

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.

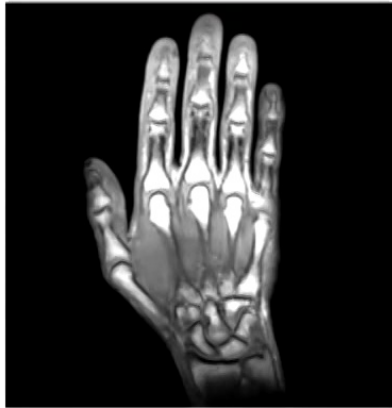
Kurahashi Neilson is an associate professor at Drexel University and the recipient of a CAREER award from the National Science Foundation. Symmetry magazine featured her among 10 early-career experimentalists of note in 2019.

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



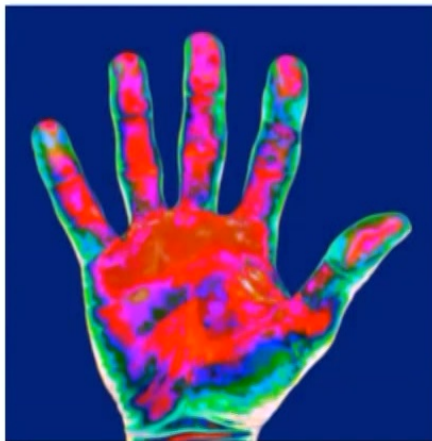
If you don't know what a hand is....



MRI image



X-ray image



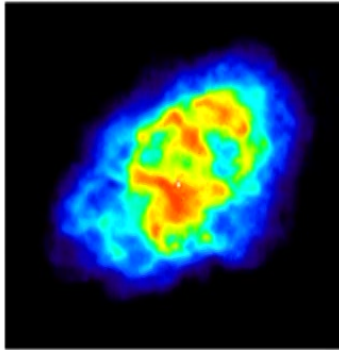
Infrared image



Optical image

The Crab Nebula

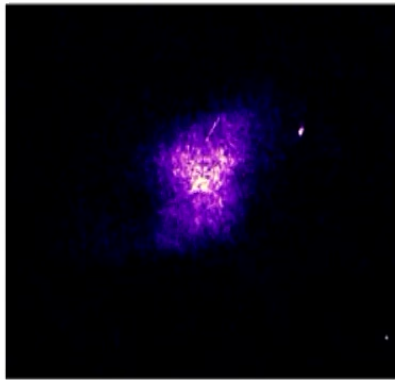
Star with gas cloud around it



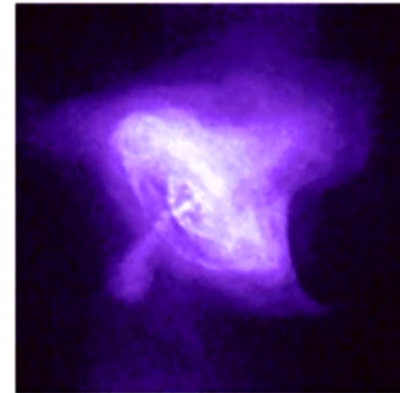
Radio image



Ultraviolet image



Optical image

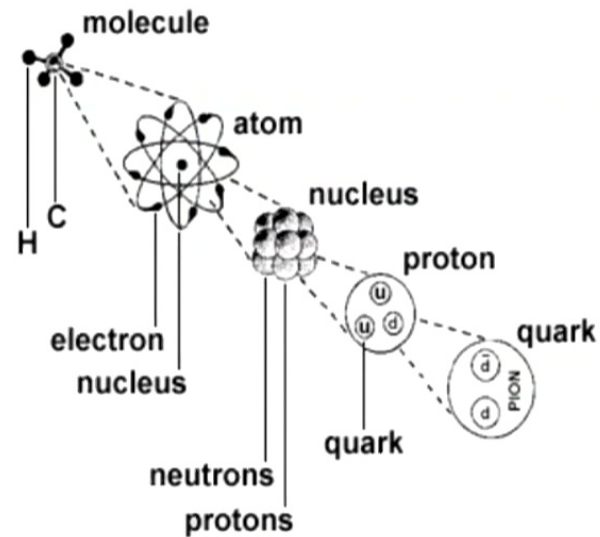
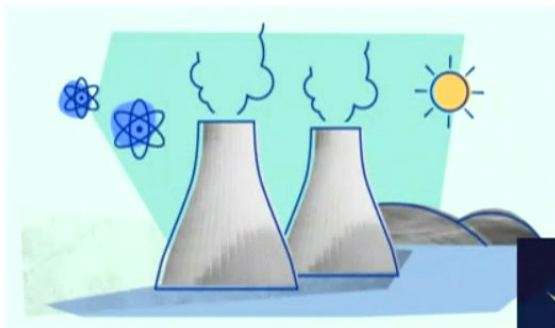


X-ray image

What are neutrinos?



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

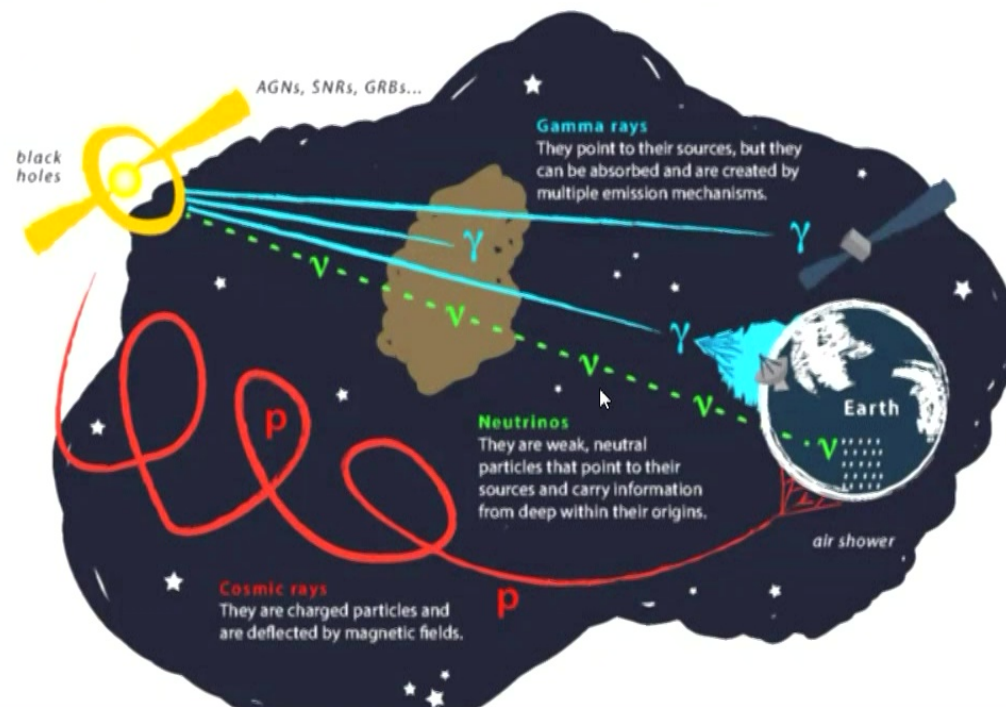


img credit: <http://neutrino.aquaphoenix.com>

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

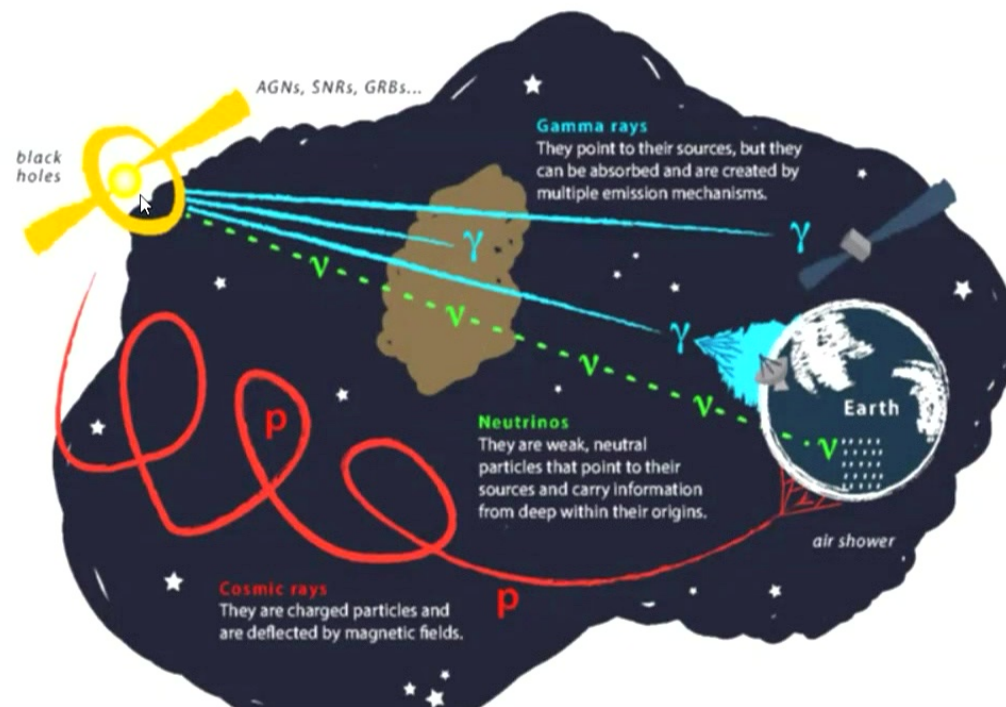
High Energy Astronomy ~ A tale of 3 signals ~

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



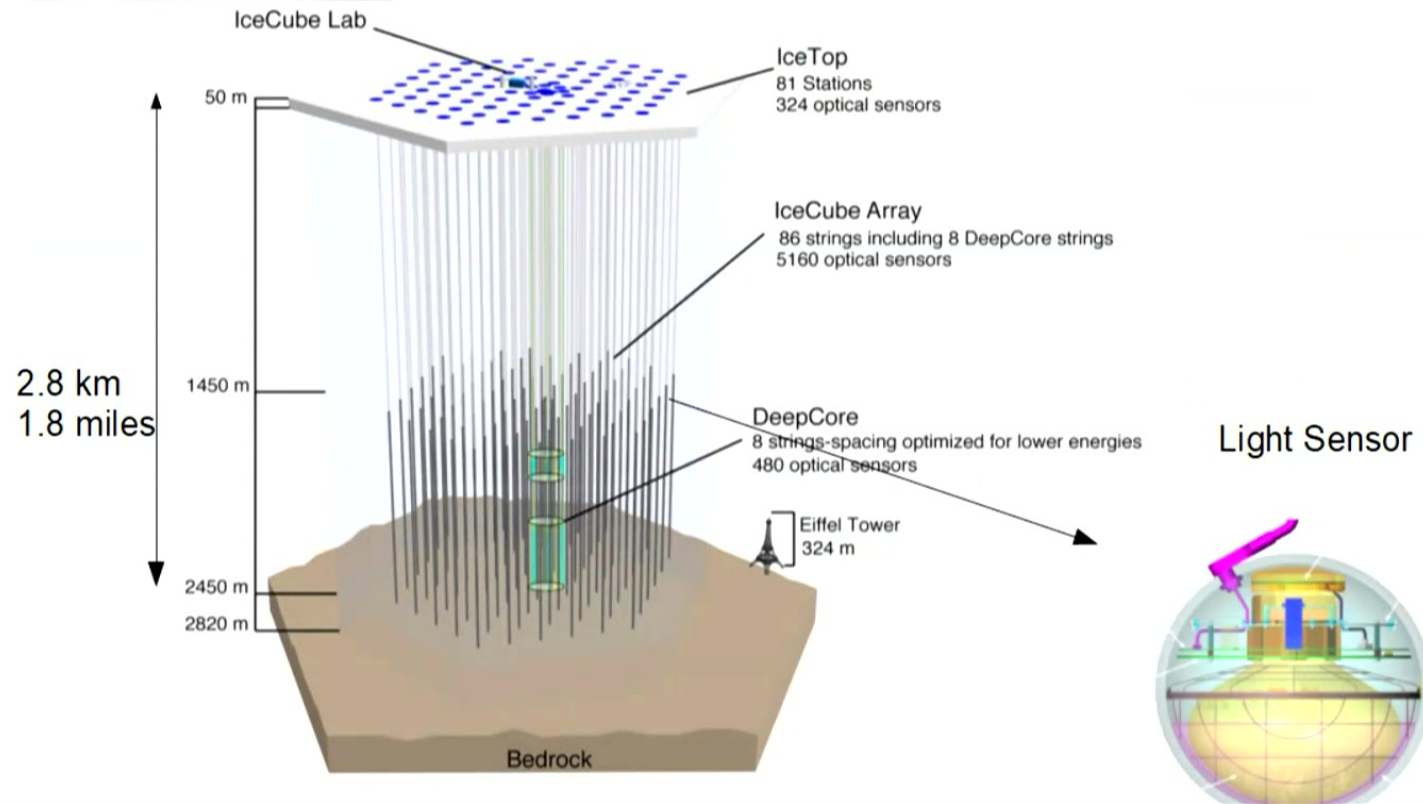
High Energy Astronomy ~ A tale of 3 signals ~

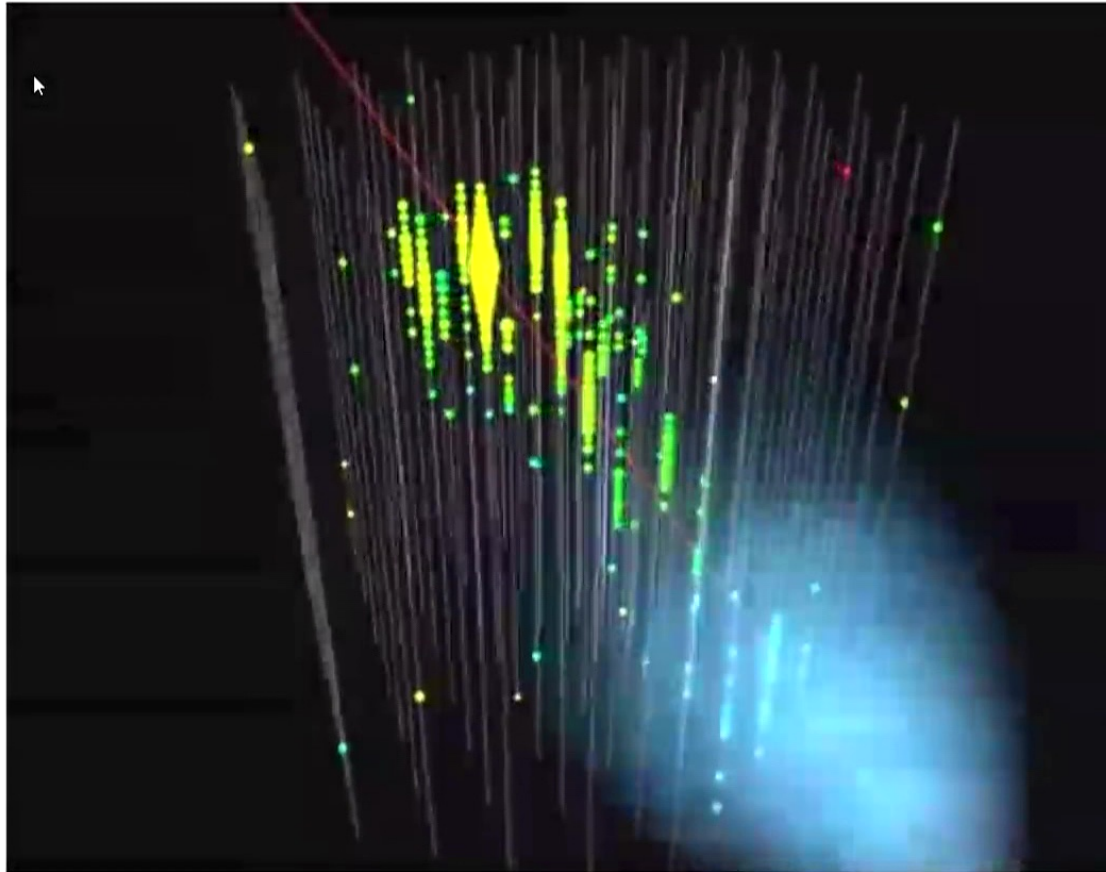
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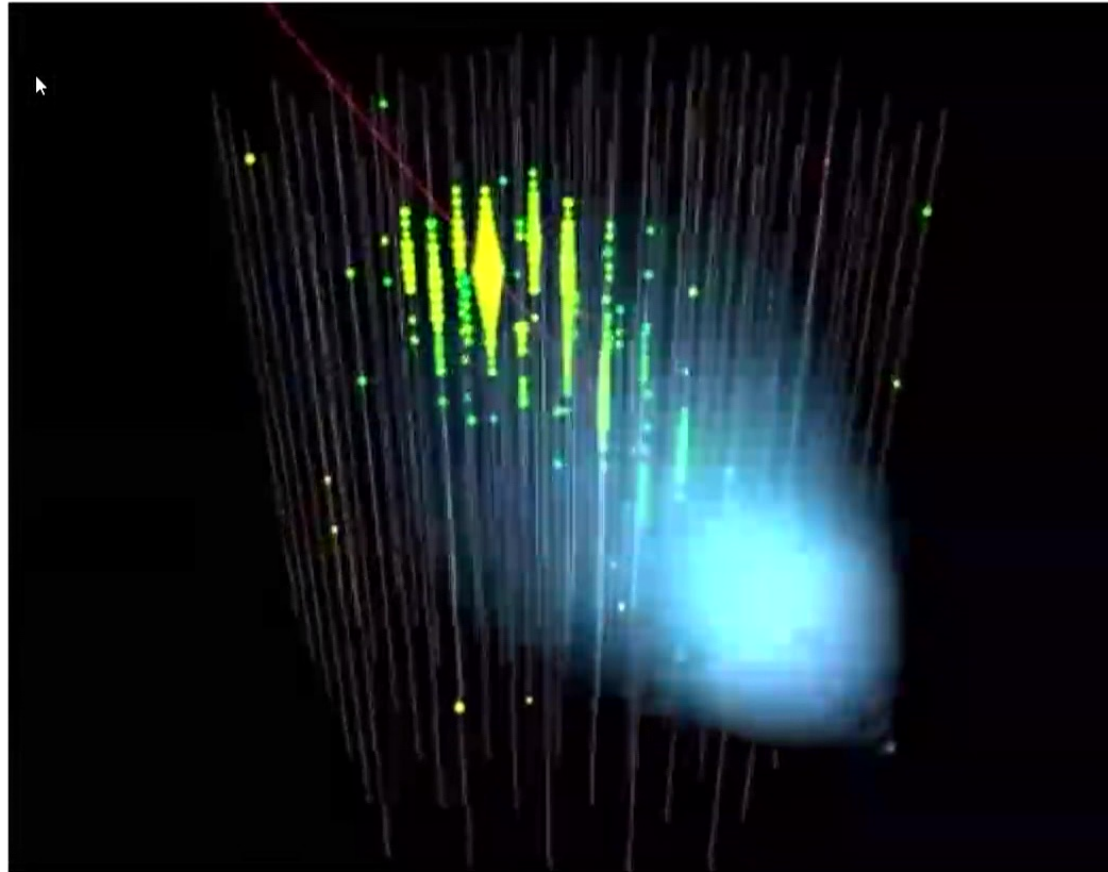




Glacier at the South Pole









FUNDING AGENCIES

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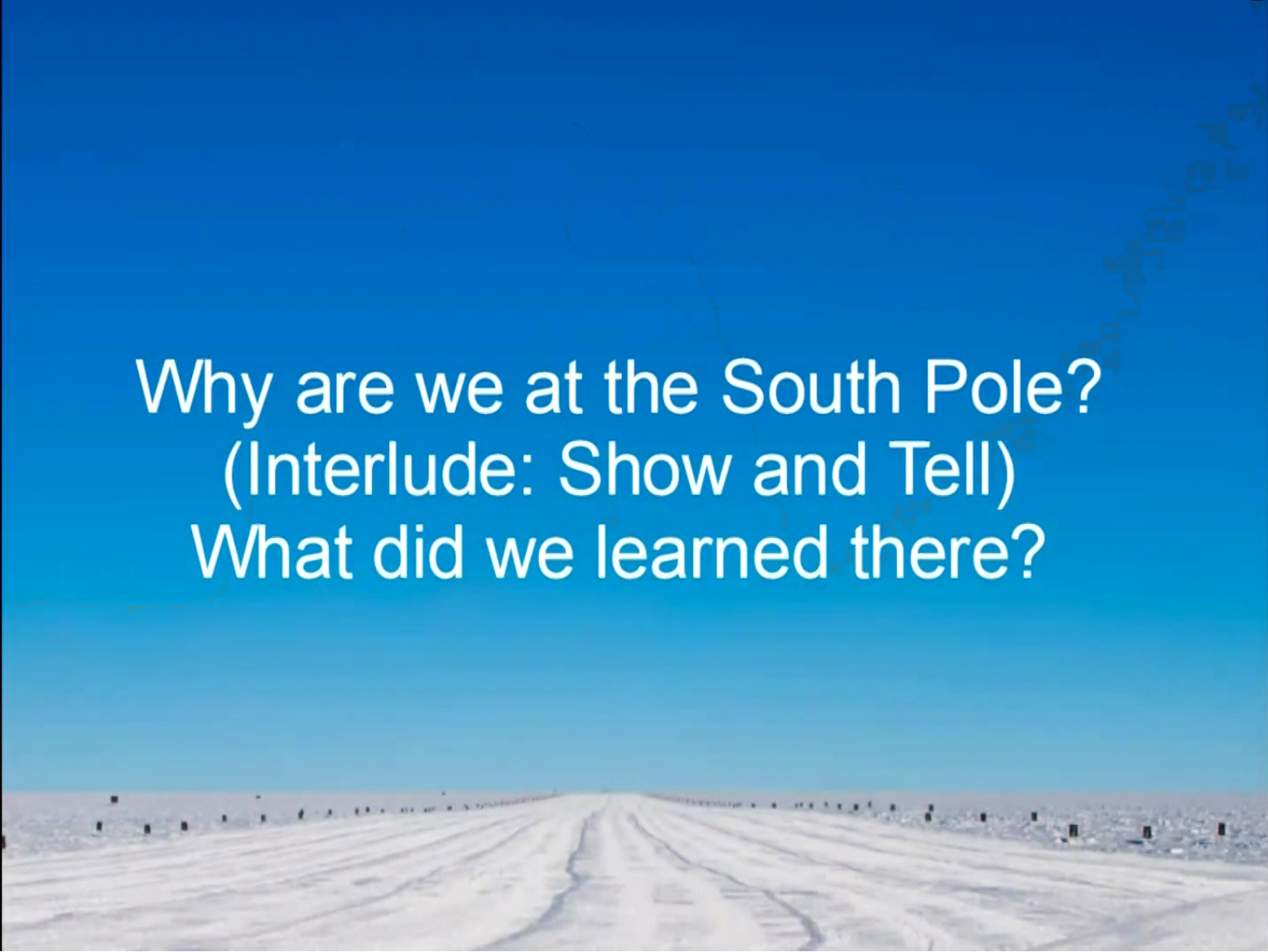
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Why are we at the South Pole?
(Interlude: Show and Tell)
What did we learned there?





Why are we at the South Pole?
(Interlude: Show and Tell)
What did we learned there?



Arriving at McMurdo



McMurdo Station



C130 to South Pole Station



PI

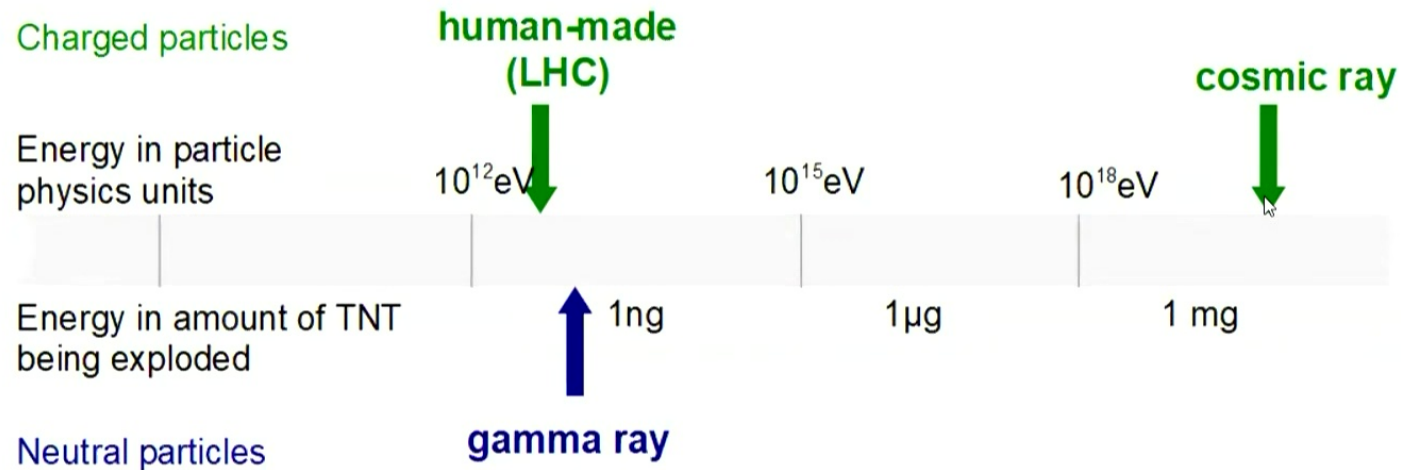


Winter Over!

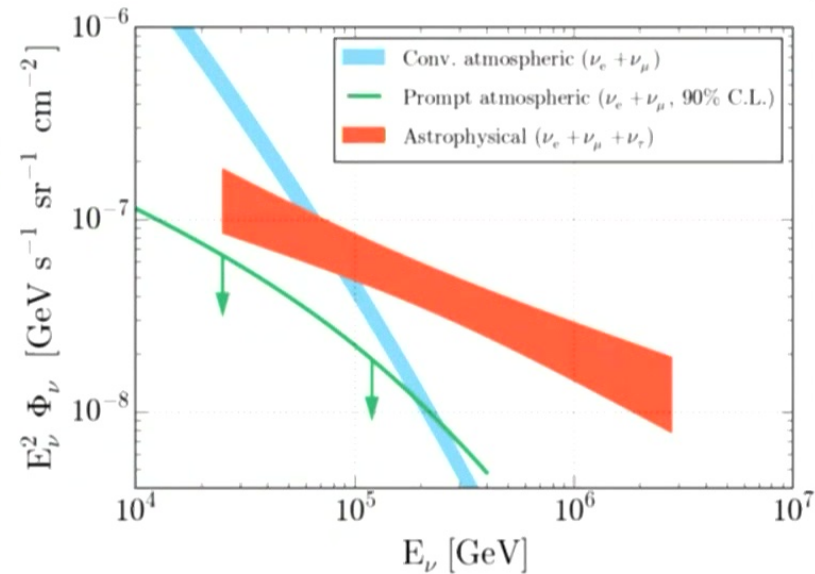
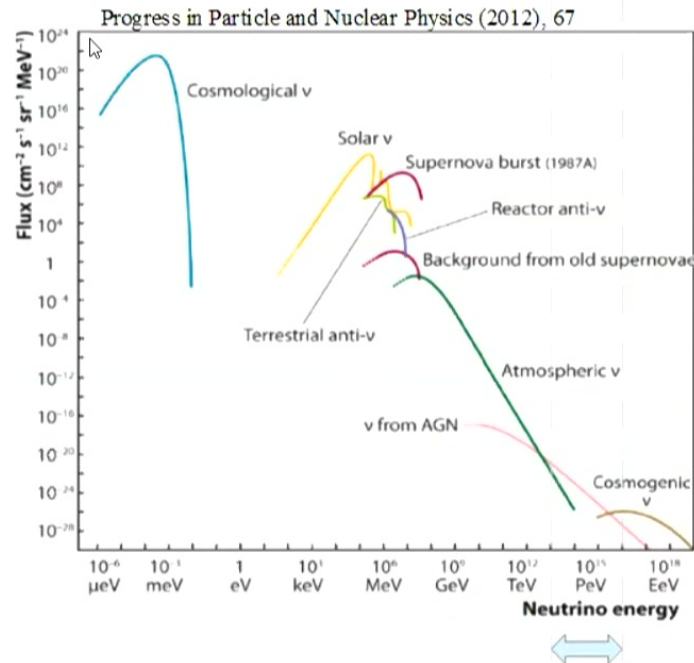


PI

Highest energy particles observed



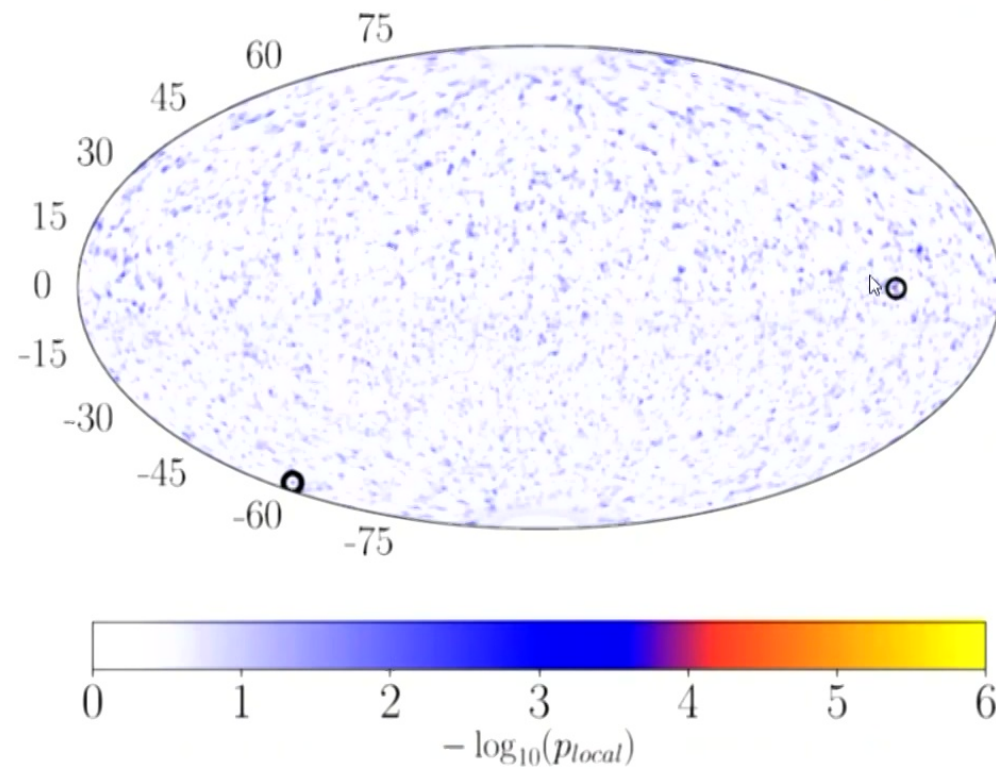
Why is High Energy interesting?



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



Look for a “hot spot” on the sky



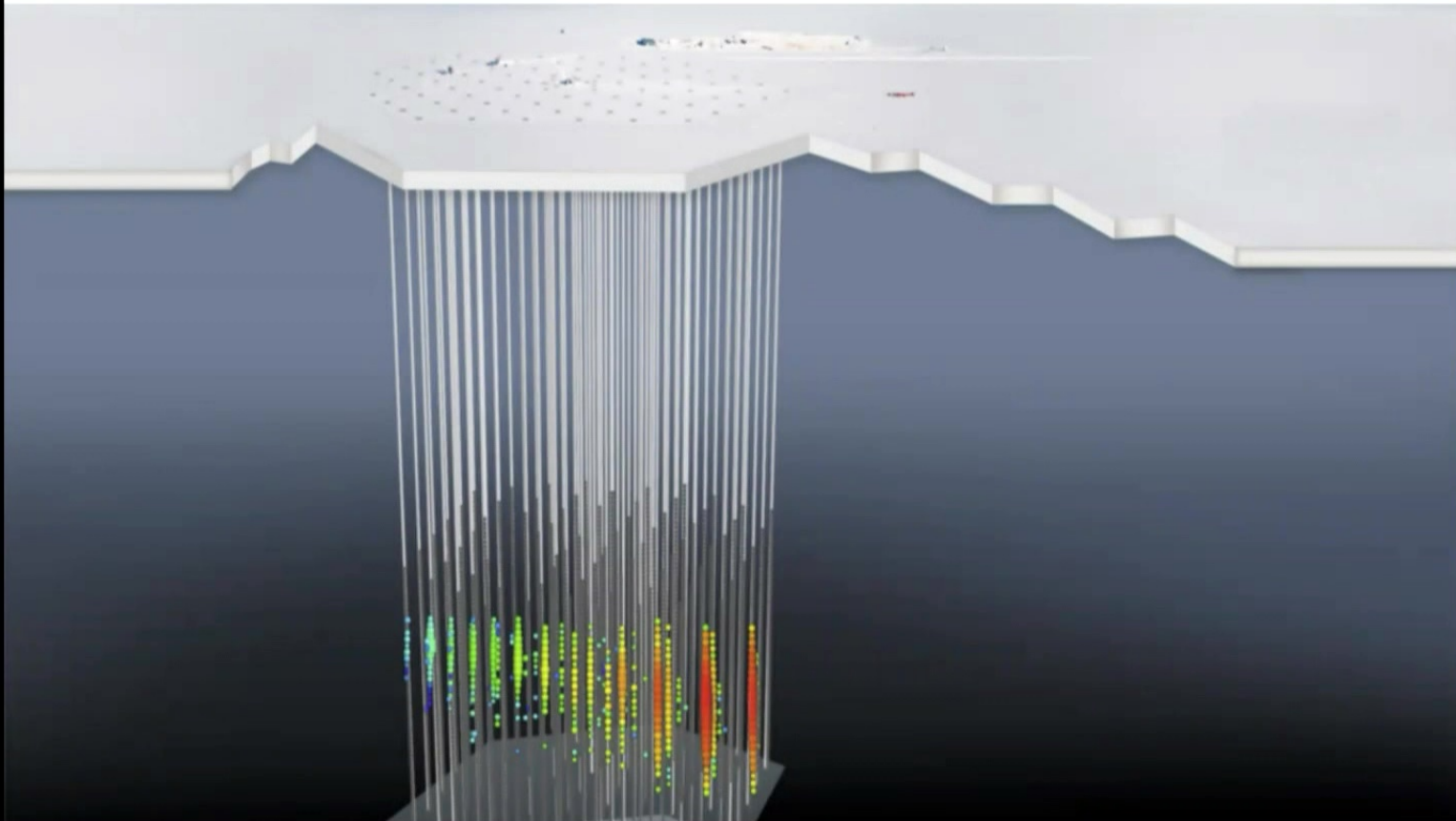
IceCube Collaboration (2020) Phys. Rev. Lett. 124

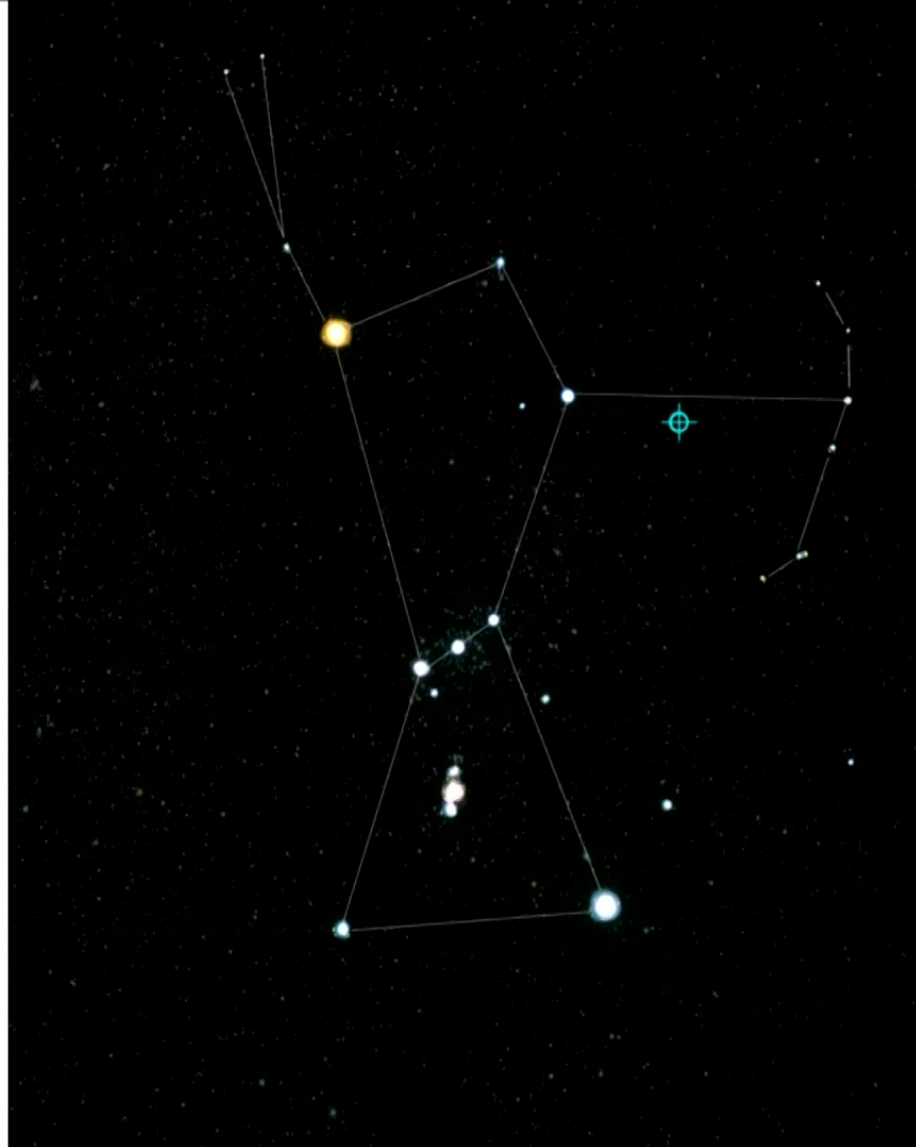


2018
First hint of
what makes
these
neutrinos!

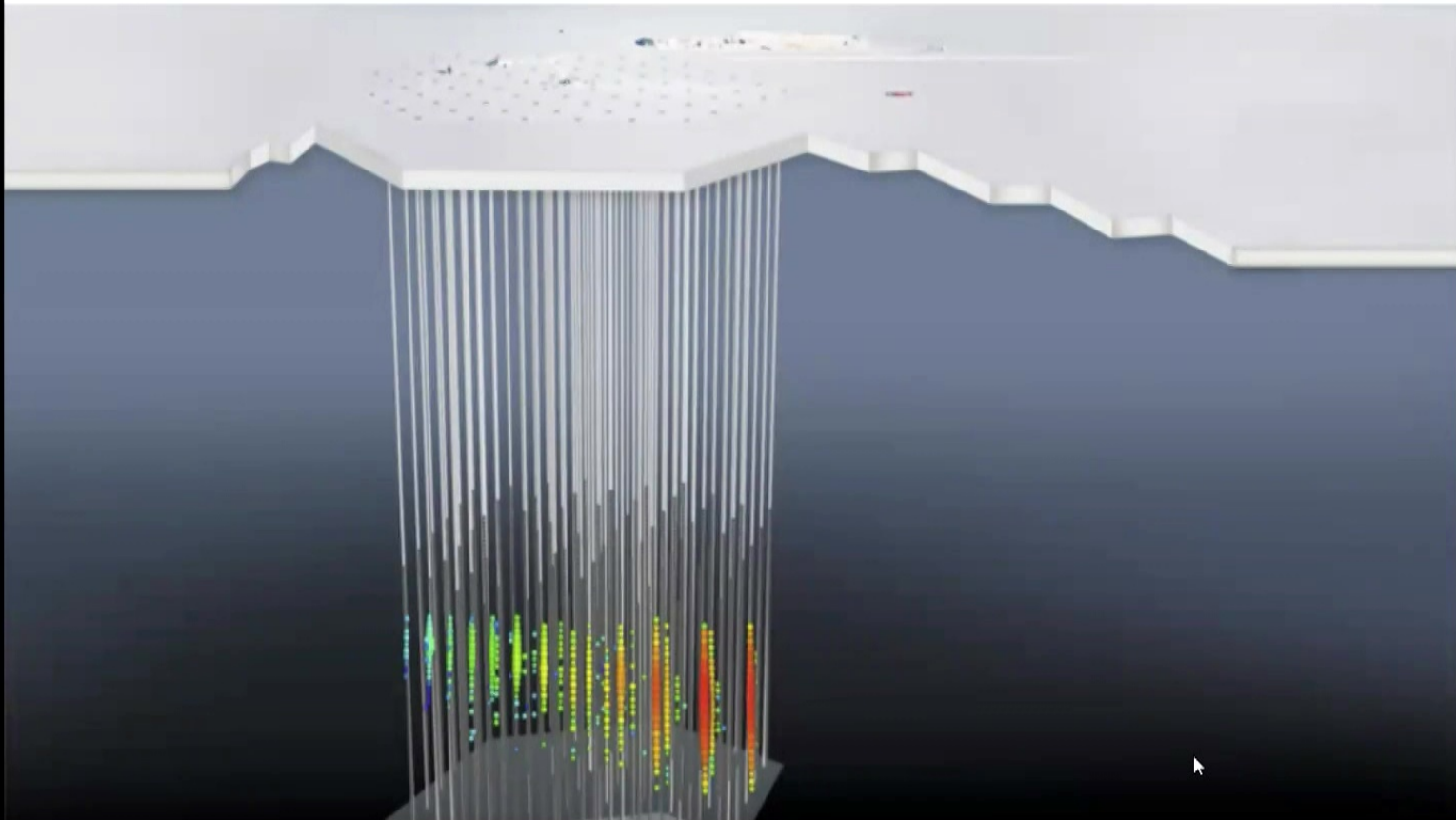
PI

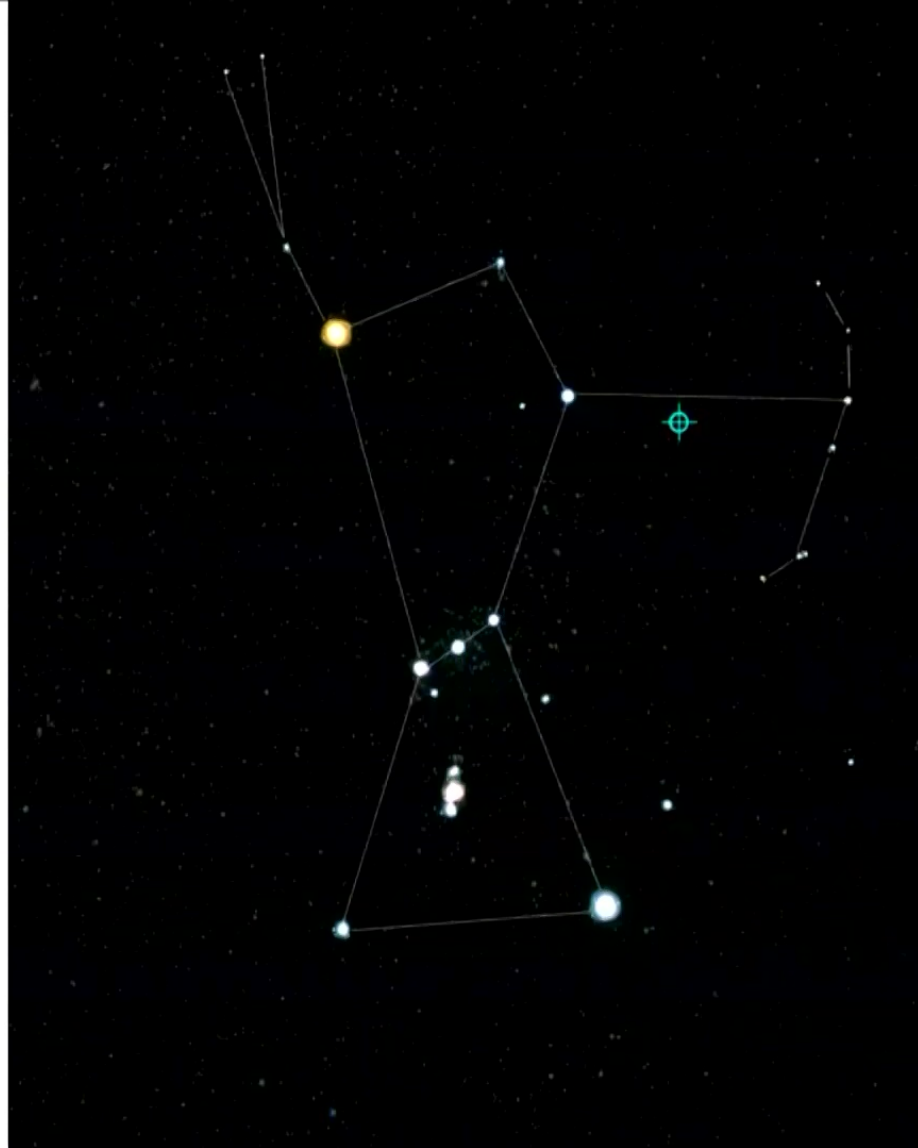
On Sept 22, 2017 a high energy neutrino left a spectacular trail of light





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





IceCube Neutrino Flare

2014 - 2015



PI

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?

