

Photo Credit: McGill University

GIGANTIC TELESCOPES FOR TINY COSMIC MESSENGERS

BRIAN CLARK
MICHIGAN STATE UNIVERSITY

ASTRONOMY ON TAP
OCTOBER 9, 2019

Original plan was to be a lawyer...

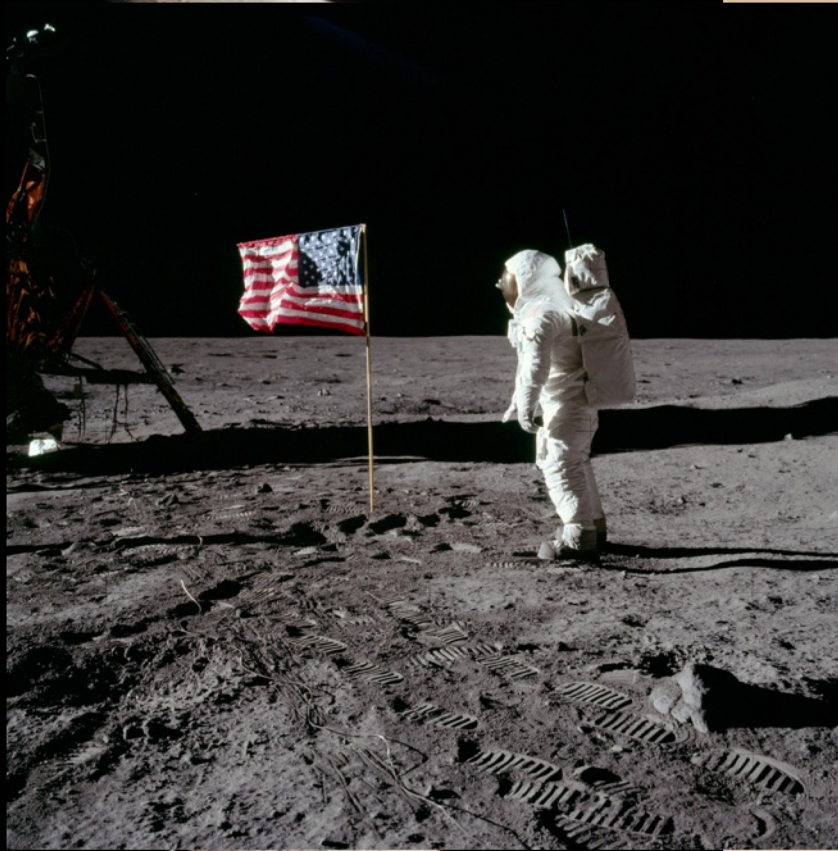


...Now I build telescopes in Antarctica!

TELESCOPES



IC: Gary Seronik

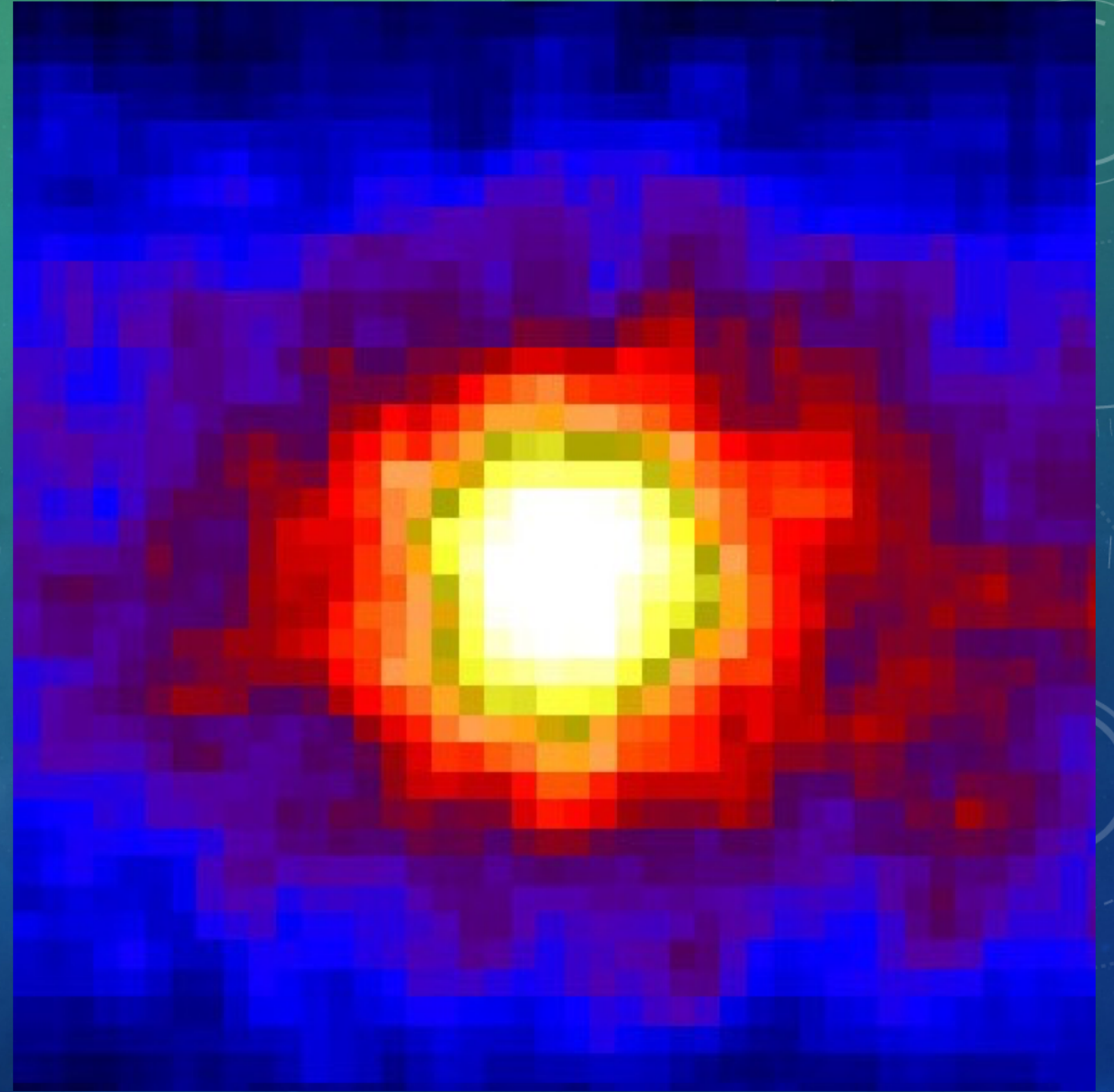
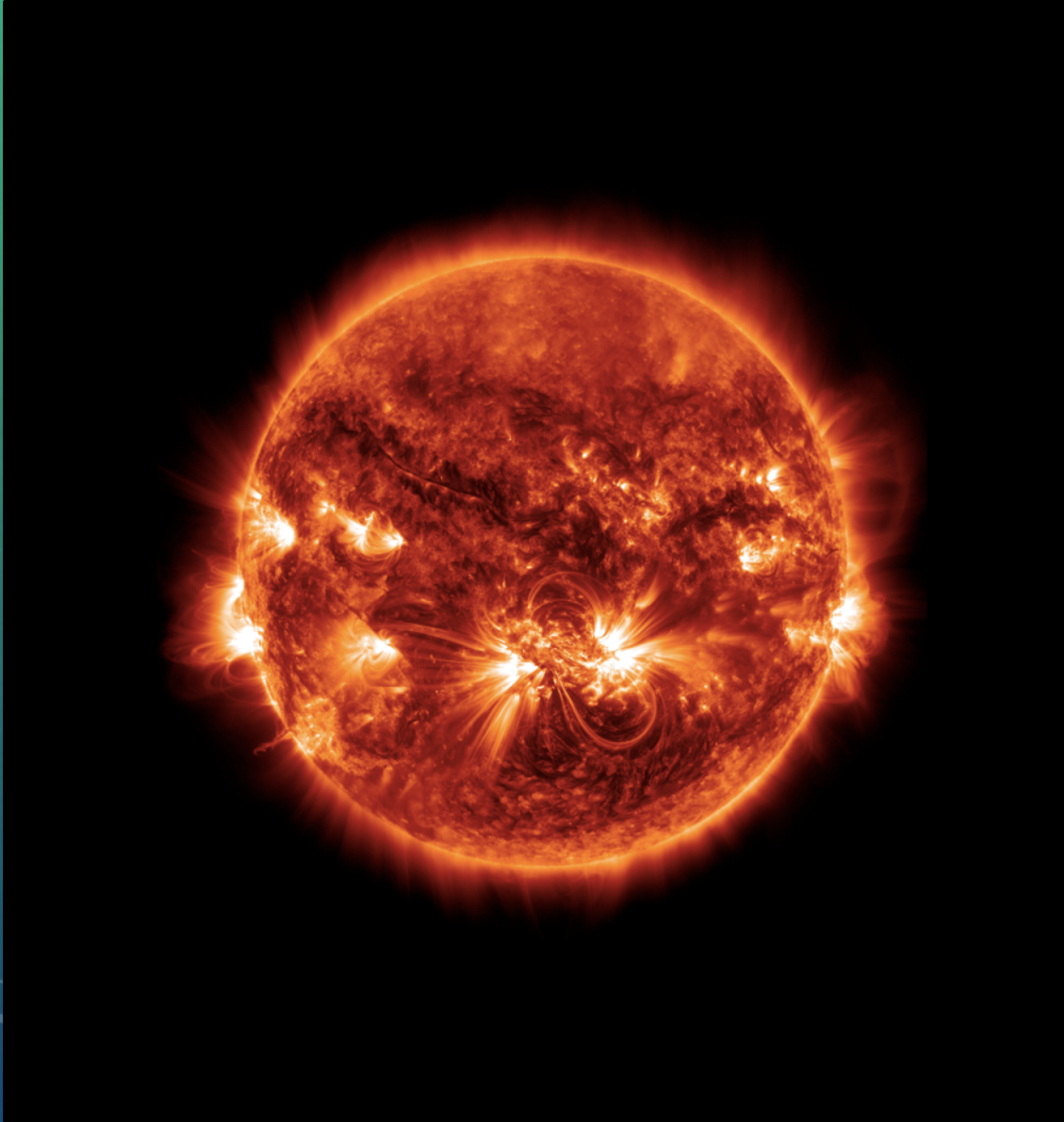


1609: Galileo observes the “rough and unequal” surface of the moon in *visible* light.

GALILEO USED *LIGHT*...

...ANYTHING ELSE?

Yes! Neutrinos



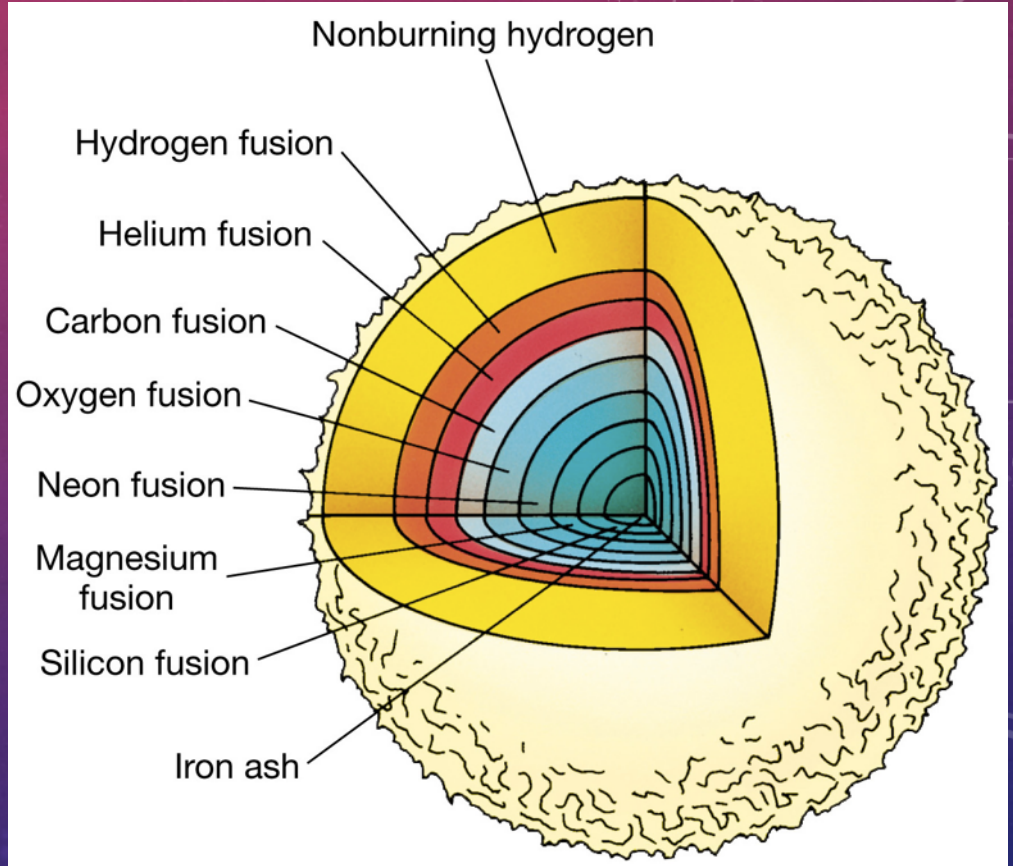


NEUTRINOS: THE GHOST MESSENGER

BORN IN ANY NUCLEAR REACTION



Fission in Nuclear Reactors



Fusion Inside stars

LIGHT AND WEAKLY INTERACTING

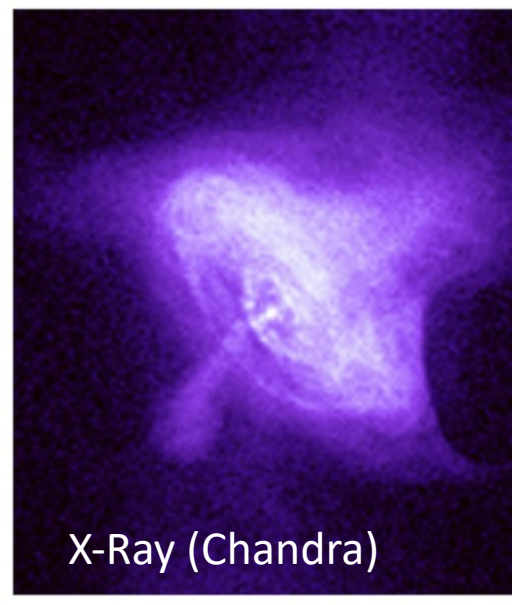
100 trillion neutrinos pass through your body **every second!!!**



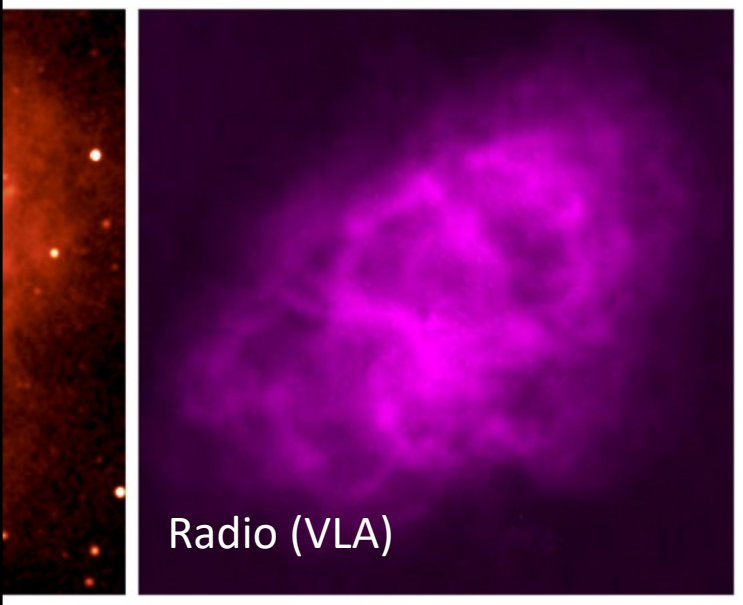


**DREAM FOR ME:
SEE THE UNIVERSE
THROUGH NEUTRINO EYES**

In Neutrinos?



X-Ray (Chandra)



Radio (VLA)

Crab Pulsar (HAWC)

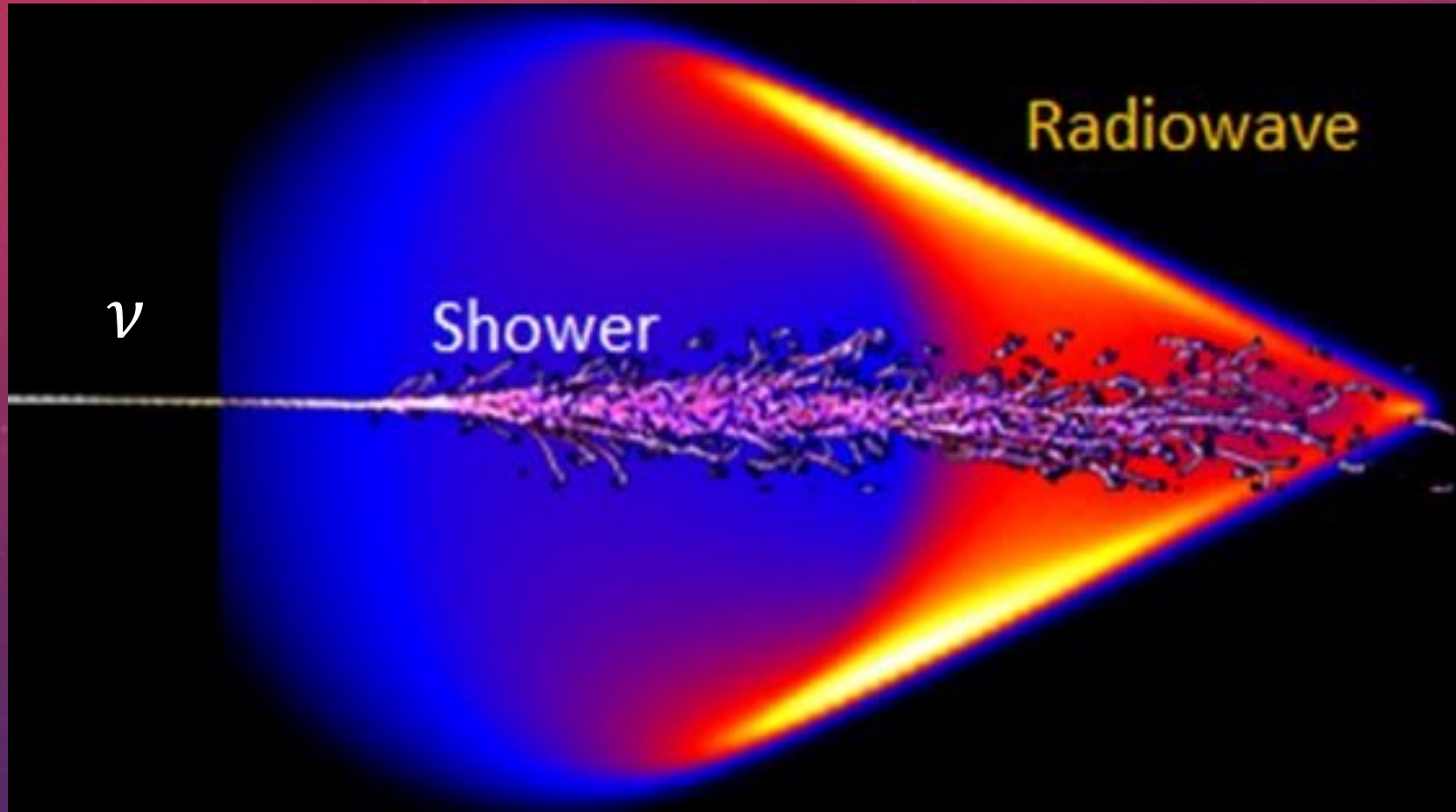
WHAT DOES A NEUTRINO INTERACTION LOOK LIKE?

The background features a gradient from red to blue with faint, semi-transparent scientific diagrams. On the right side, there are circular gauges with numerical scales (e.g., 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200) and arrows. At the bottom, there are dashed circular paths with arrows indicating direction.

F-18 going Supersonic



Sonic boom...



...but in light!
Puff of Blue Light + Puff of Radio Waves

SWEET! THIS ALL SOUND SWELL.

...SO WHY DO I HAVE A JOB?

BECAUSE LIFE IS HARD

Neutrino energy

$\sim 10^{18}$ eV

1,000,000,
000,000,
000,000



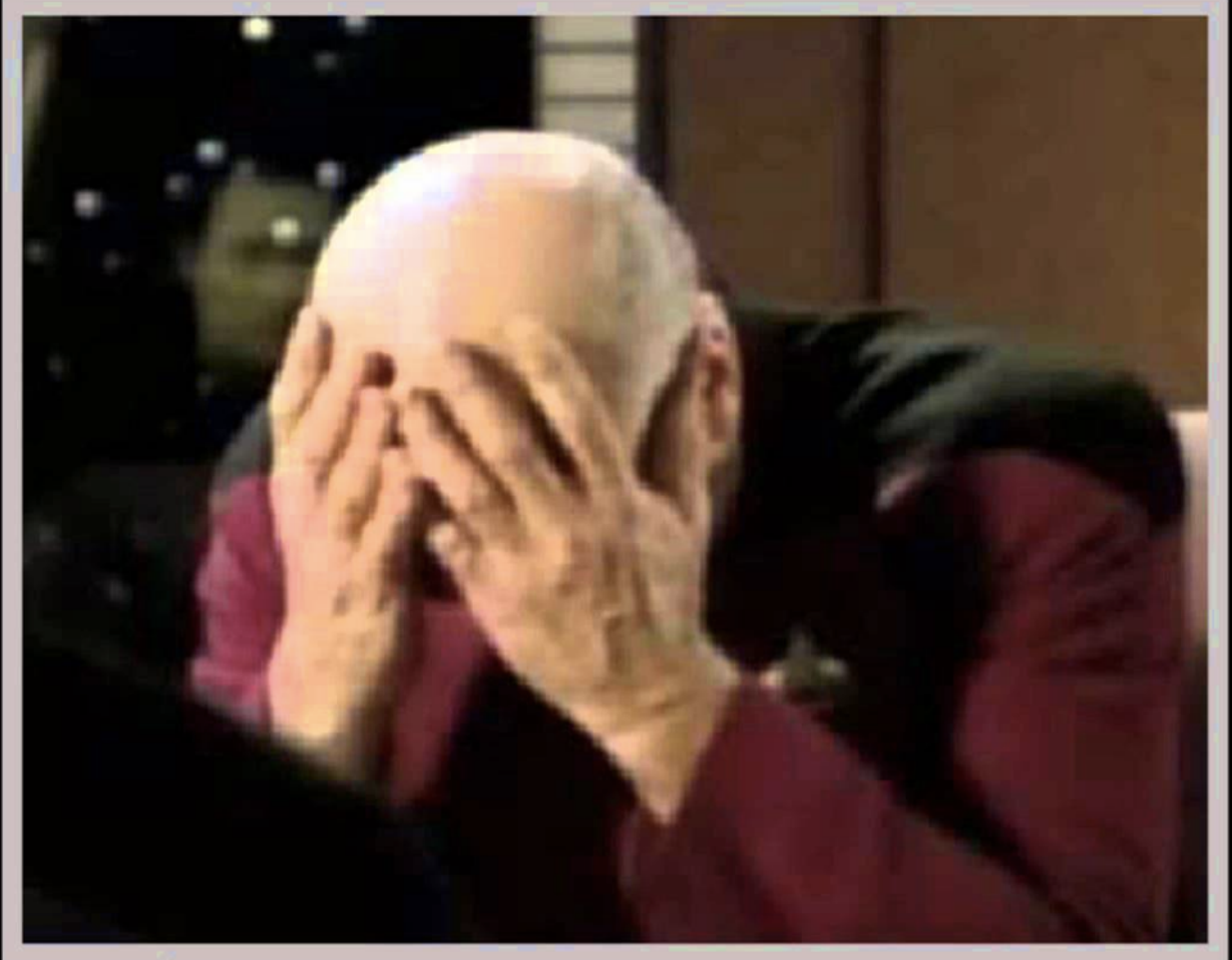


IC: Matt Cashore, USA Today



Passes through Spartan stadium $\sim 1/\text{year}$
Interacts $\sim 1/\text{decade}$

A *rare*
particle
that also
interacts
rarely.



DOUBLE FACEPALM

When the Fail is so strong, one Facepalm is not enough.

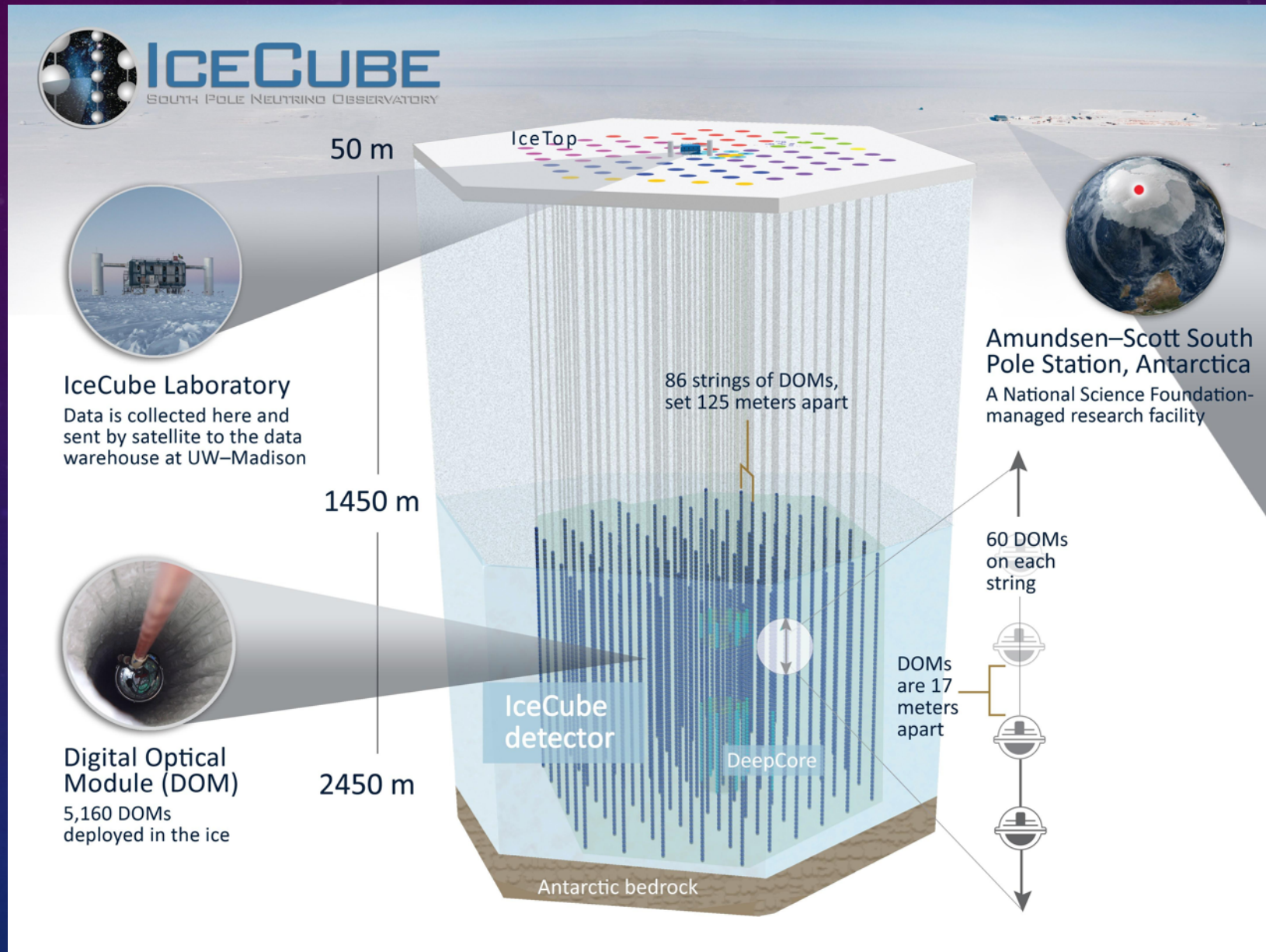
QUESTION:

**WHERE DO YOU FIND A
GIGANTIC AMOUNT OF *SUPER*
CLEAR ICE?**

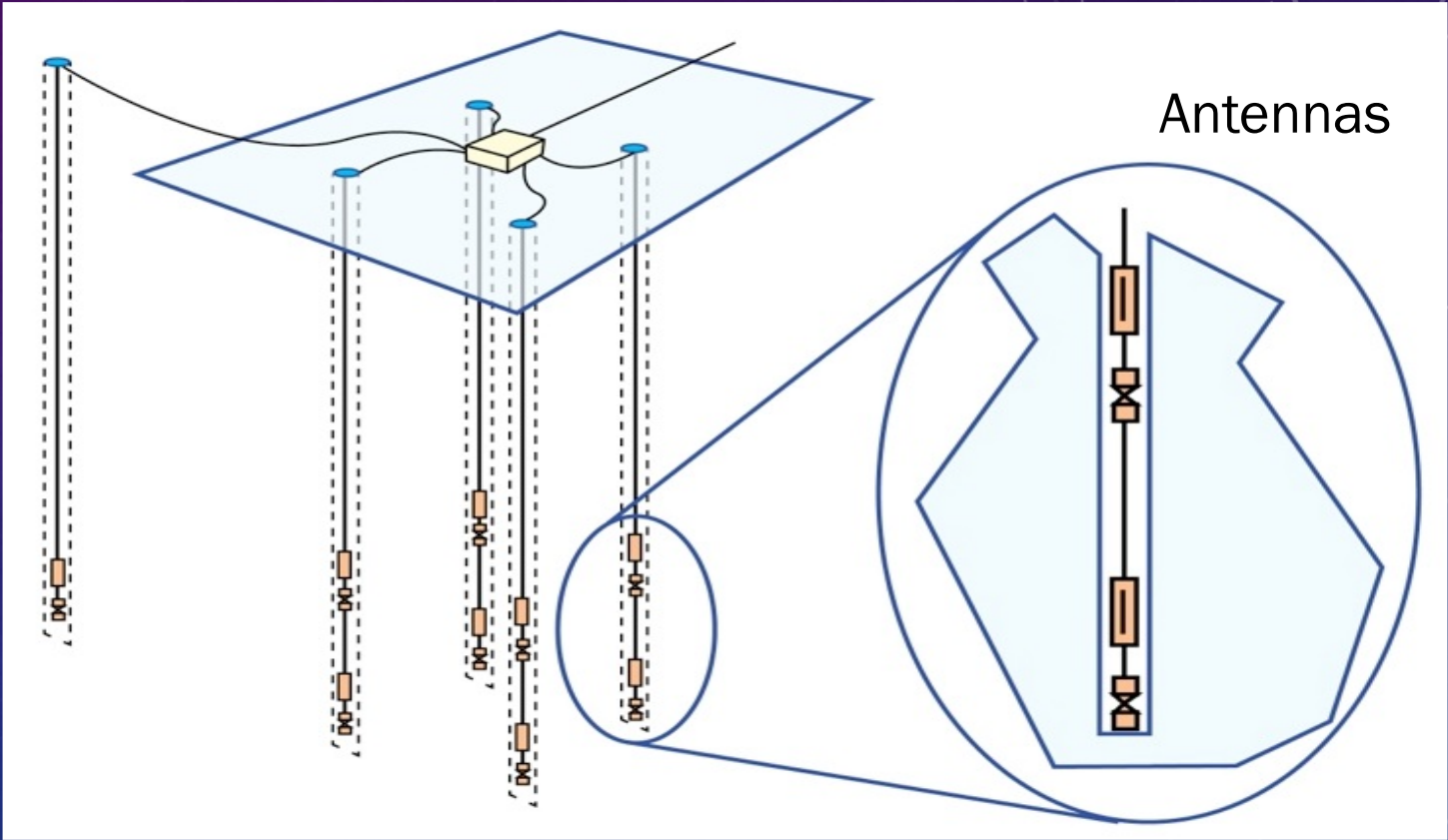
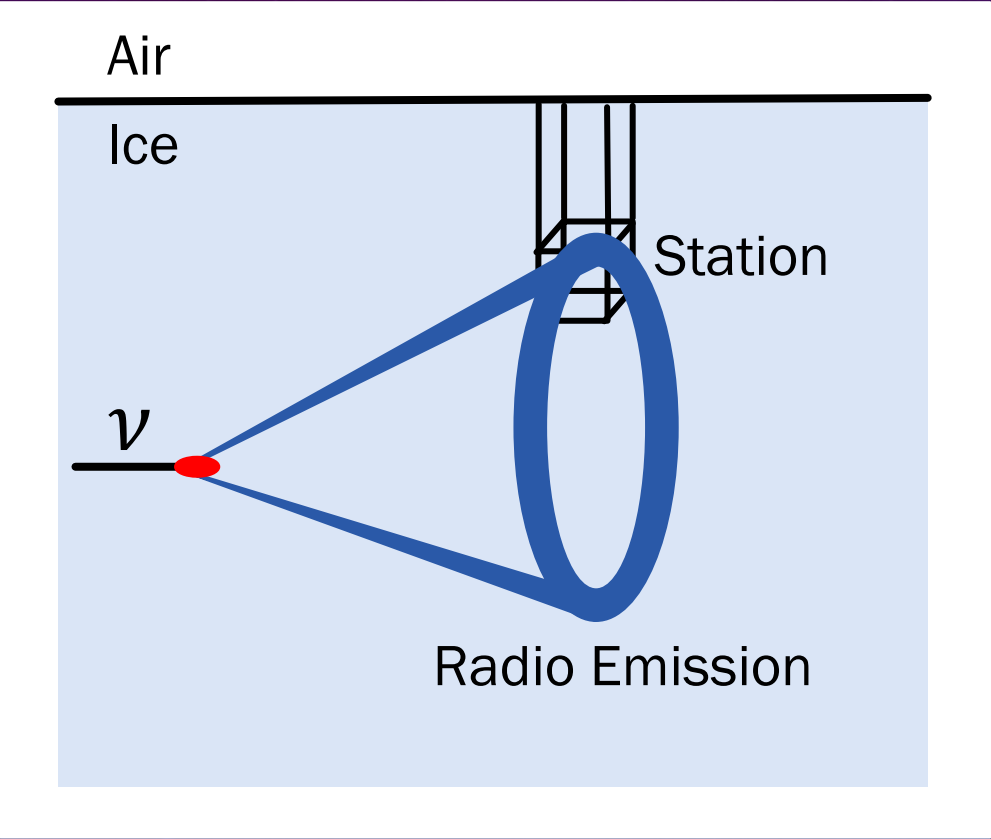
ANTARCTICA



The IceCube Detector: the world's biggest "neutrino camera"



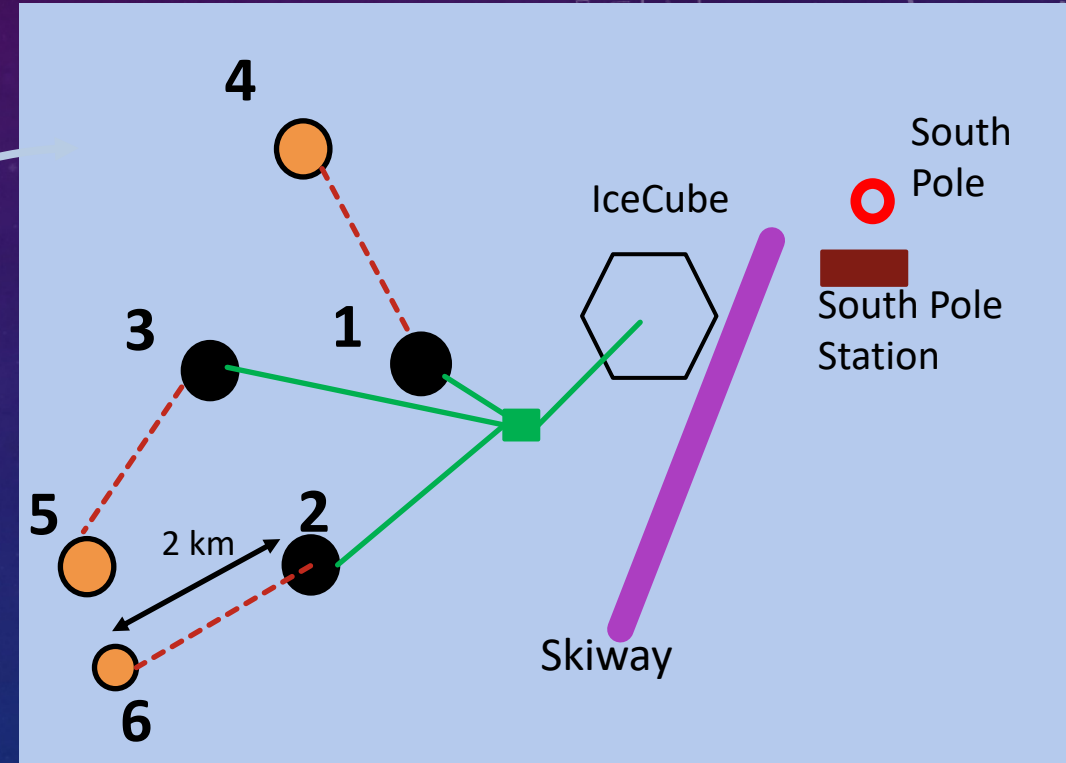
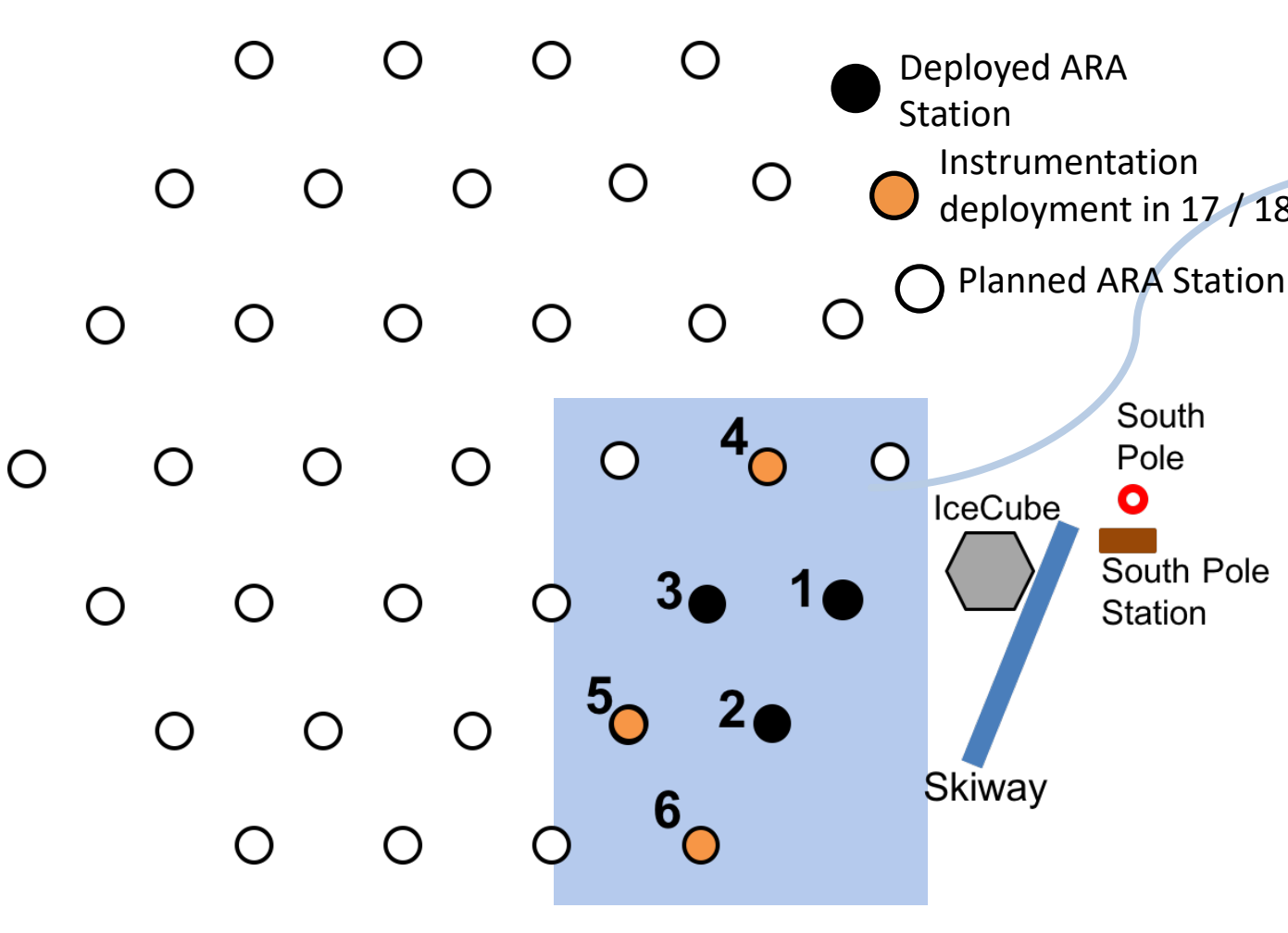
ASKARYAN RADIO ARRAY



Detection Concept

Station Design

STATUS OF ARA



Amundsen-Scott South Pole Station

COSMO Sky-Med RADAR image

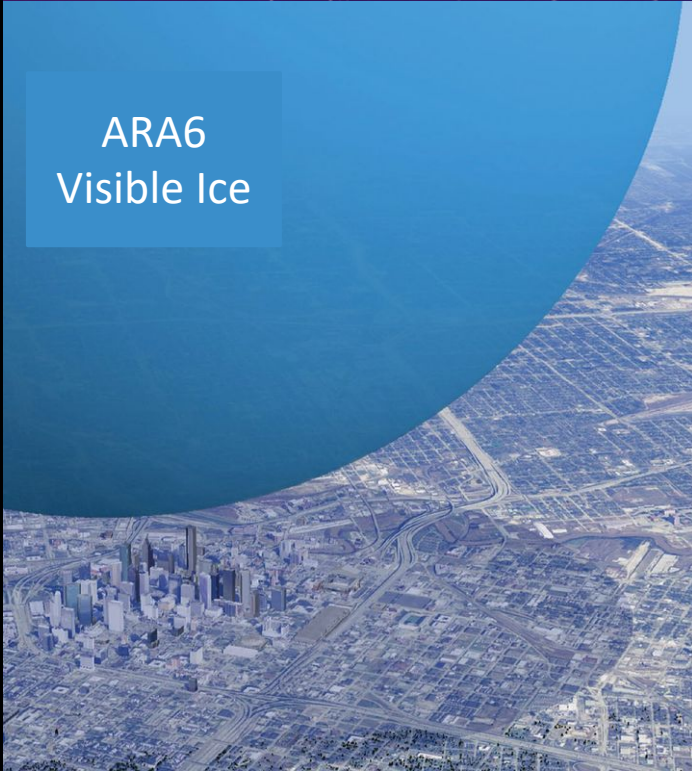
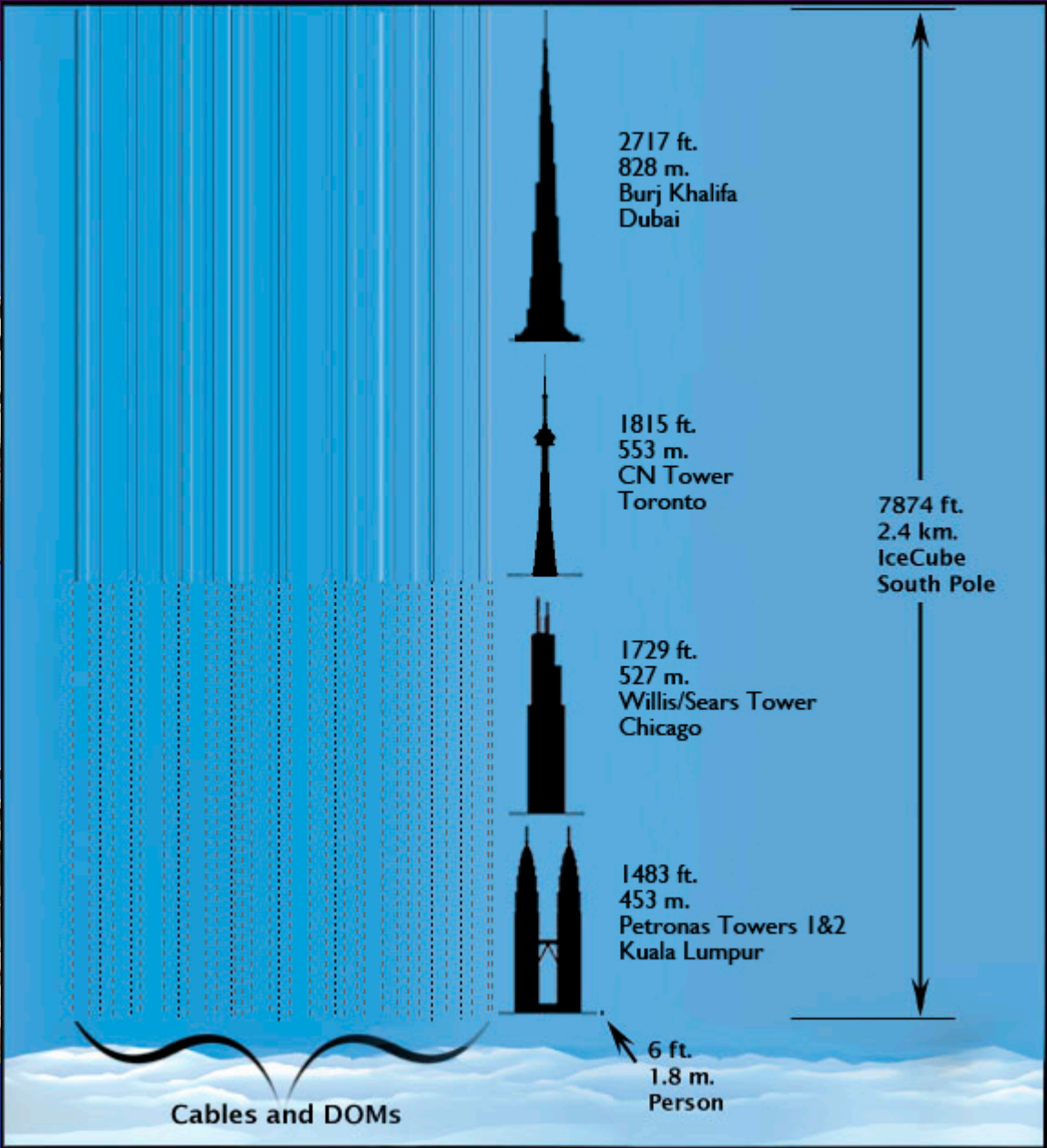
July 6, 2012



GARGANTUAN INSTRUMENTS



Michigan Capitol
267 ft



The background features a dark blue gradient with a subtle pattern of white stars and technical diagrams. On the right side, there are several circular diagrams with concentric lines and arrows, resembling a technical drawing or a diagram of a particle detector. The text is centered and reads:

**BUT DO THESE HIGH-ENERGY
NEUTRINOS *ACTUALLY* EXIST?**



THEY DO EXIST

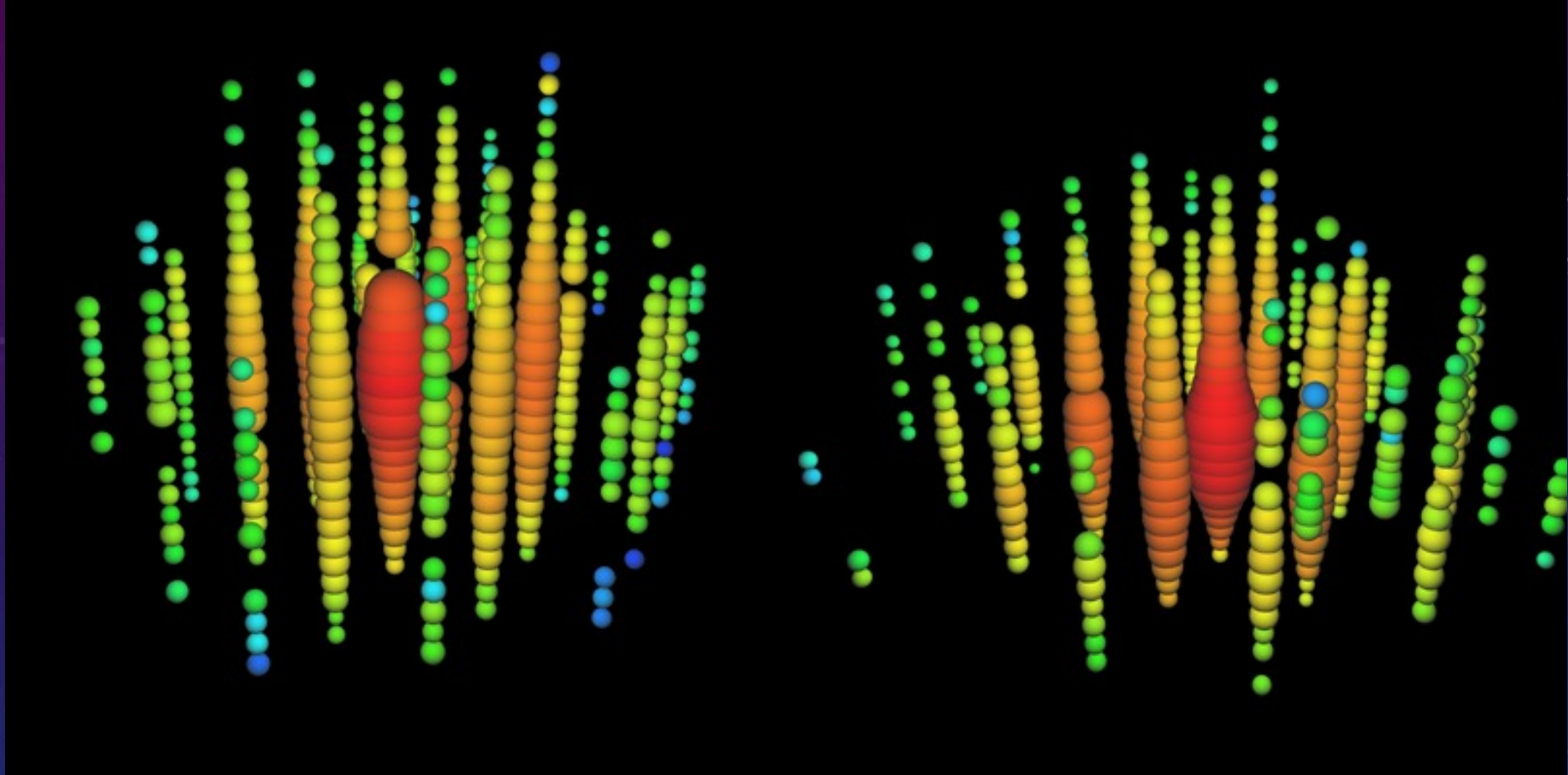
TV Commercials

memegenerator.net

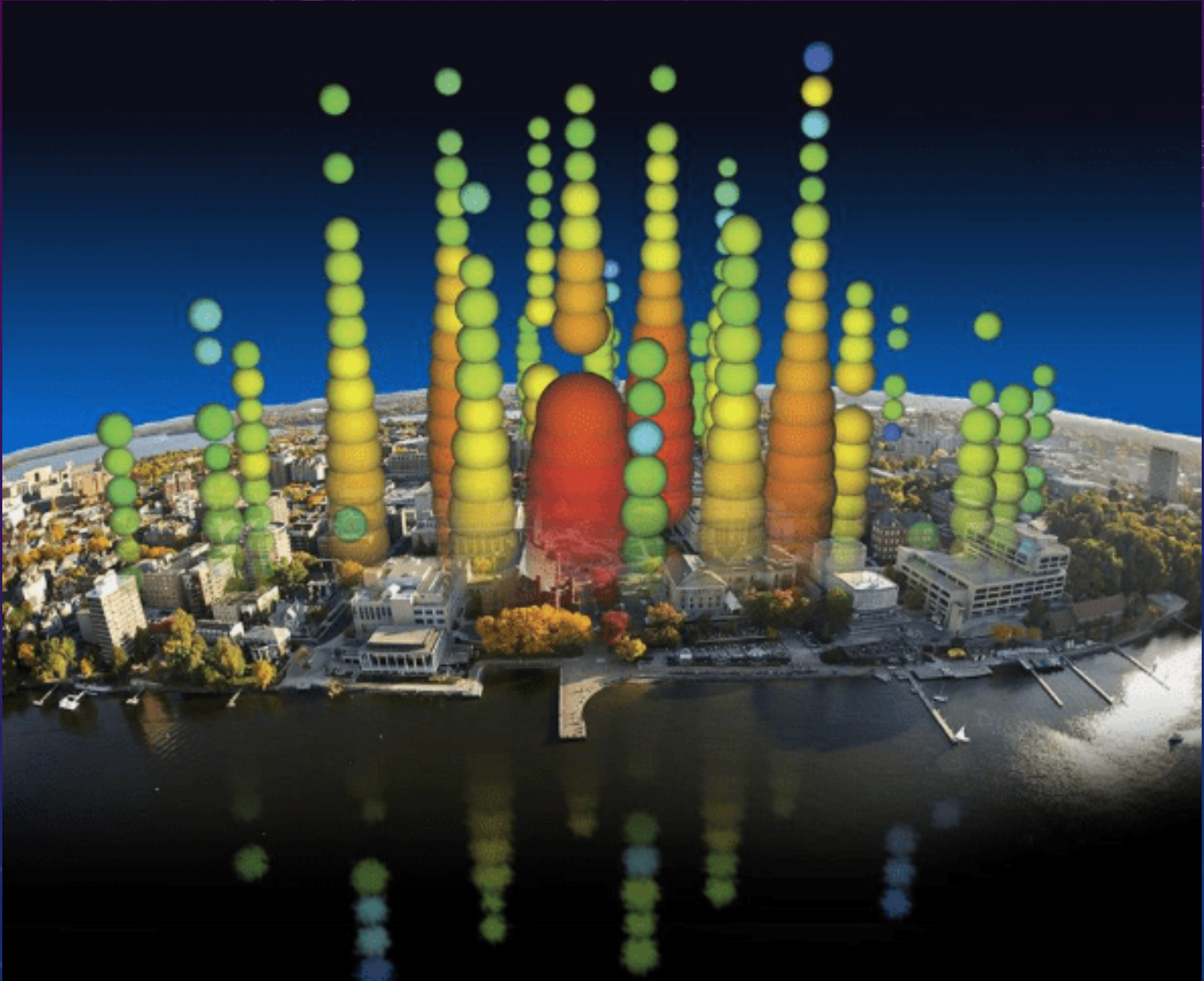


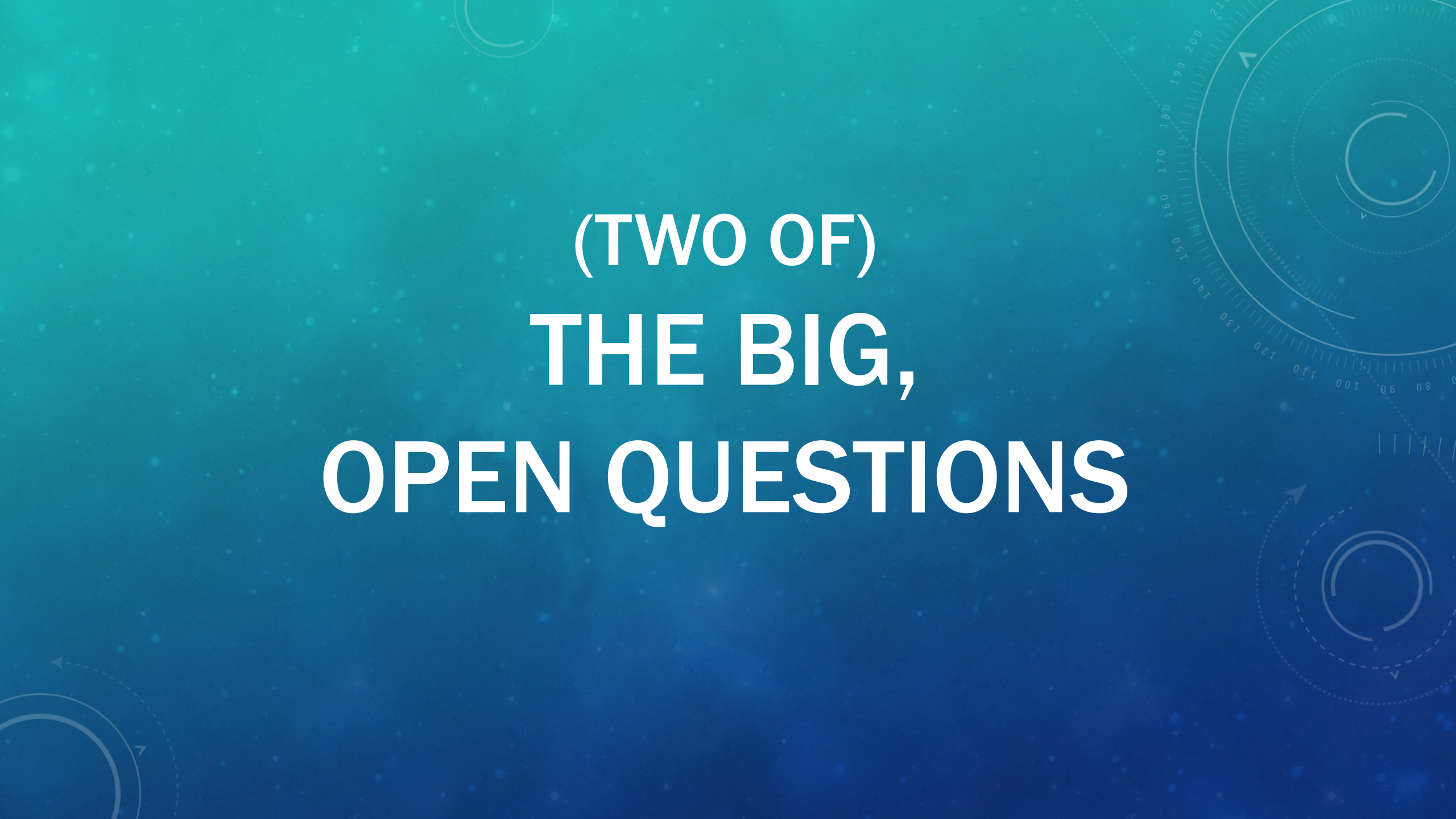
HE DOES EXIST!

2012: IceCube reveals "Bert and Ernie"



First cosmic neutrinos



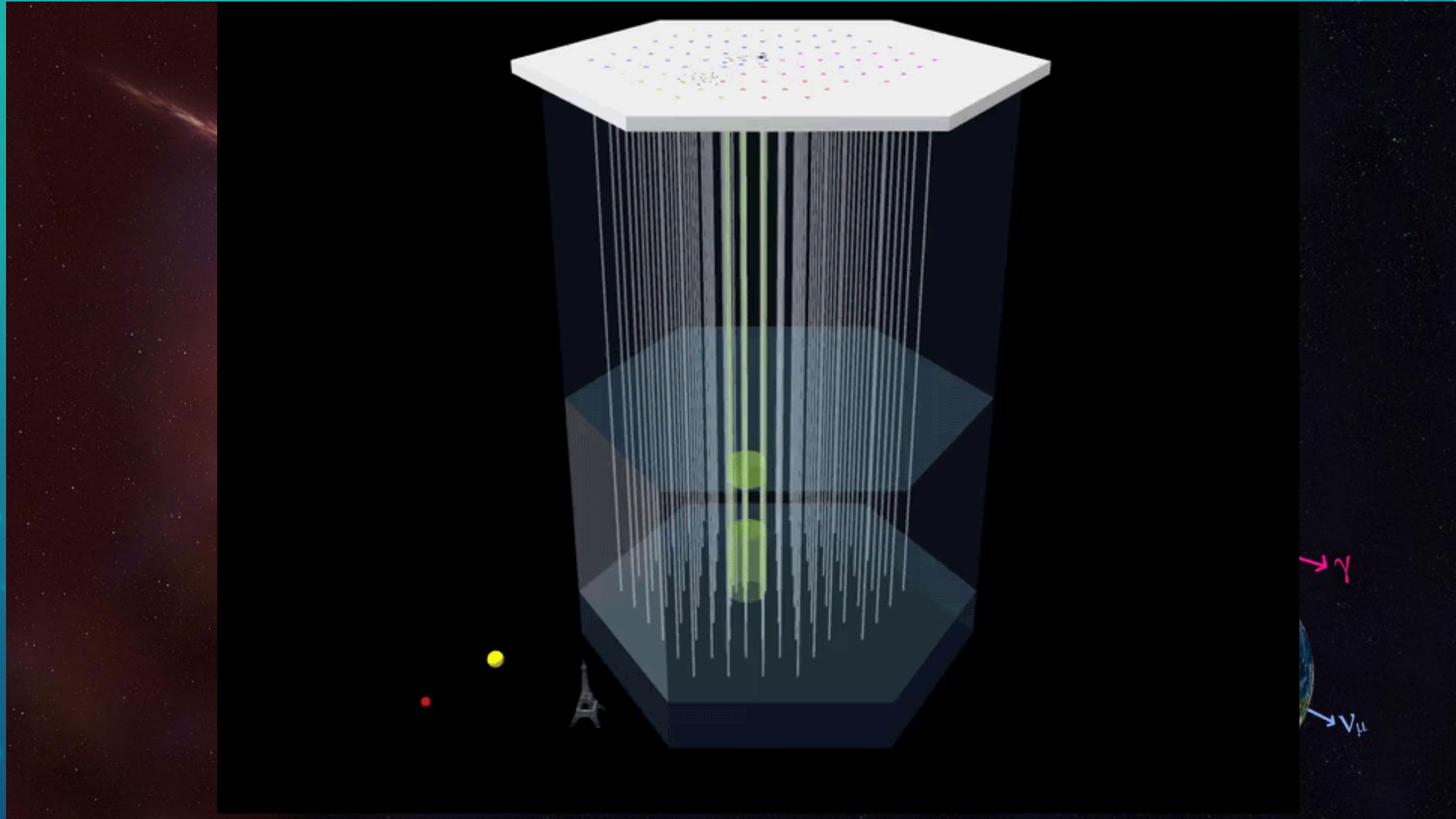


**(TWO OF)
THE BIG,
OPEN QUESTIONS**

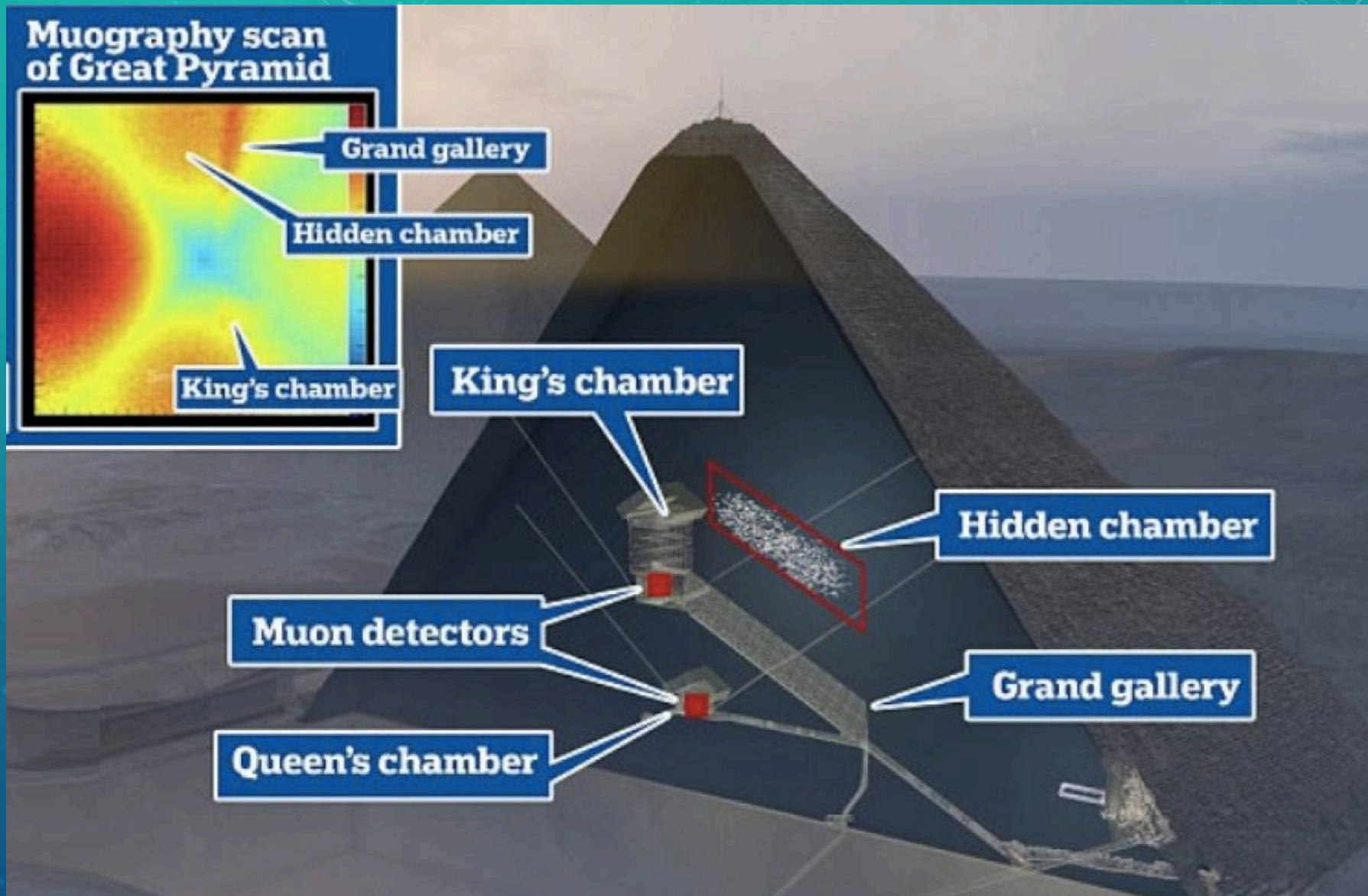


Active Galactic Nucleus Centaurus A.
(ESO public image release)

What are the neutrino “engines”?



Neutrinos from blazars—first possible source!



What can we do with them?

THANK YOU!
QUESTIONS?

