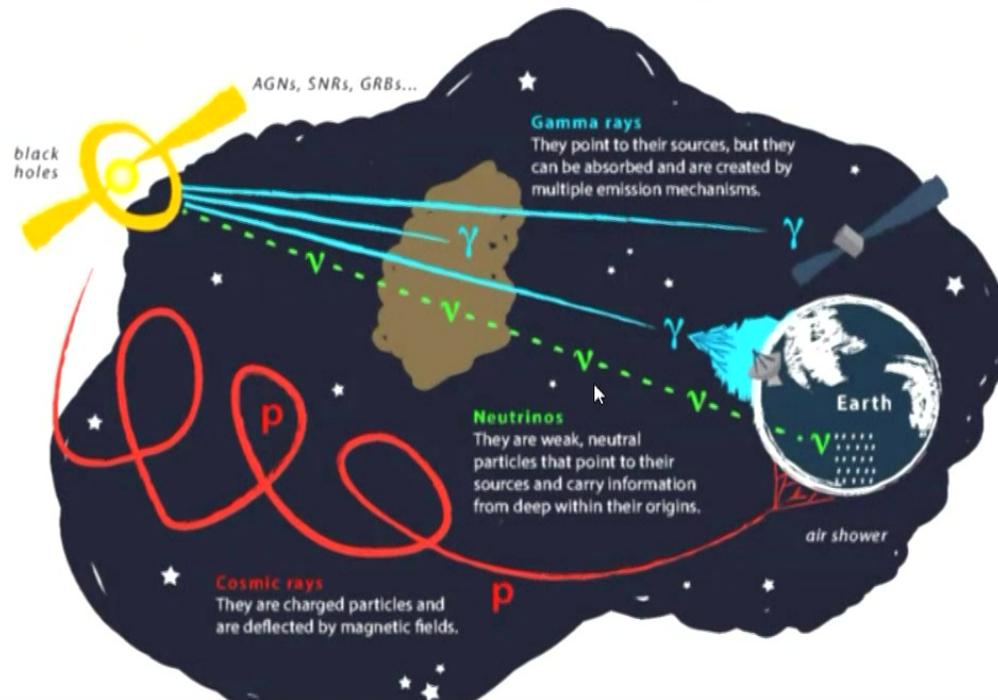


img credit: <http://neutrino.aquaphoenix.com>

Once in a while, interacts with stuff to create charged particles (like electrons, muons). These charged particles make light.

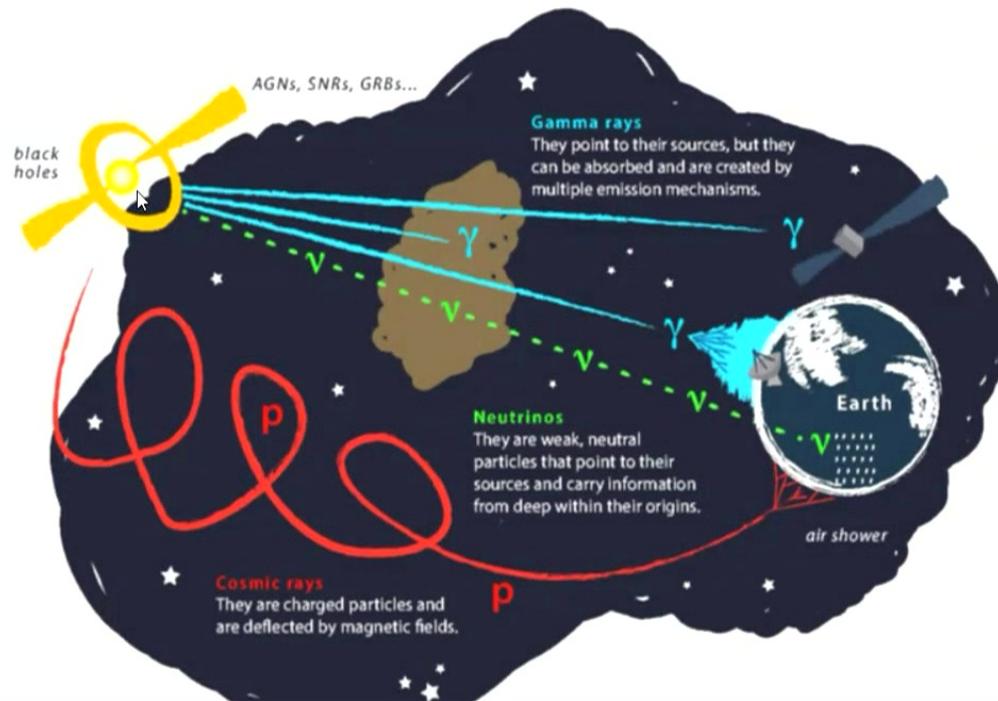
High Energy Astronomy ~ A tale of 3 signals ~

Charged nuclei: Cosmic Rays
Light (Photons): Gamma rays
Neutrinos



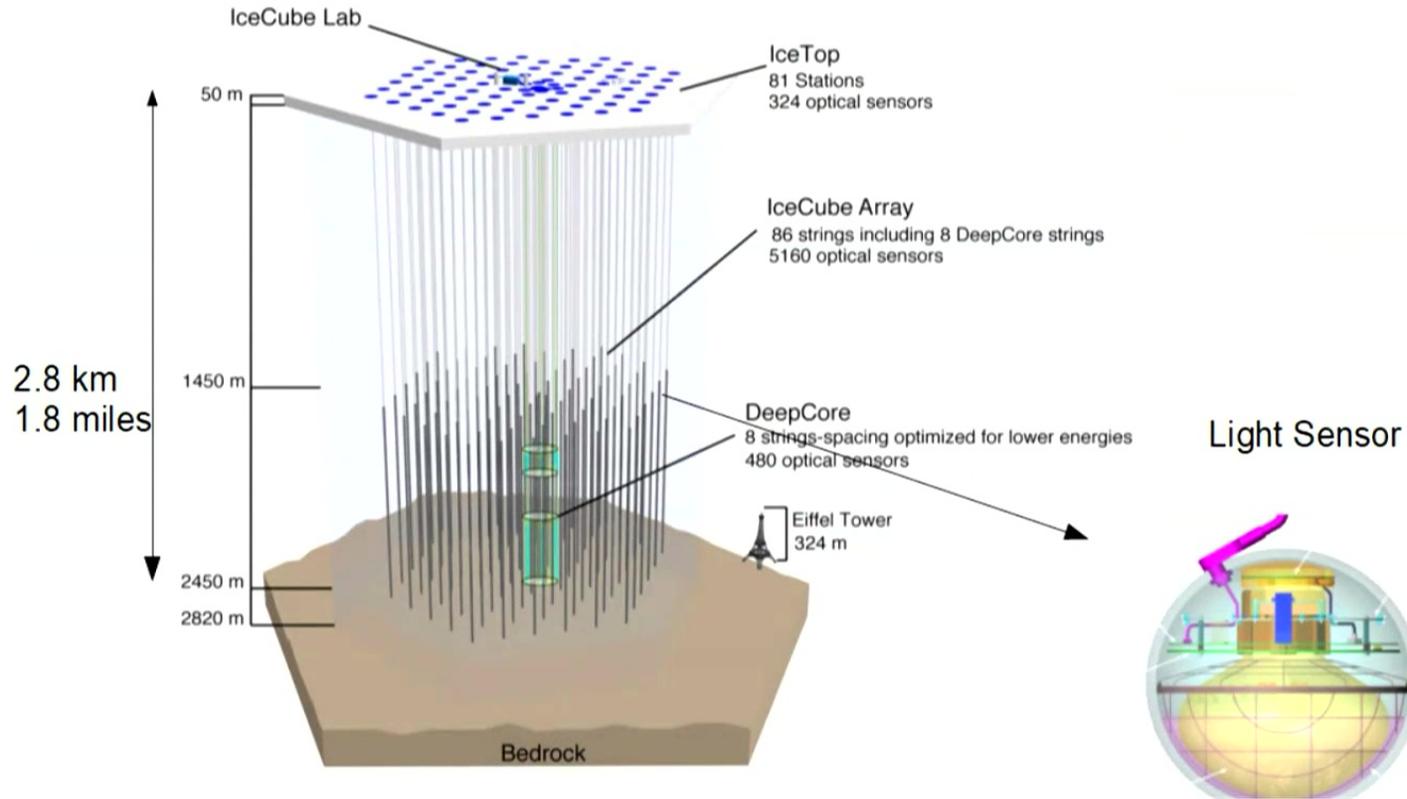
High Energy Astronomy ~ A tale of 3 signals ~

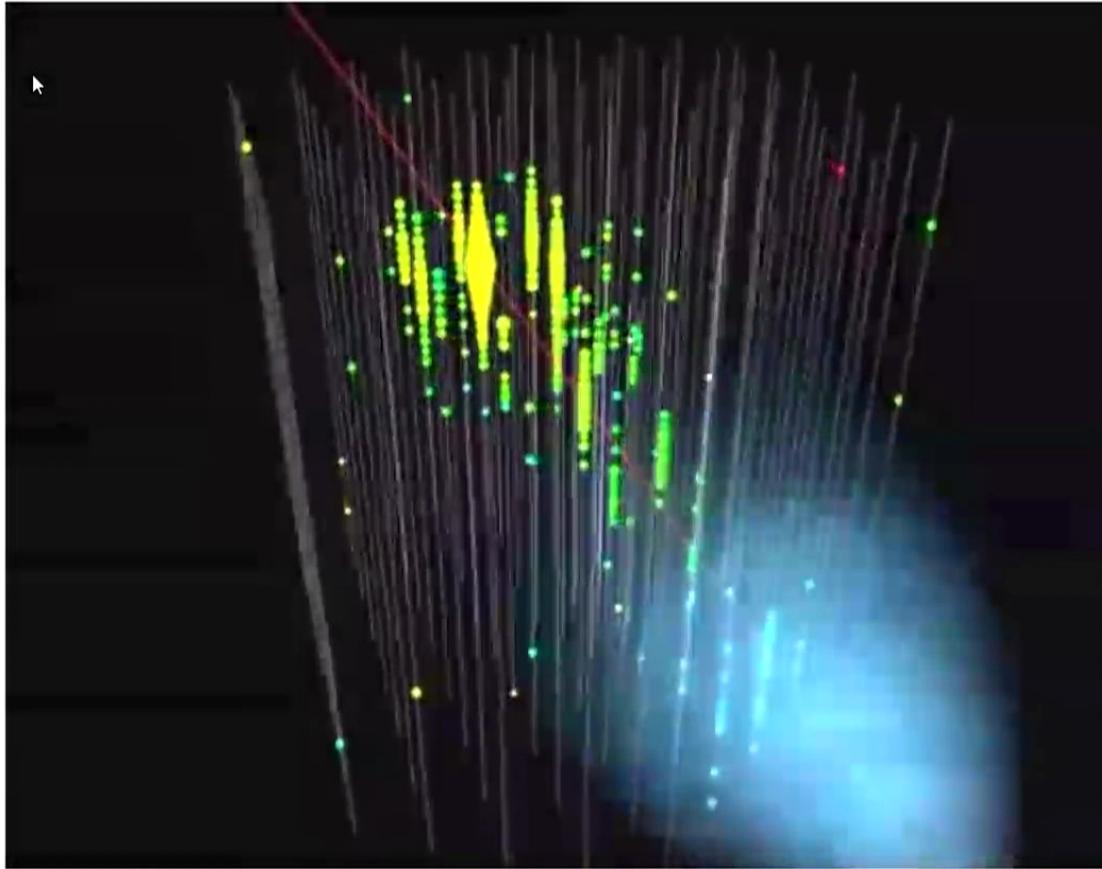
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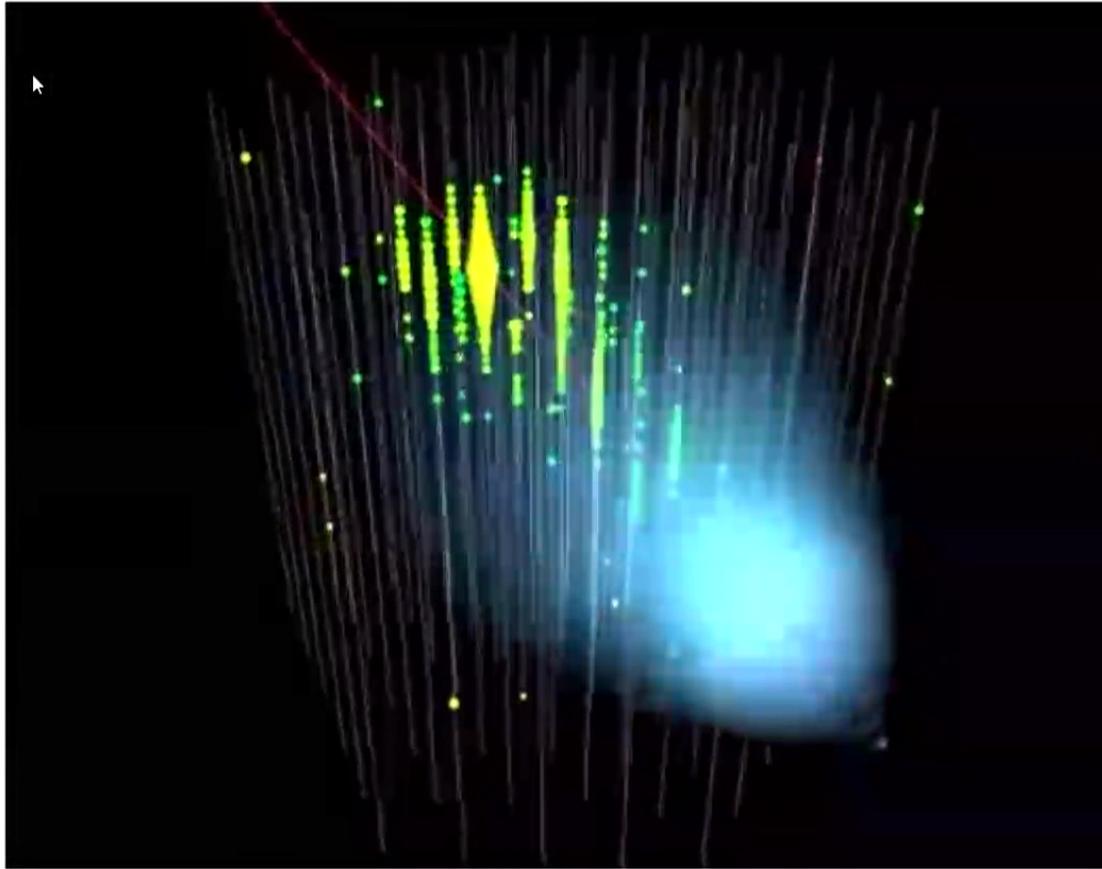




Glacier at the South Pole









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(FWO-Vlaanderen)

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German Research Foundation (DFG)
Deutsches Elektronen-Synchrotron (DESY)

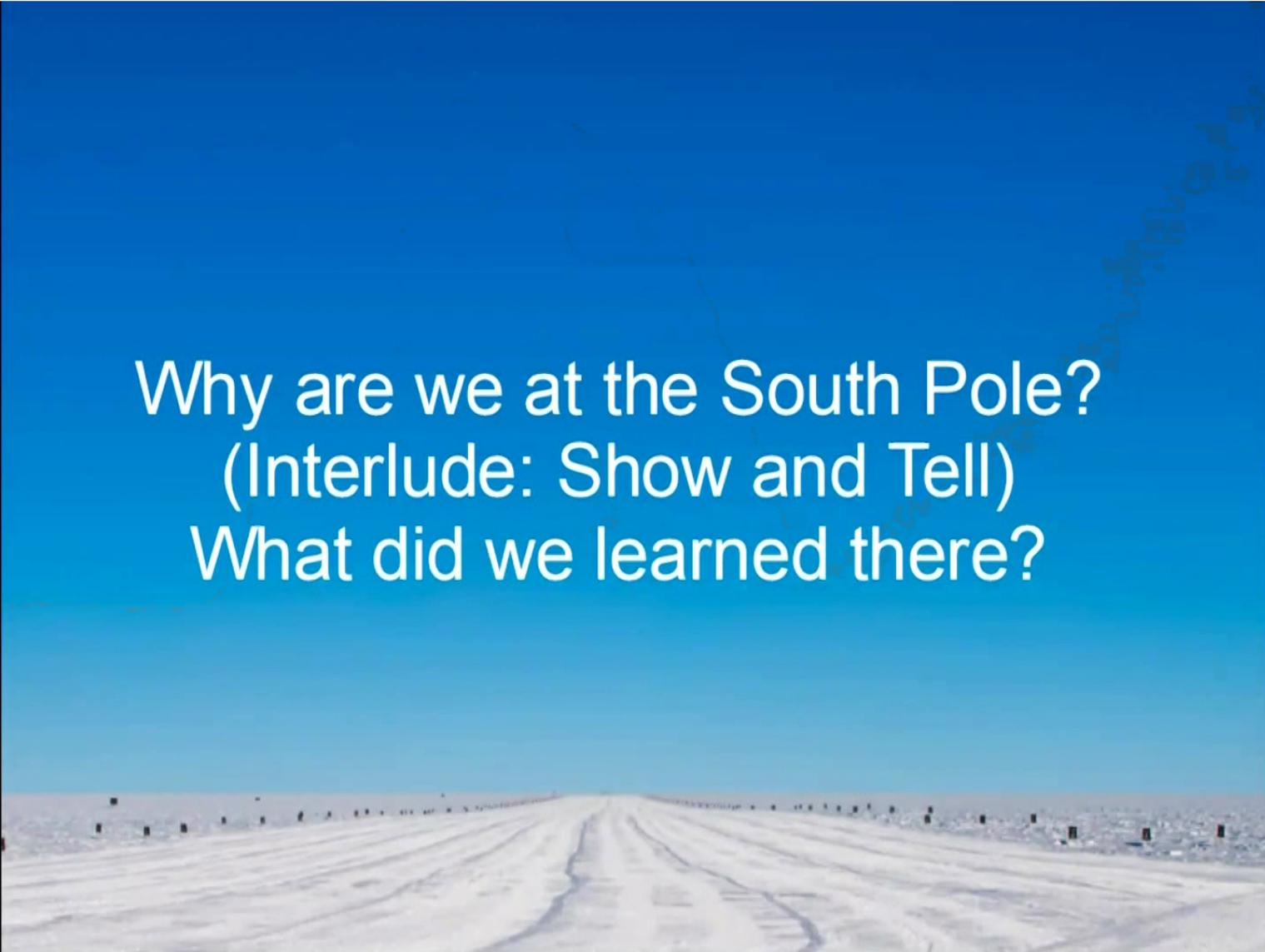
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The Swedish Research Council (VR)
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Why are we at the South Pole?
(Interlude: Show and Tell)
What did we learned there?





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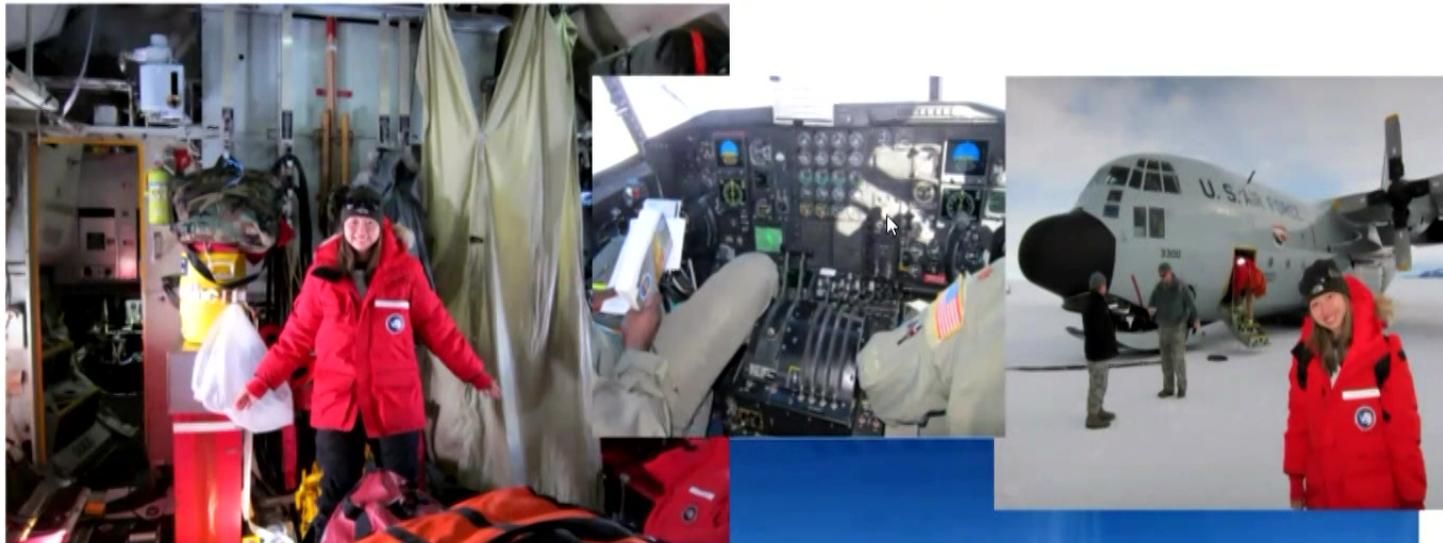
Arriving at McMurdo



McMurdo Station



C130 to South Pole Station

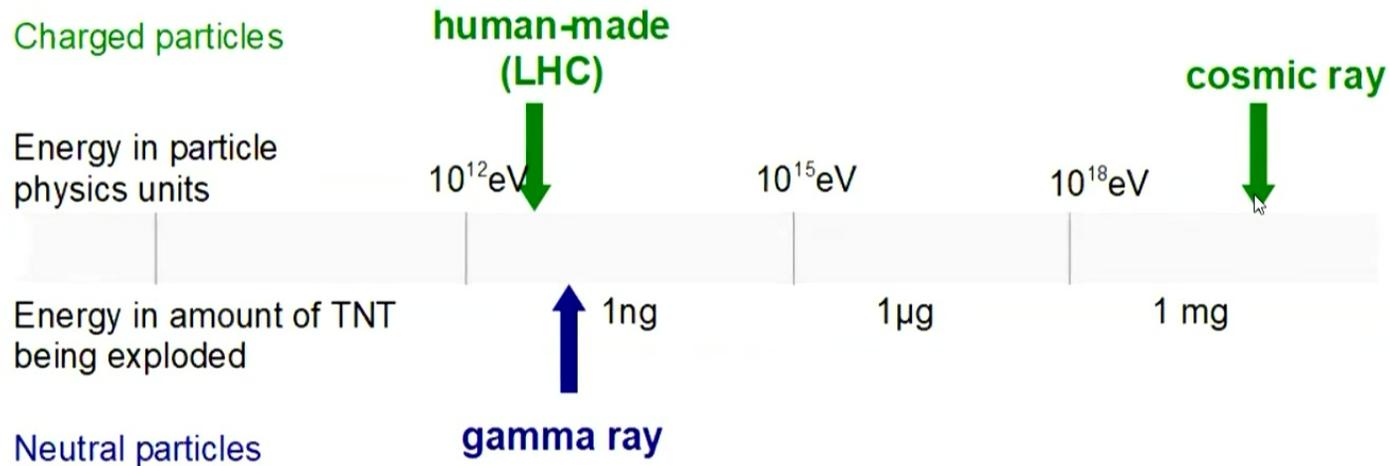




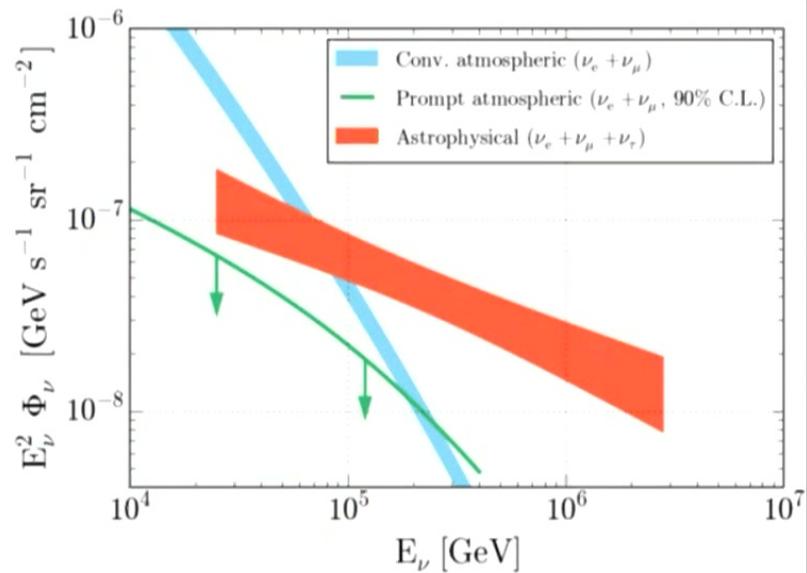
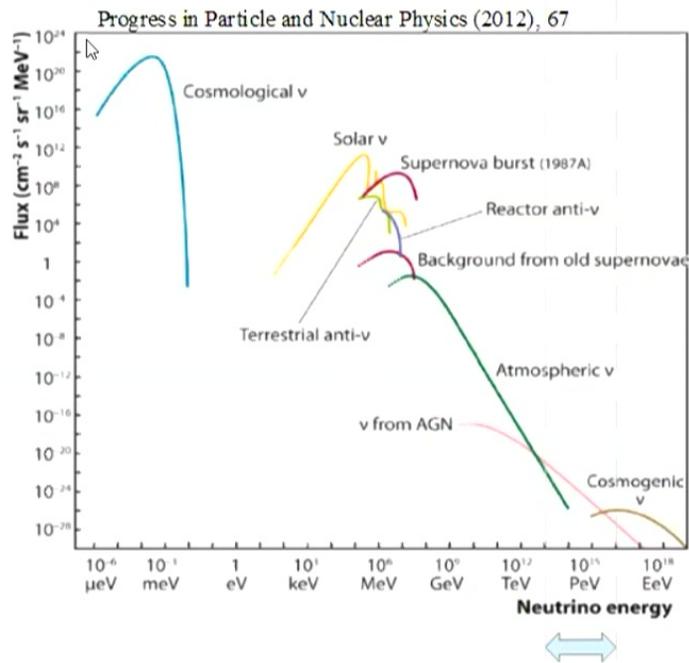
Winter Over!



Highest energy particles observed



Why is High Energy interesting?



But where do these super-high-energy neutrinos come from?



“outer space stuff” is the best description!



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Extraterrestrials on Earth: Scientists find outer space stuff at South Pole

By Gene J. Koprowski Published November 21, 2013 FoxNews.com

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The IceCube Laboratory sits on the surface of the ice on top of the detector, collecting data from sensors under the ice. All 5,160 sensors that make up the neutrino array are connected to the lab via cables. (Sven Lidstrom, IceCube/NSF)

ET isn't out there ... he's already here.

Scientists have discovered travelers from beyond our solar system buried under the ice of the South Pole – not living creatures or space beings but tiny, extra-terrestrial particles known as neutrinos.

"Extra-terrestrial in this context means coming from outside the solar system." Olga Rotnar, a professor in the department of physics and

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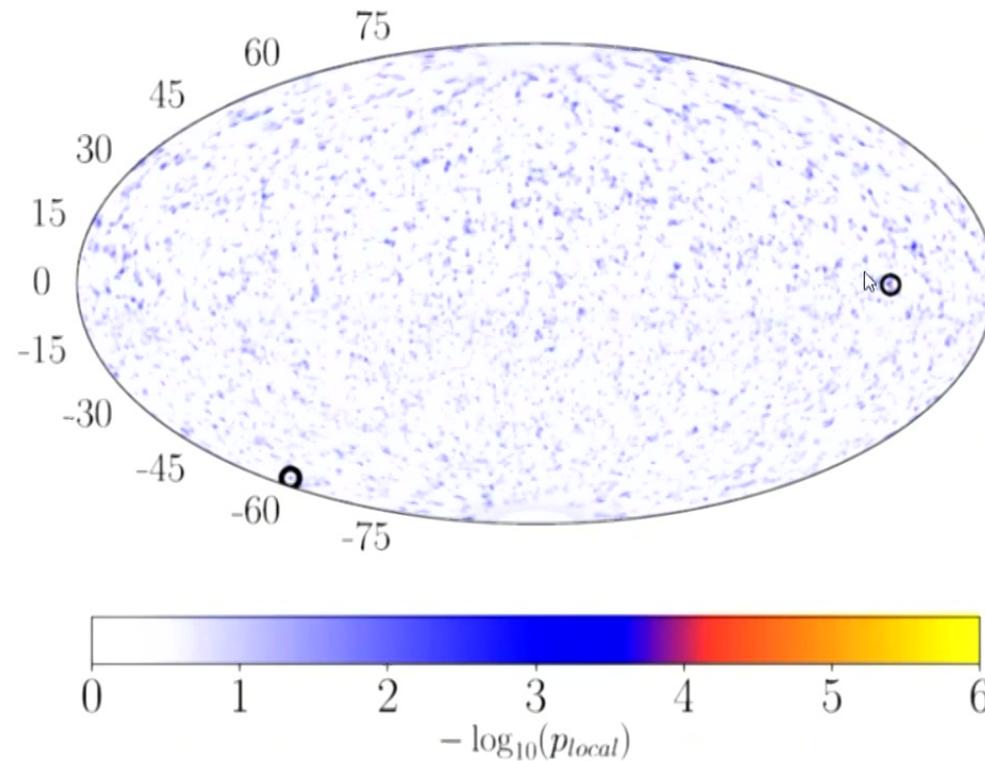
Mars meteorite 'not

Tribute to The Thing?

1982 film about scientists at a remote antarctic base finding an alien.....



Look for a “hot spot” on the sky



IceCube Collaboration (2020) Phys. Rev. Lett. 124

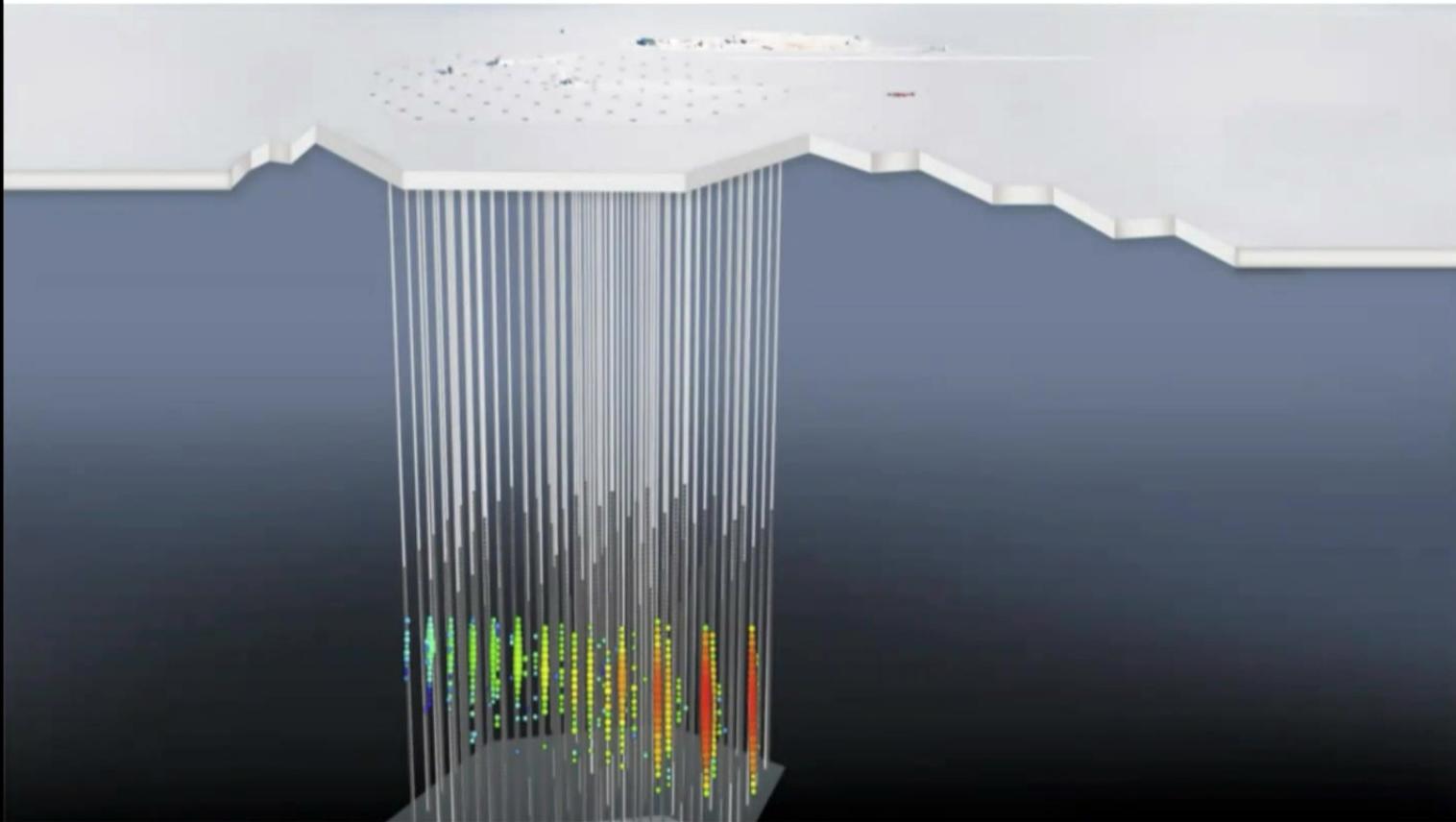


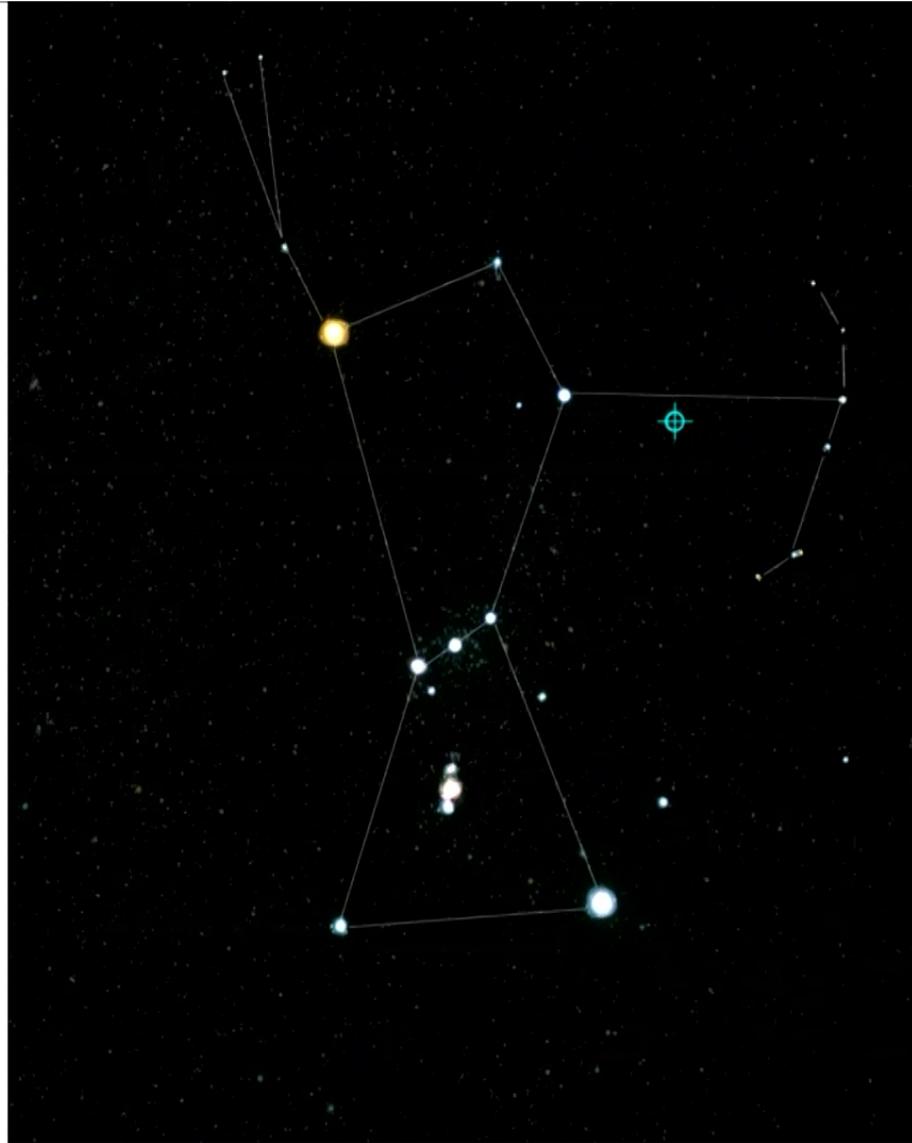


2018
First hint of
what makes
these
neutrinos!

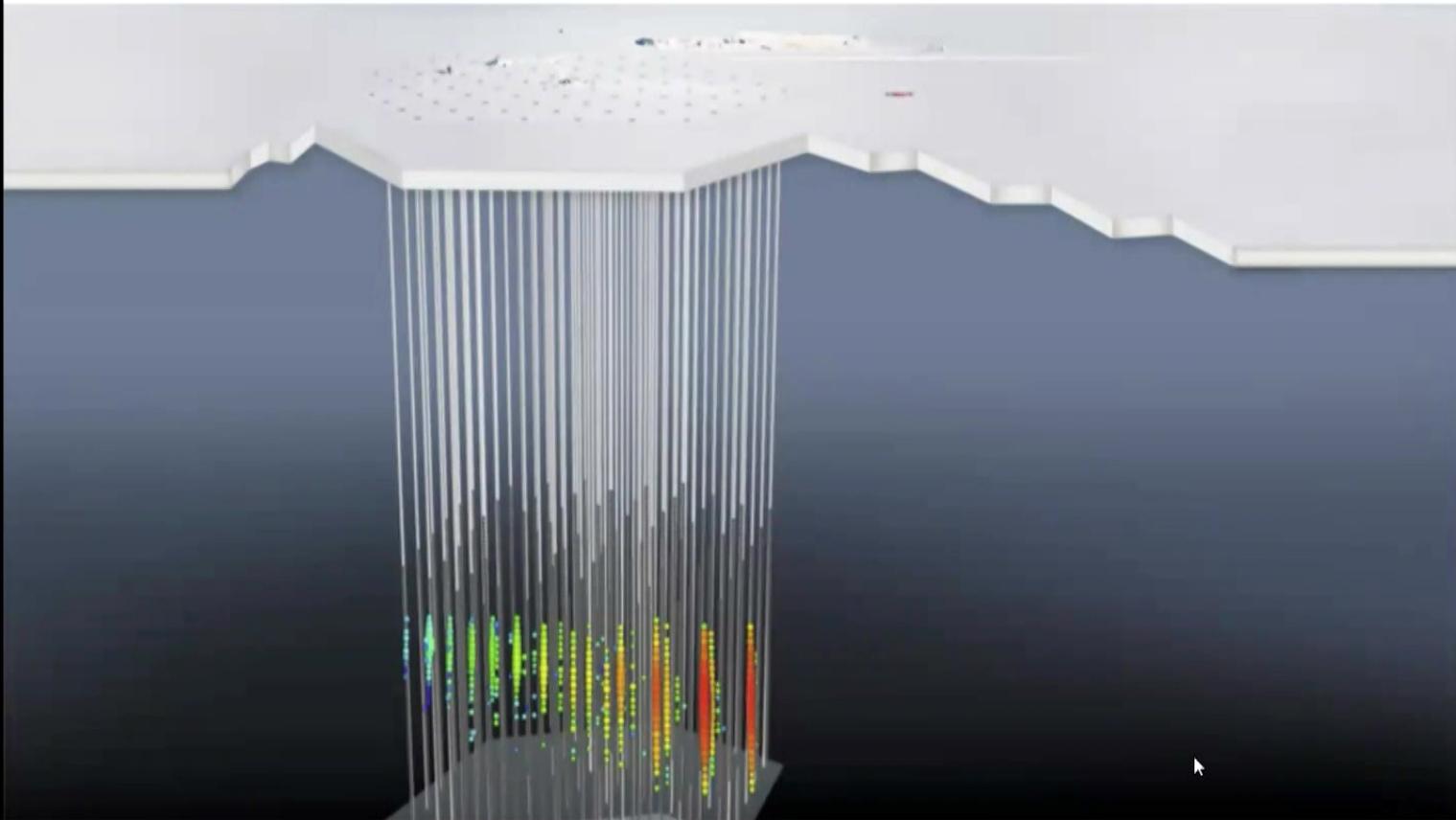


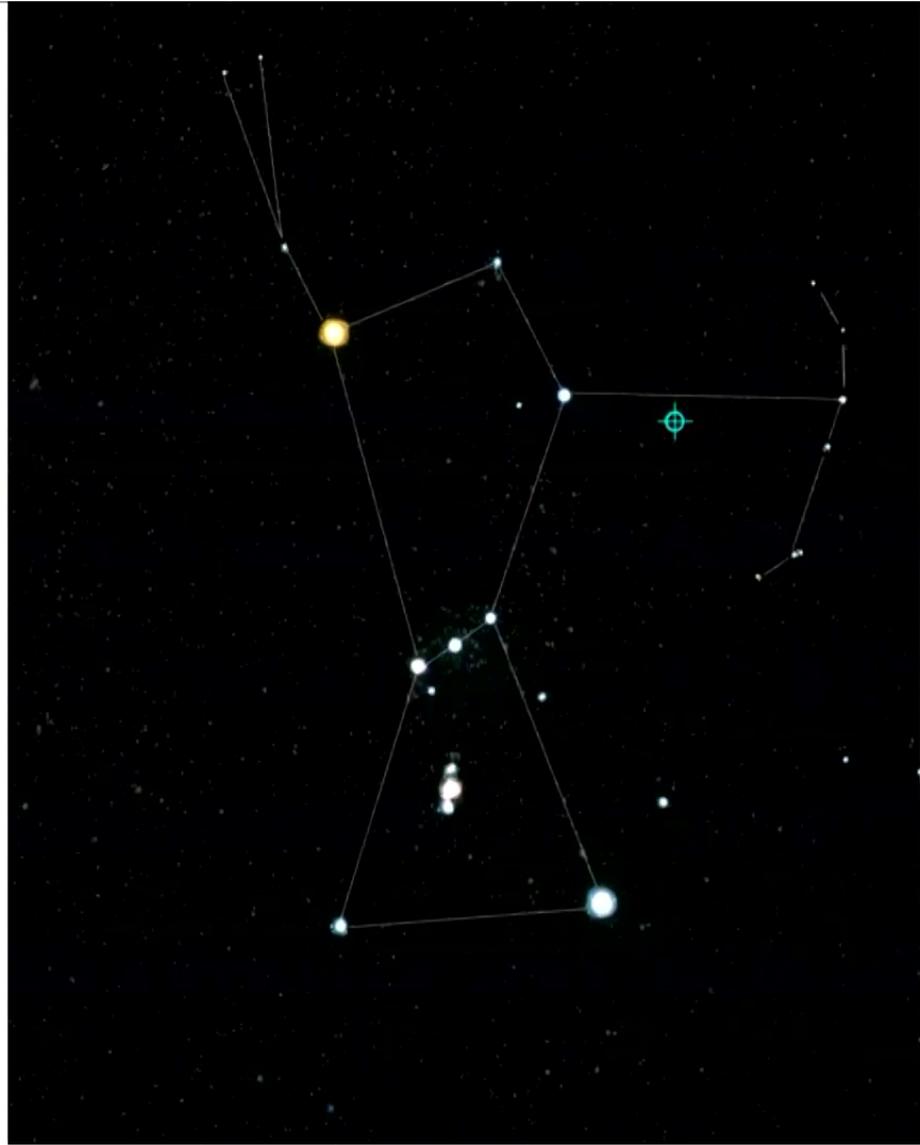
On Sept 22, 2017 a high energy neutrino left a spectacular trail of light





On Sept 22, 2017 a high energy neutrino left a spectacular trail of light





IceCube Neutrino Flare

2014 - 2015



Where do we stand?

- We have discovered neutrinos from outside our galaxy
- We're starting to see the first couple of sources that make these neutrinos (but only known sources! No unknowns still..)
- What does the neutrino sky look like? What makes these sources unique? What does that tell us about our Universe?

