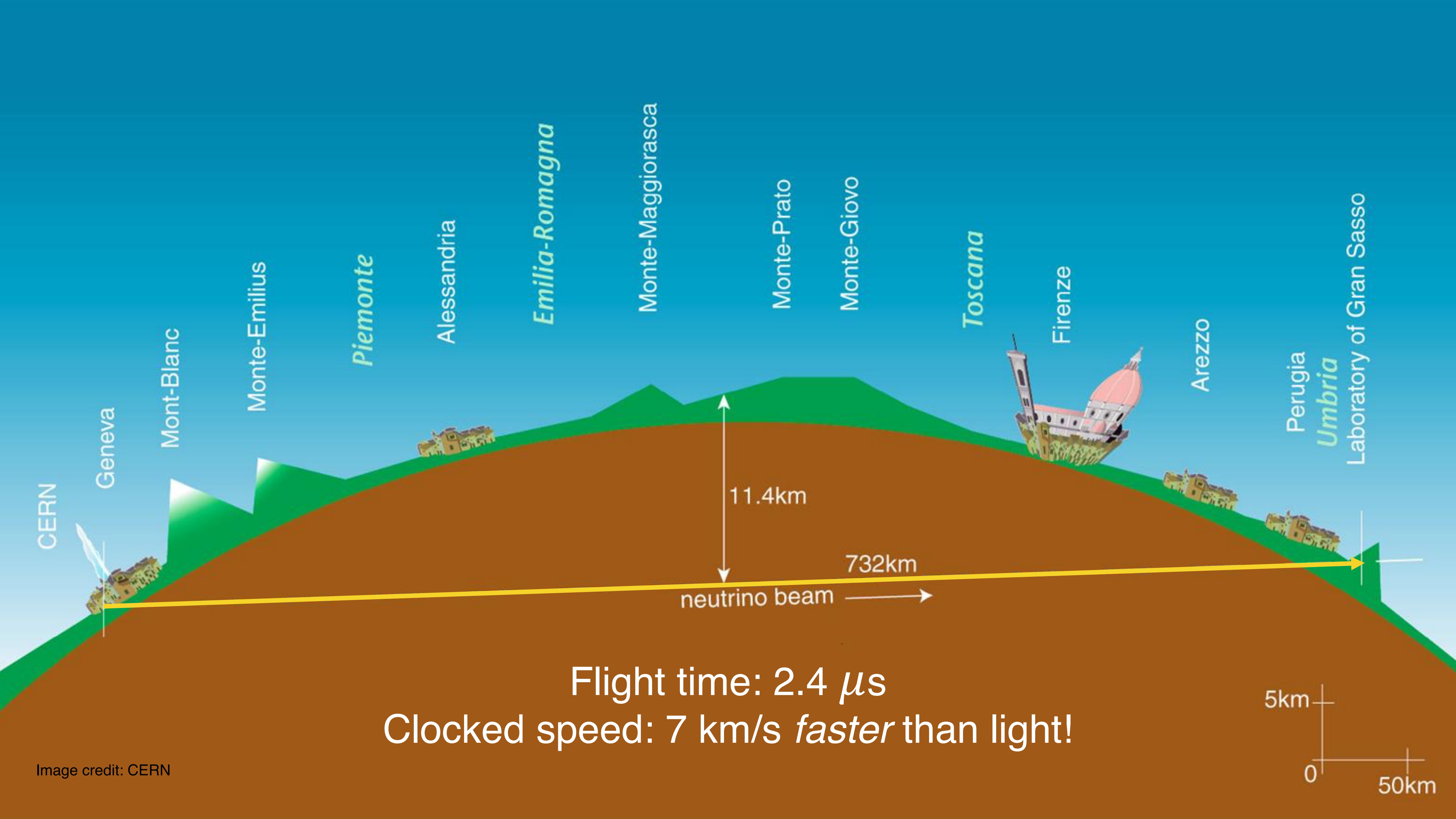


Neutrino: The Particle that Shouldn't Exist

Prof. Roberto Trotta

 @R_Trotta

Credit: Kamioka Observatory/Tokyo U.



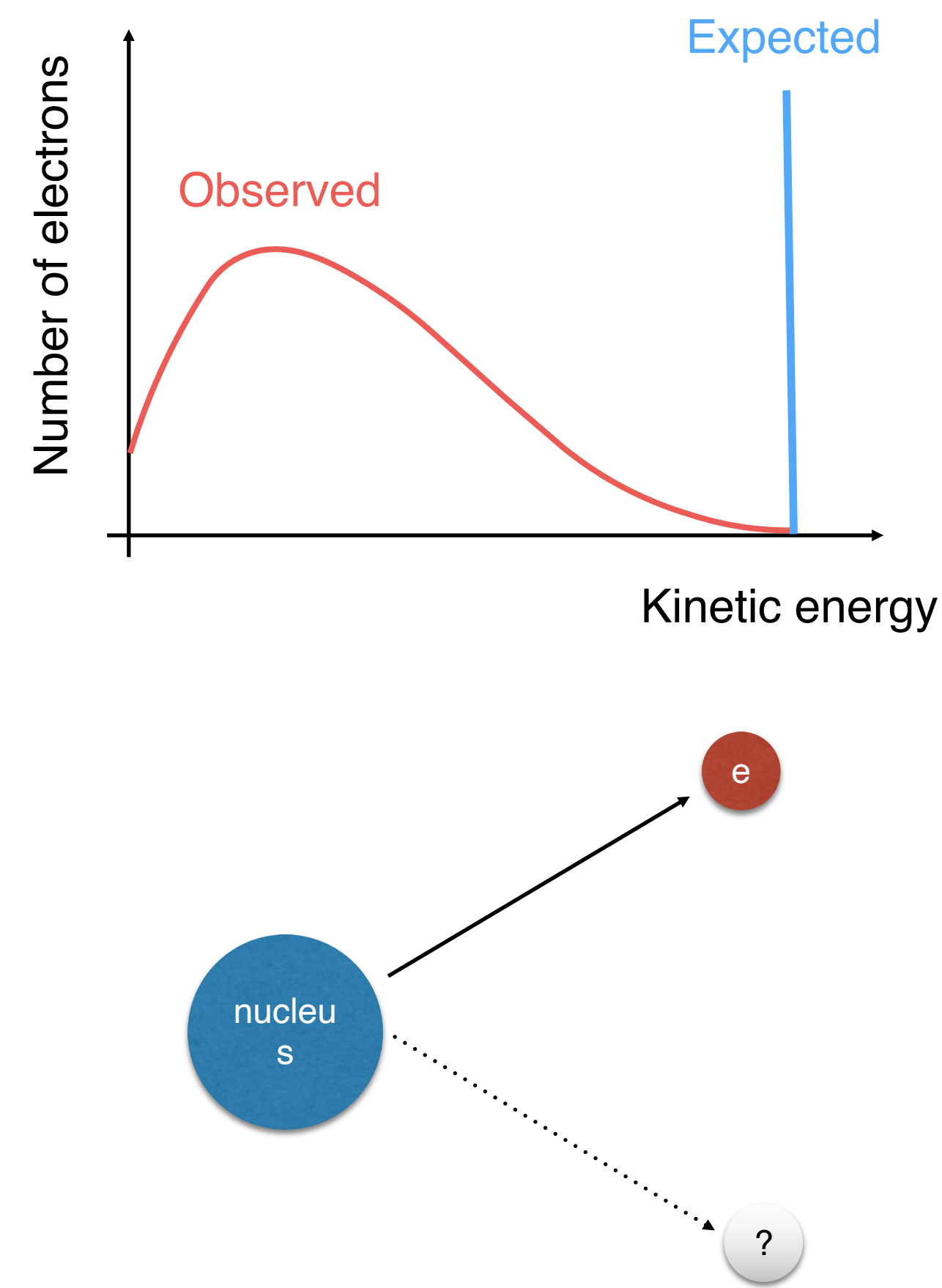
Pauli's “desperate remedy”



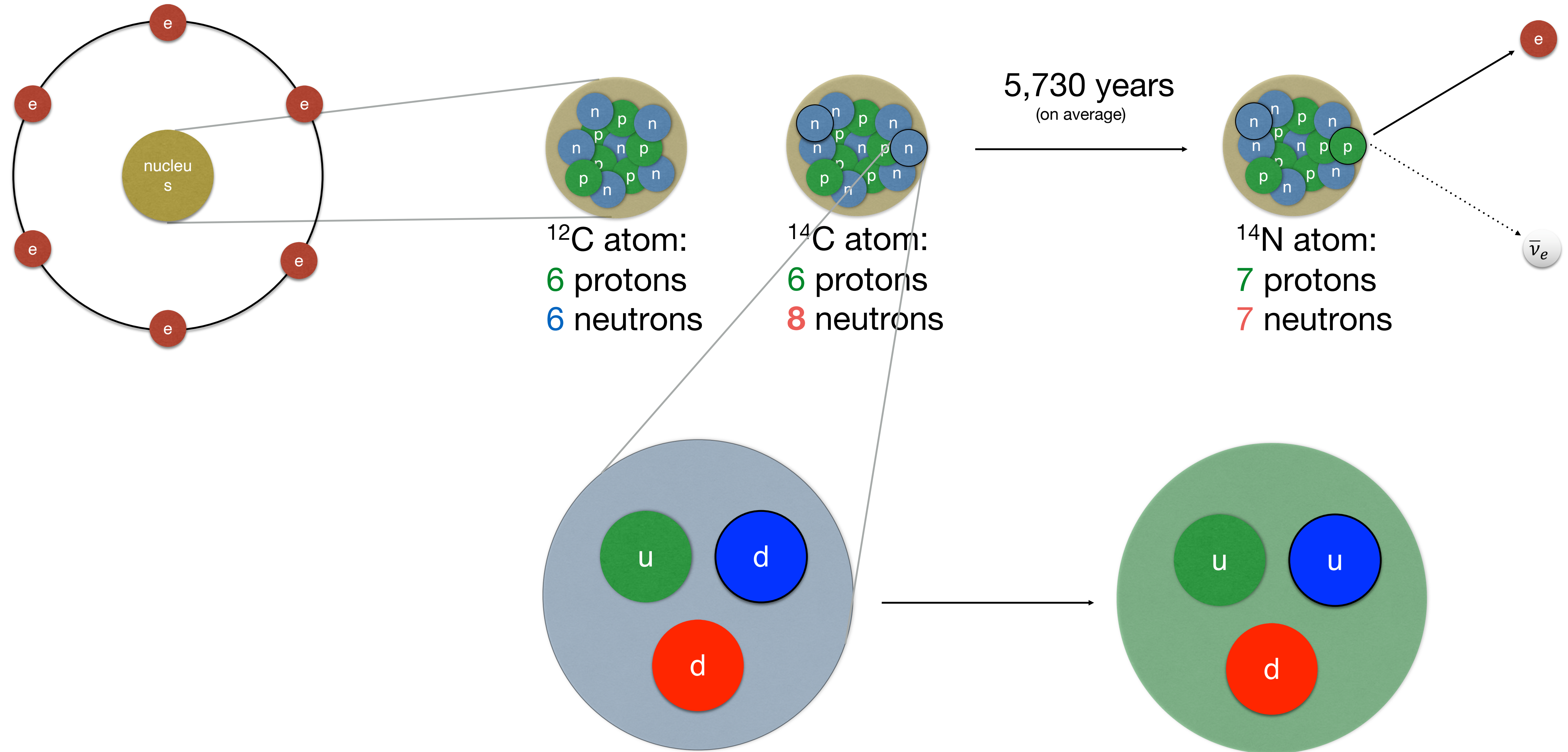
Wolfgang Pauli on his 45th birthday, 25th April 1945
(Credit: Pauli Archive Photos, CERN)

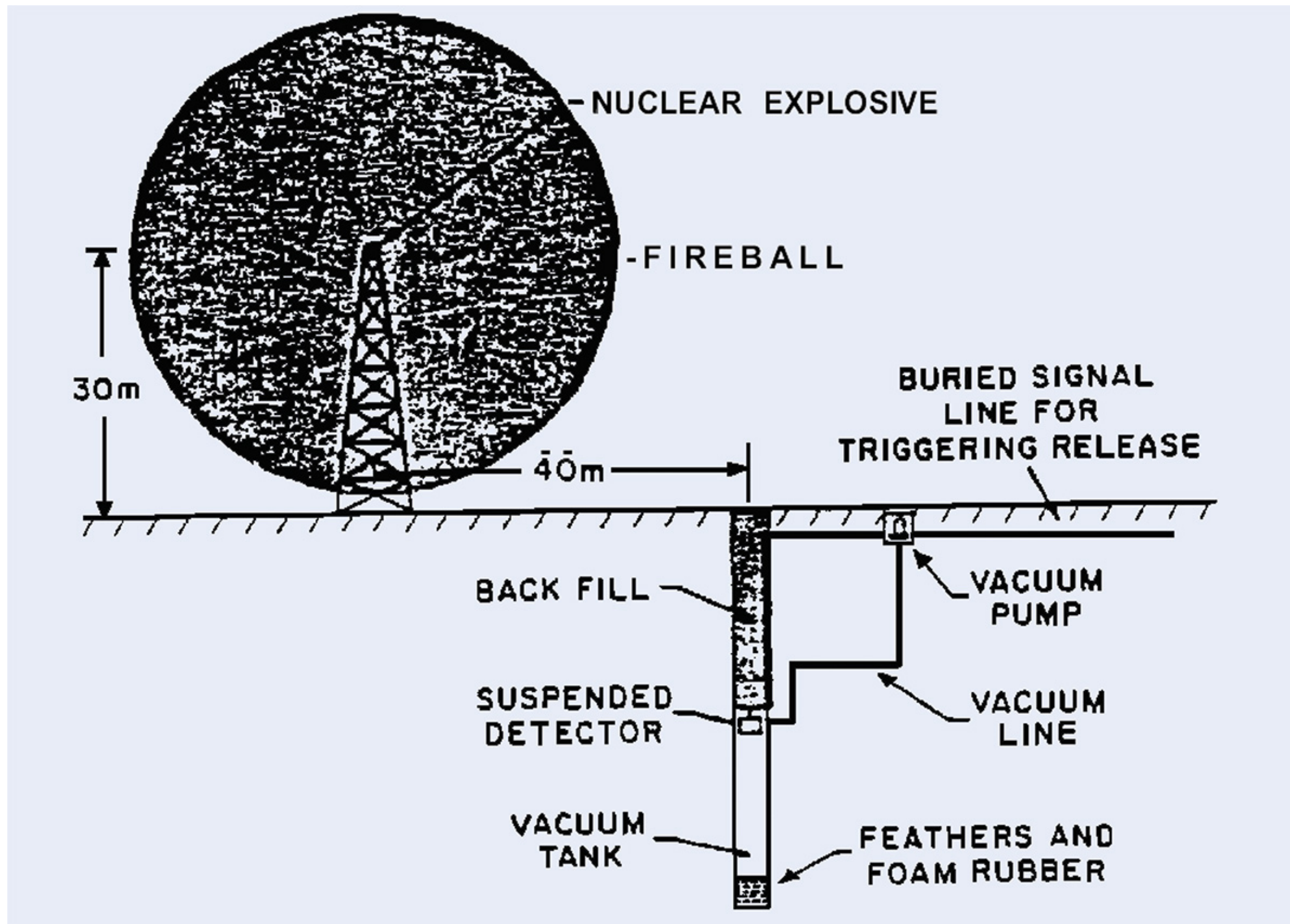


Wolfgang Pauli working with Albert Einstein in 1926
(Credit: Pauli Archive Photos, CERN)



The radioactive beta decay

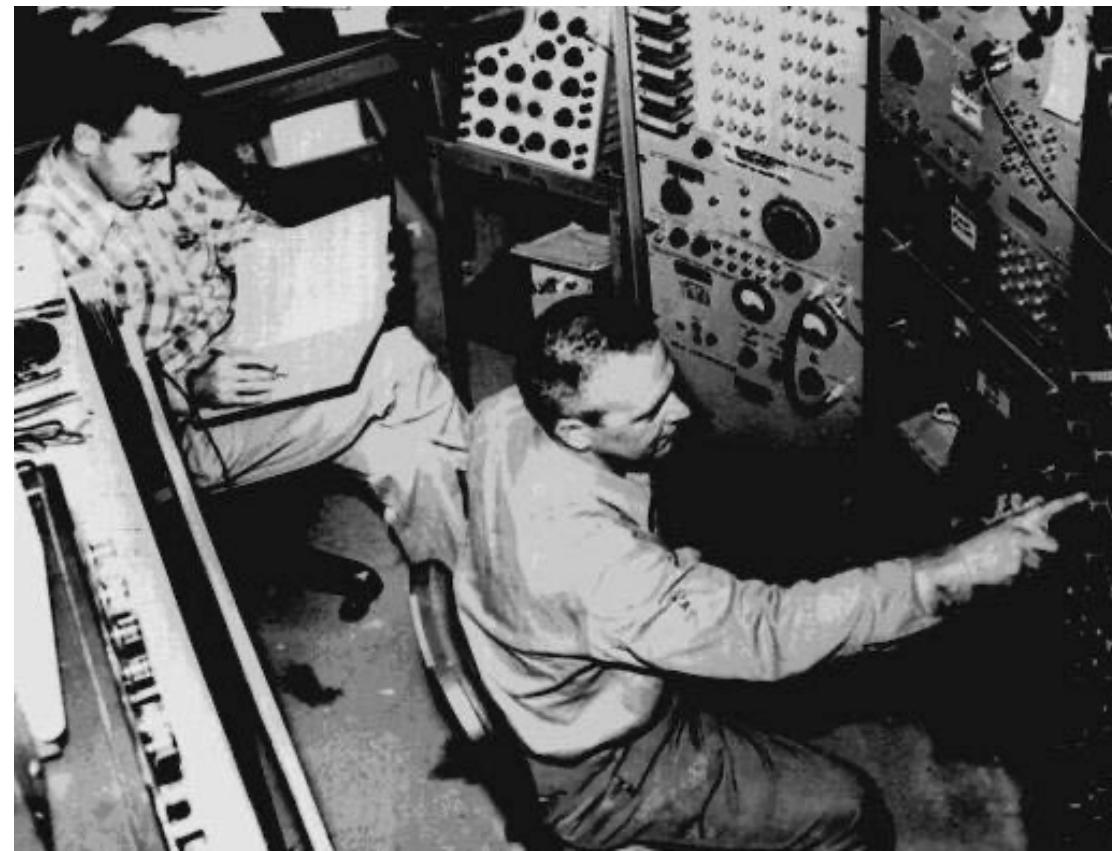




Credit: Fred Reines

1952 proposal to detect neutrinos from an atmospheric nuclear test
(not realized)

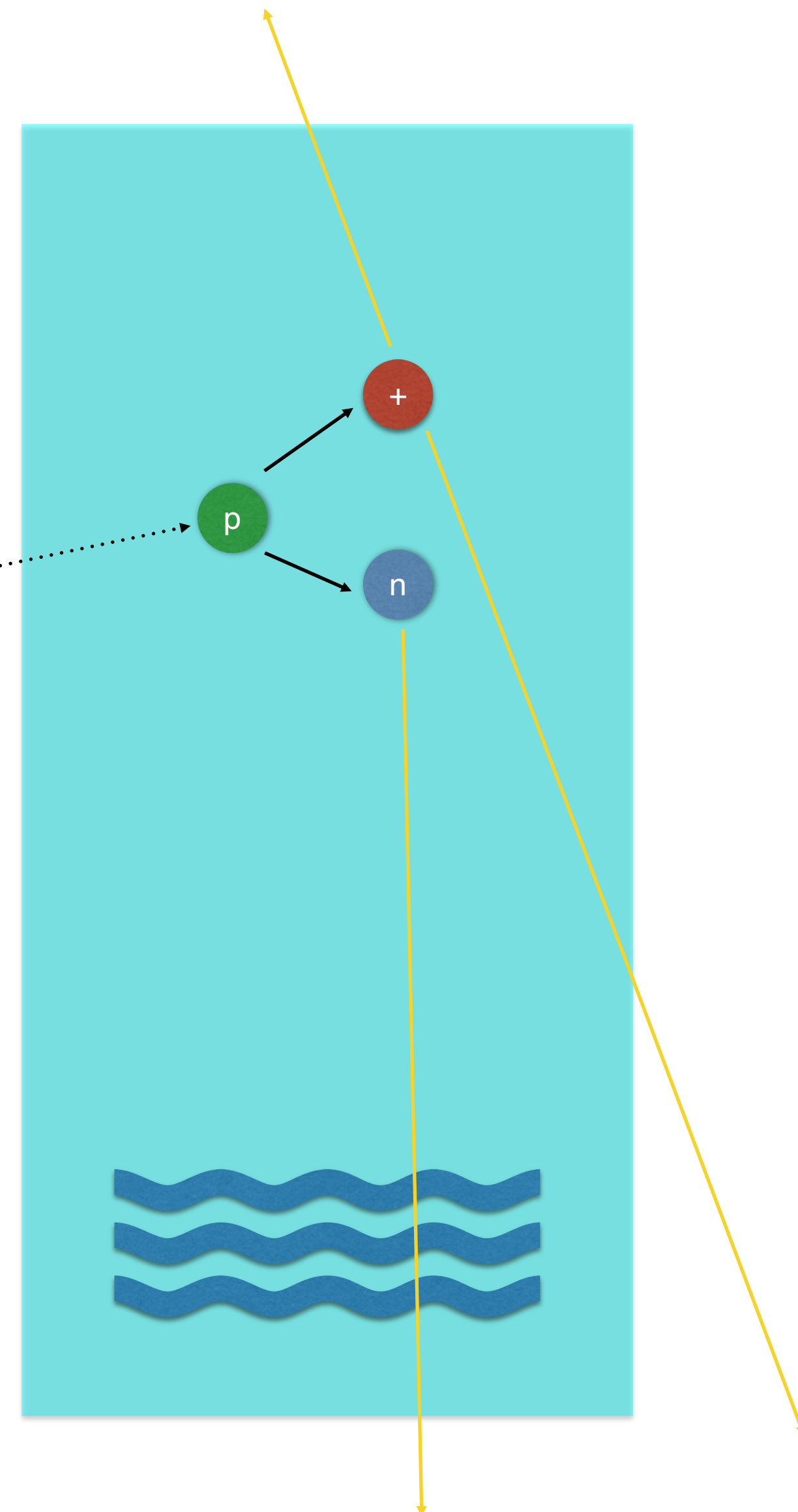
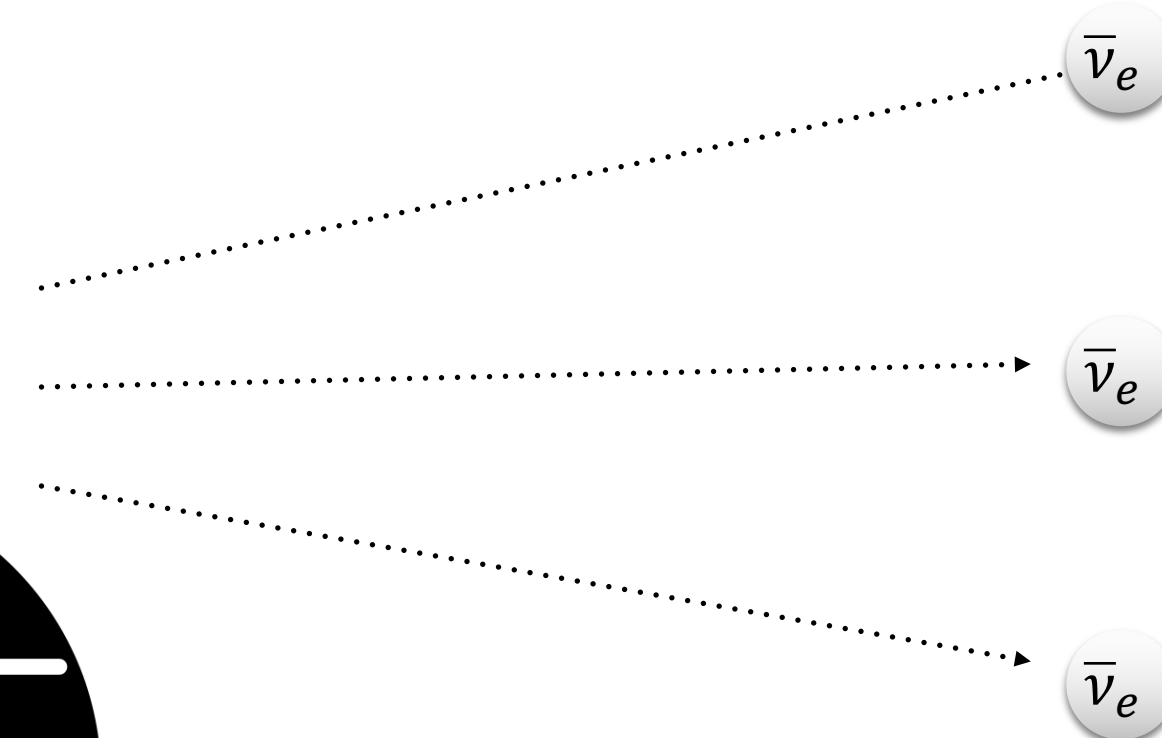
The Reines and Cowan experiment



Reines (left) and Cowan, ca 1953
(Credit: U. Of California, Irvine)



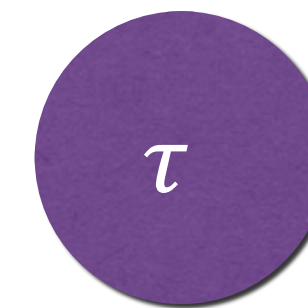
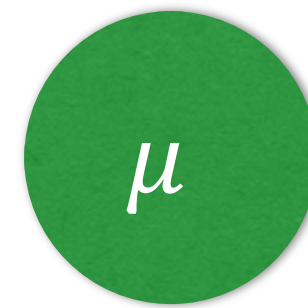
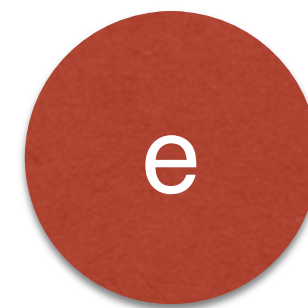
10,000 billions/(s cm²)



“[The neutrino is] The most tiny quantity of reality ever
imagined by a human being”

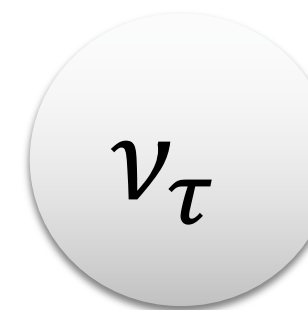
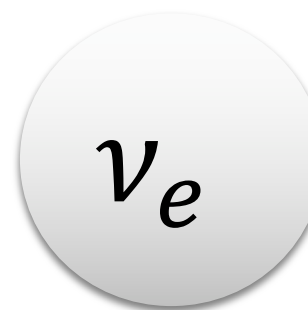
Fred Reines

The Leptons Family

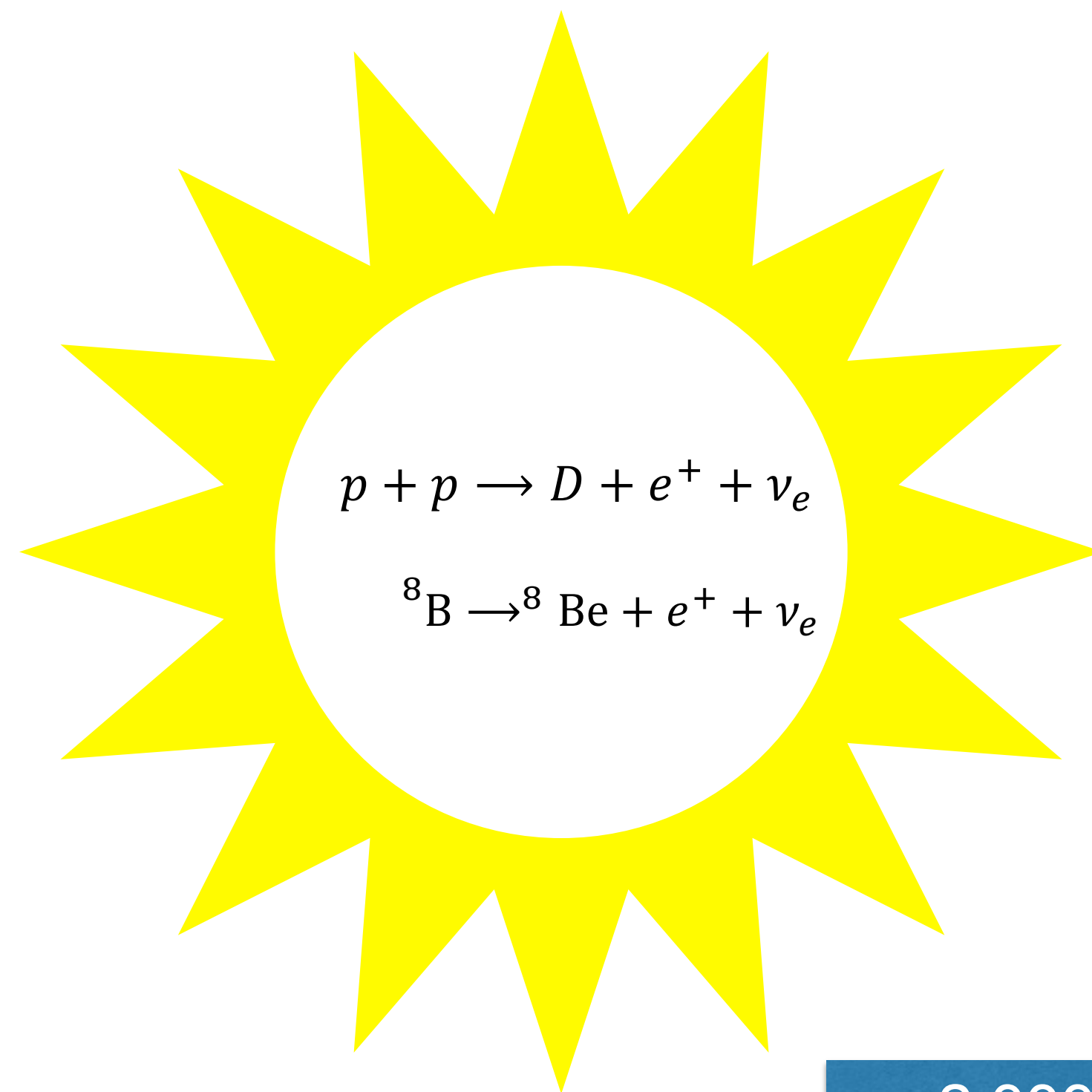


~200x heavier

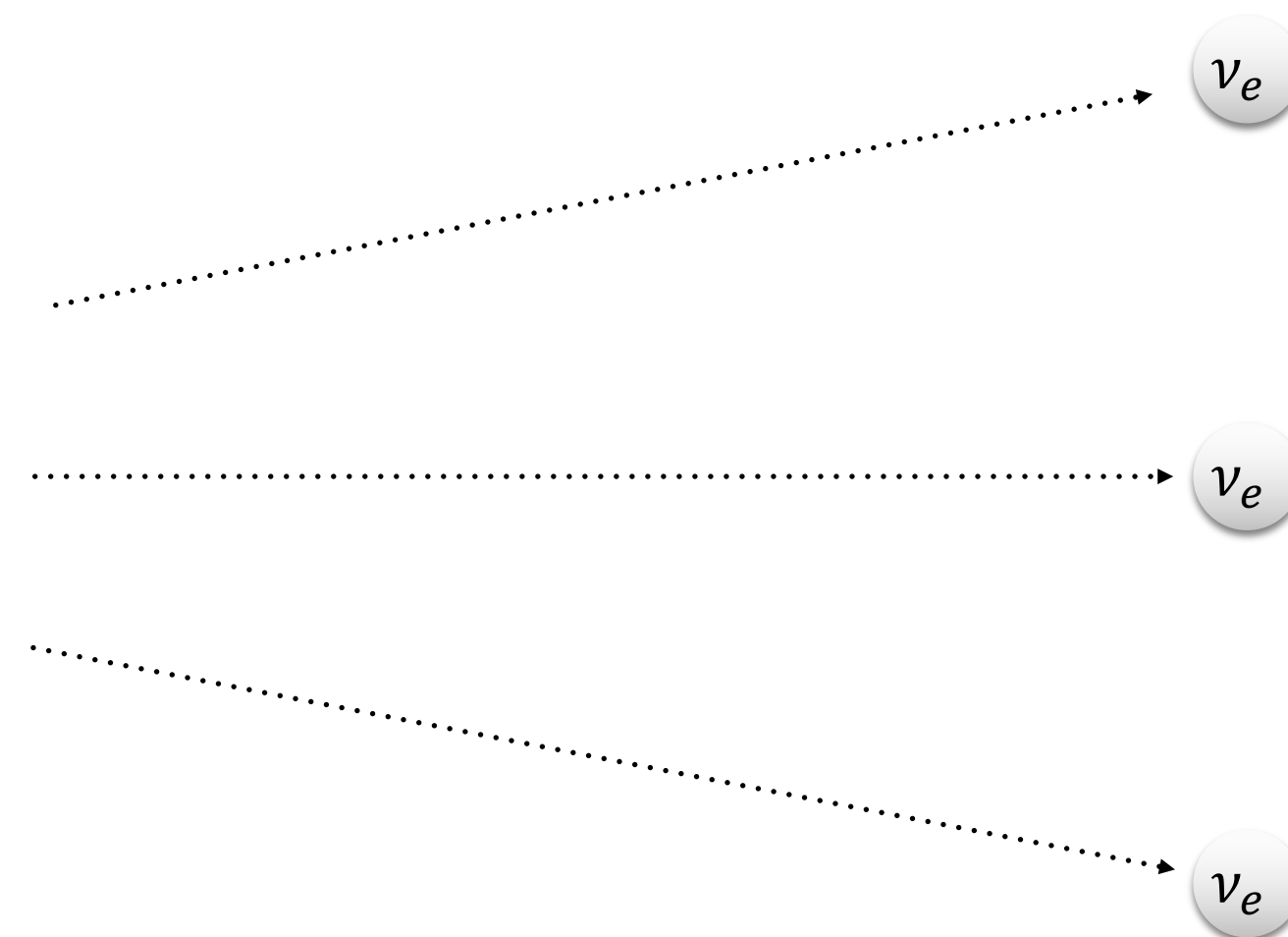
~3500x heavier



The Solar Neutrino Problem



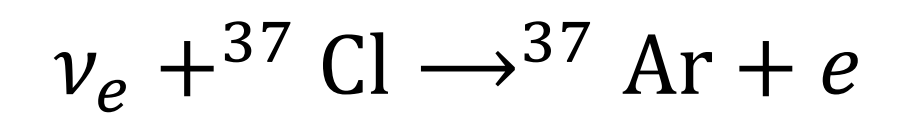
10 billions/s reach the Earth



~2,000 Ar atoms detected over 25 yrs

Only a third of the number expected.

Did the neutrinos go missing?



The Homestake experiment
(Credit: Brookhaven National Lab)

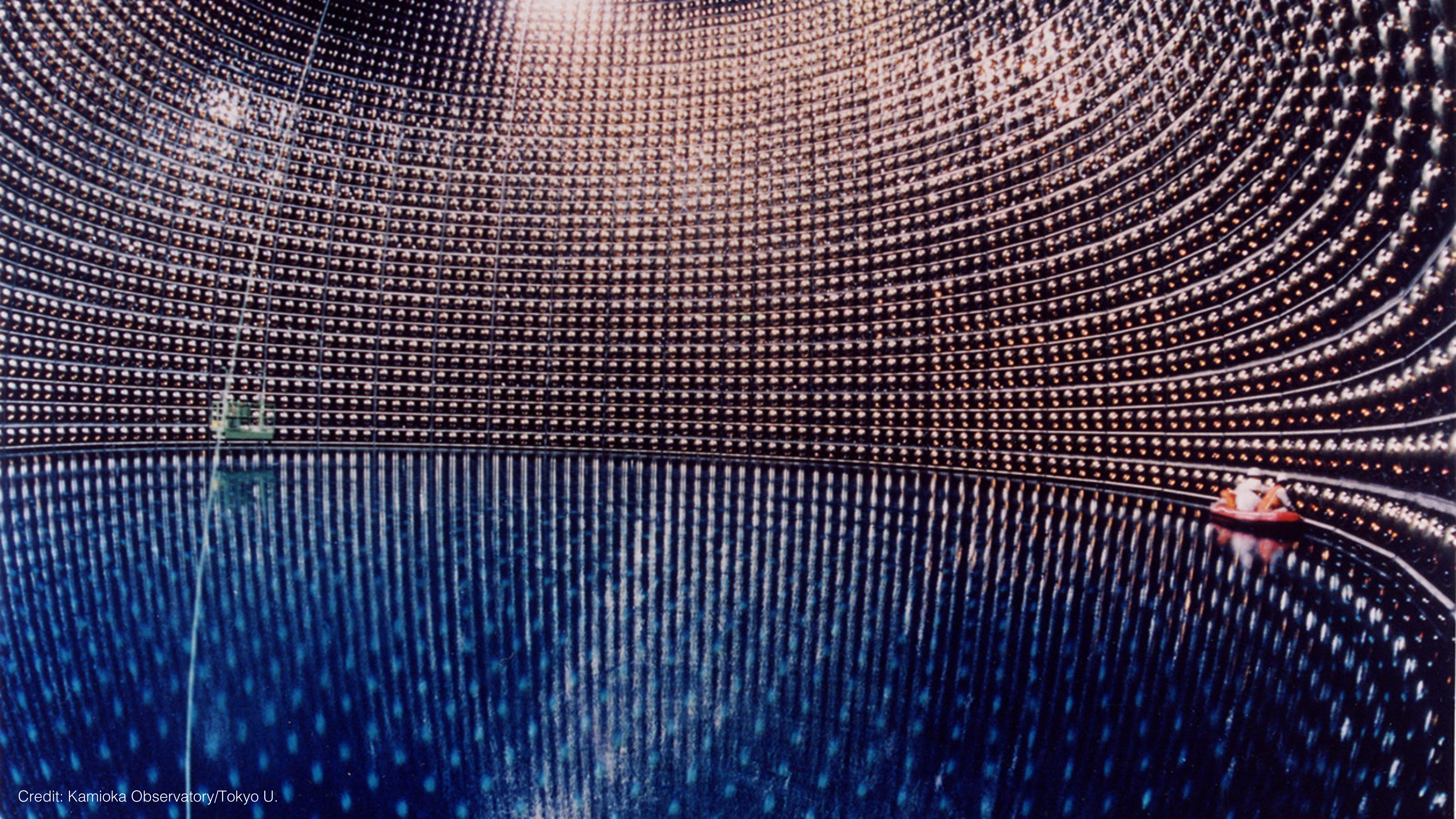


Raymond Davis in 1971
(Credit: Brookhaven National Lab)

Solar Neutrinos Change into Each Other



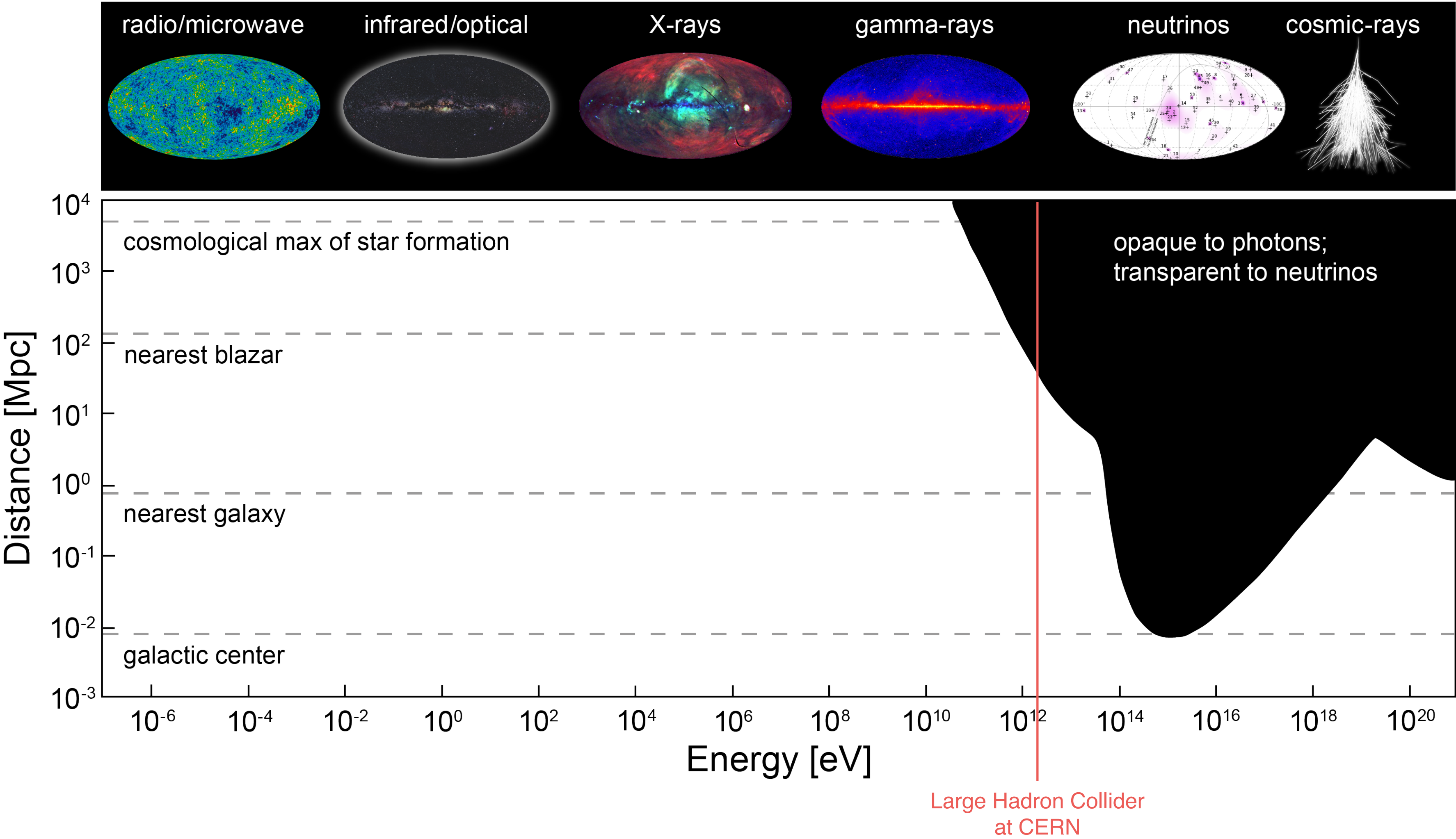
The Sudbury Neutrino Observatory under construction
(Credit: Sudbury Neutrino Observatory)



Credit: Kamioka Observatory/Tokyo U.



Our Helpful Friend the Neutrino



Credit: IceCube Collaboration



www.eso.org

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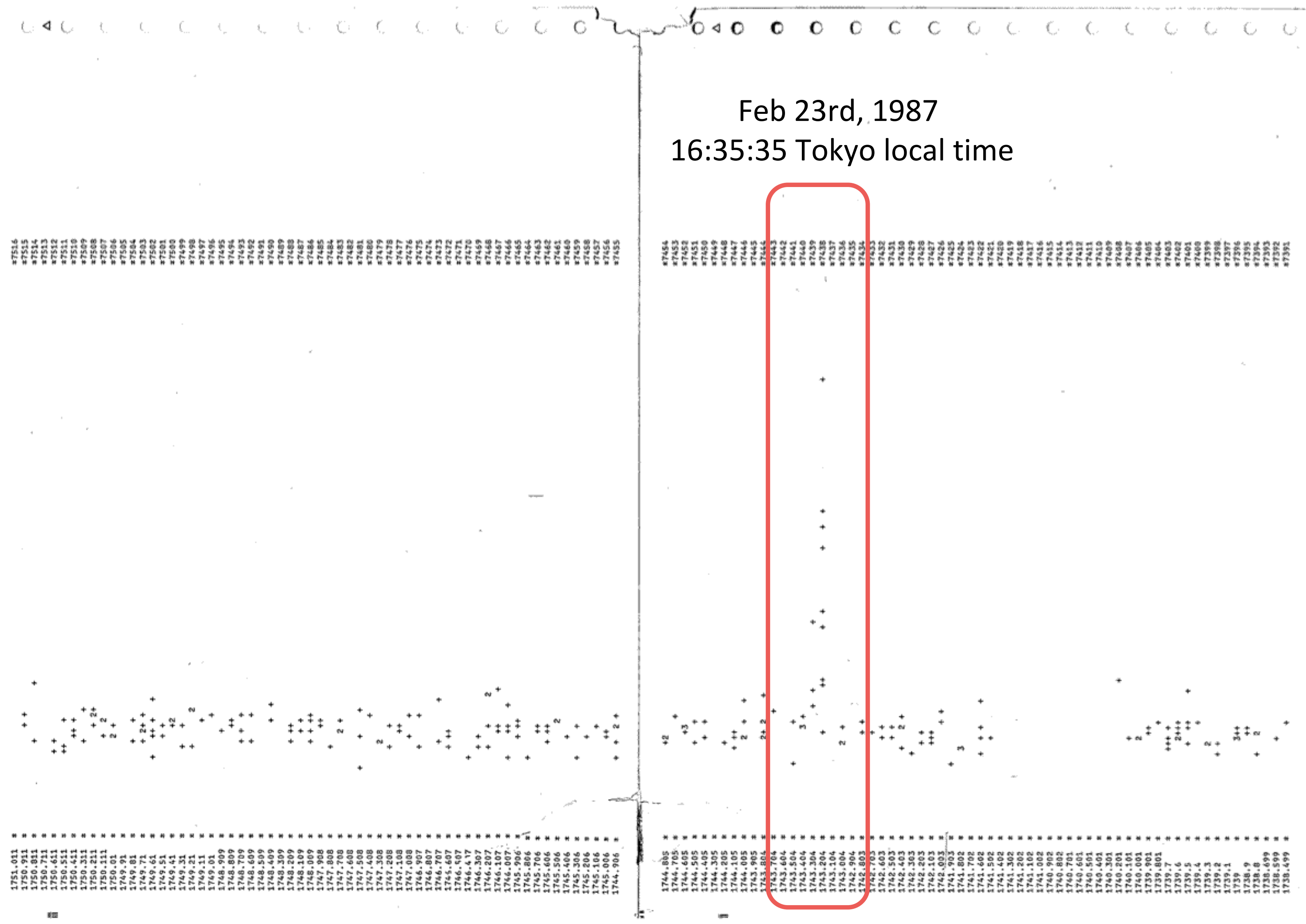
P.01

TO: EUGENE BEIER

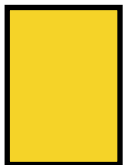
SENSATIONAL NEWS! SUPERNOVA WENT OFF
4-7 DAYS AGO IN LARGE MAGELLENIC CLOUD, 50 KPC
AWAY. NOW VISIBLE MAGNITUDE 4.5, WILL
REACH MAXIMUM MAGNITUDE (-1.0) IN A WEEK.
CAN YOU SEE IT? THIS IS WHAT WE HAVE
BEEN WAITING 350 YEARS FOR!

SID BLUDMAN
(215) 546-3083

The Birth of Neutrino Astronomy



Neutrinos as Dark Matter?



5% Normal Matter



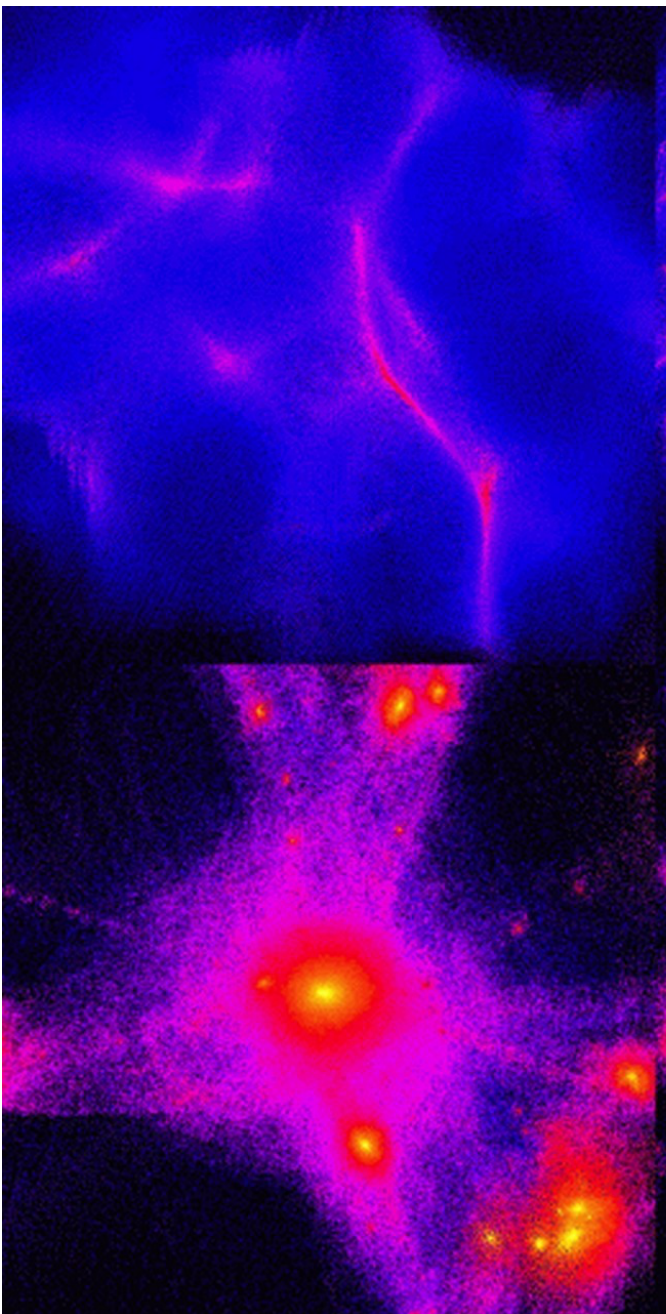
25% Dark Matter



70% Dark Energy

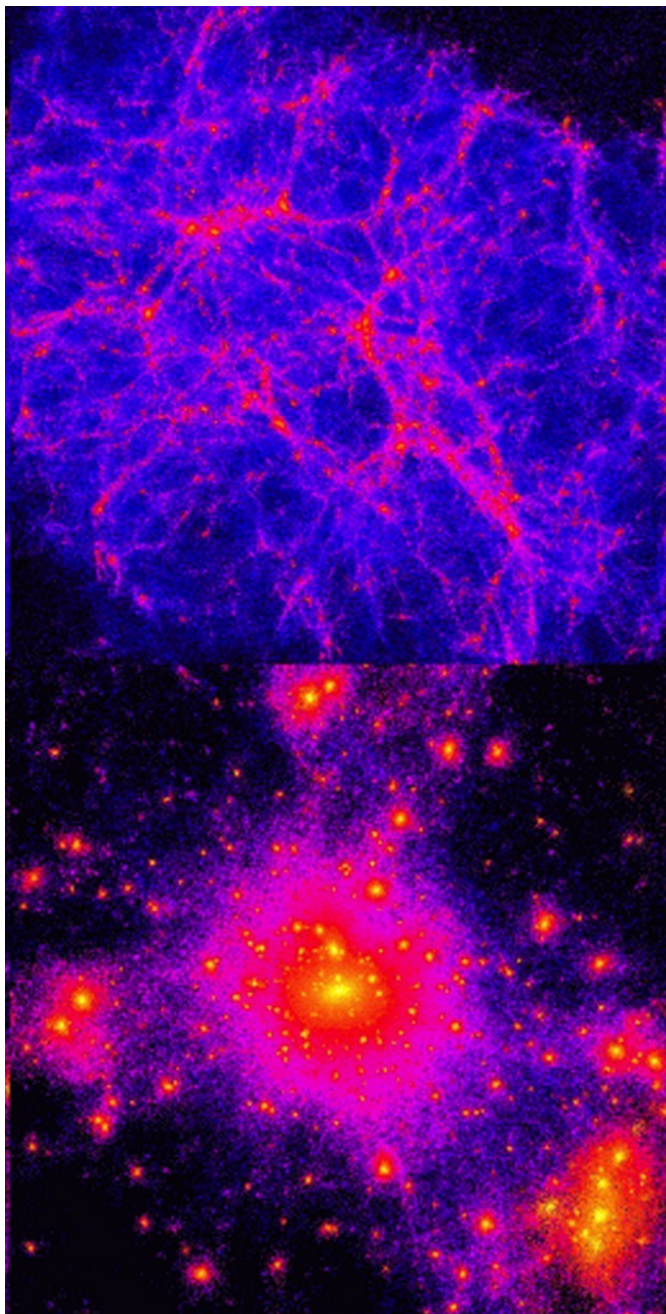
Relic neutrinos:
 $336 \text{ neutrinos/cm}^3$

Neutrinos

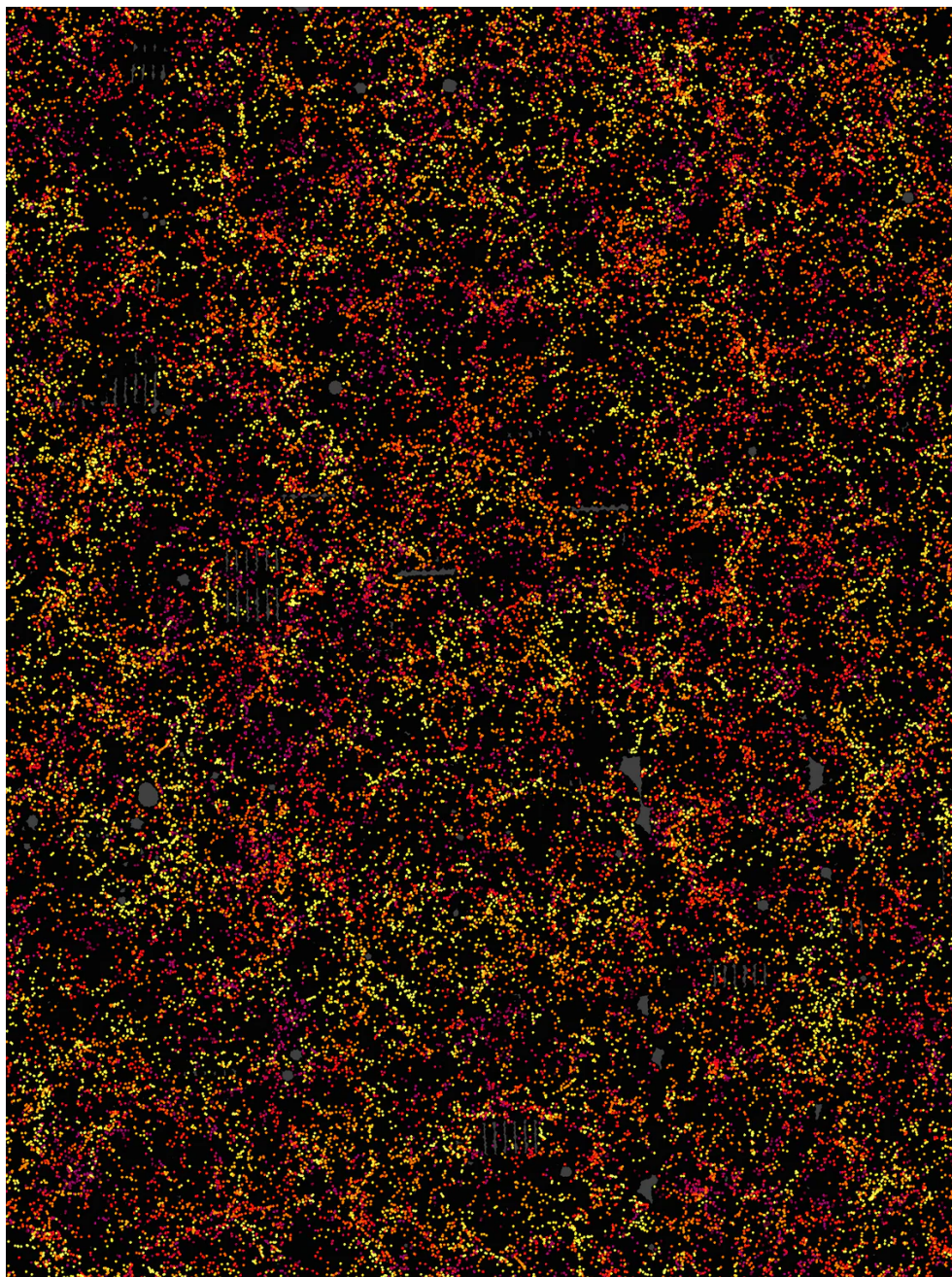


Credit: ITP, Zurich U.

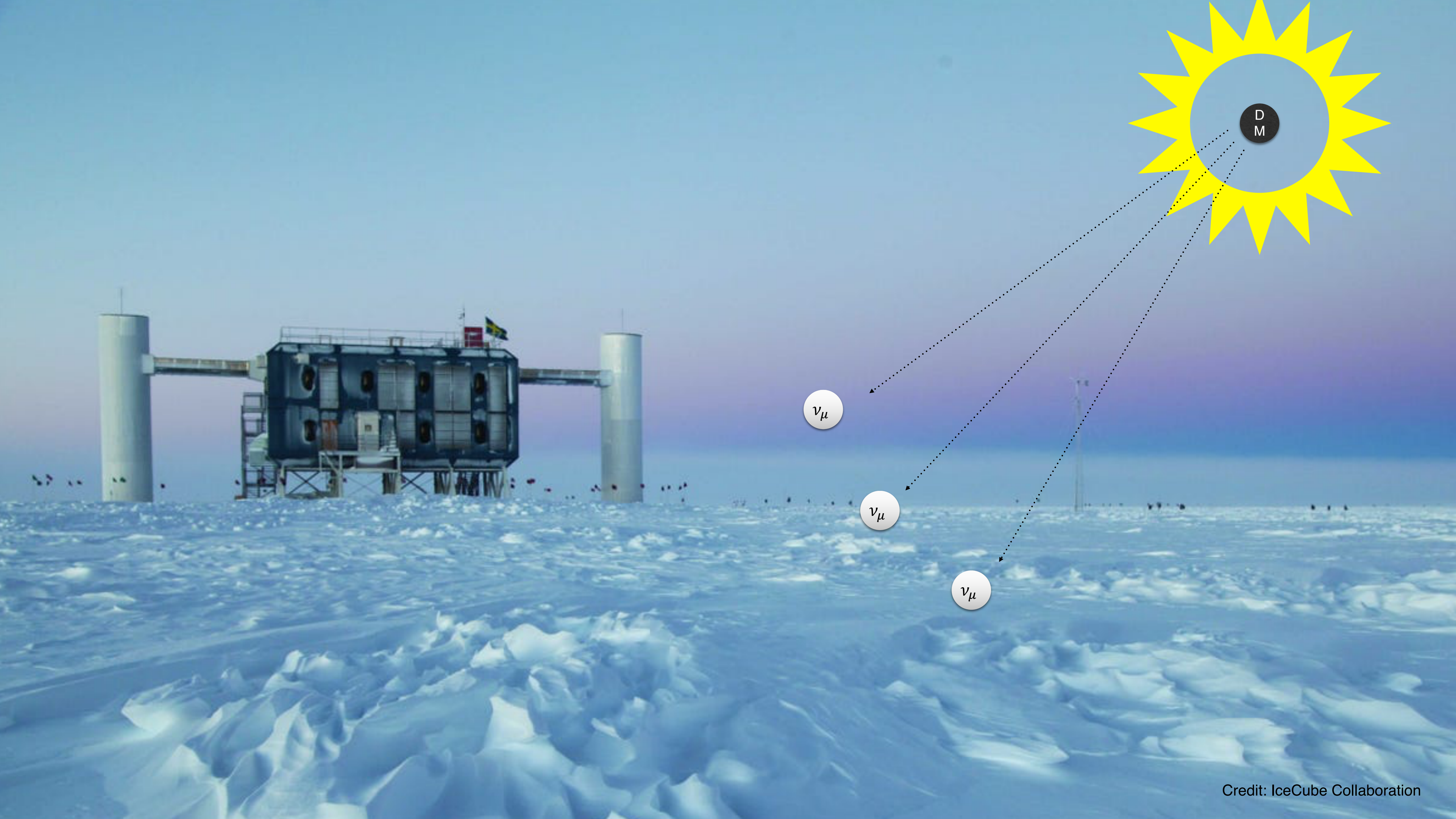
Massive particles

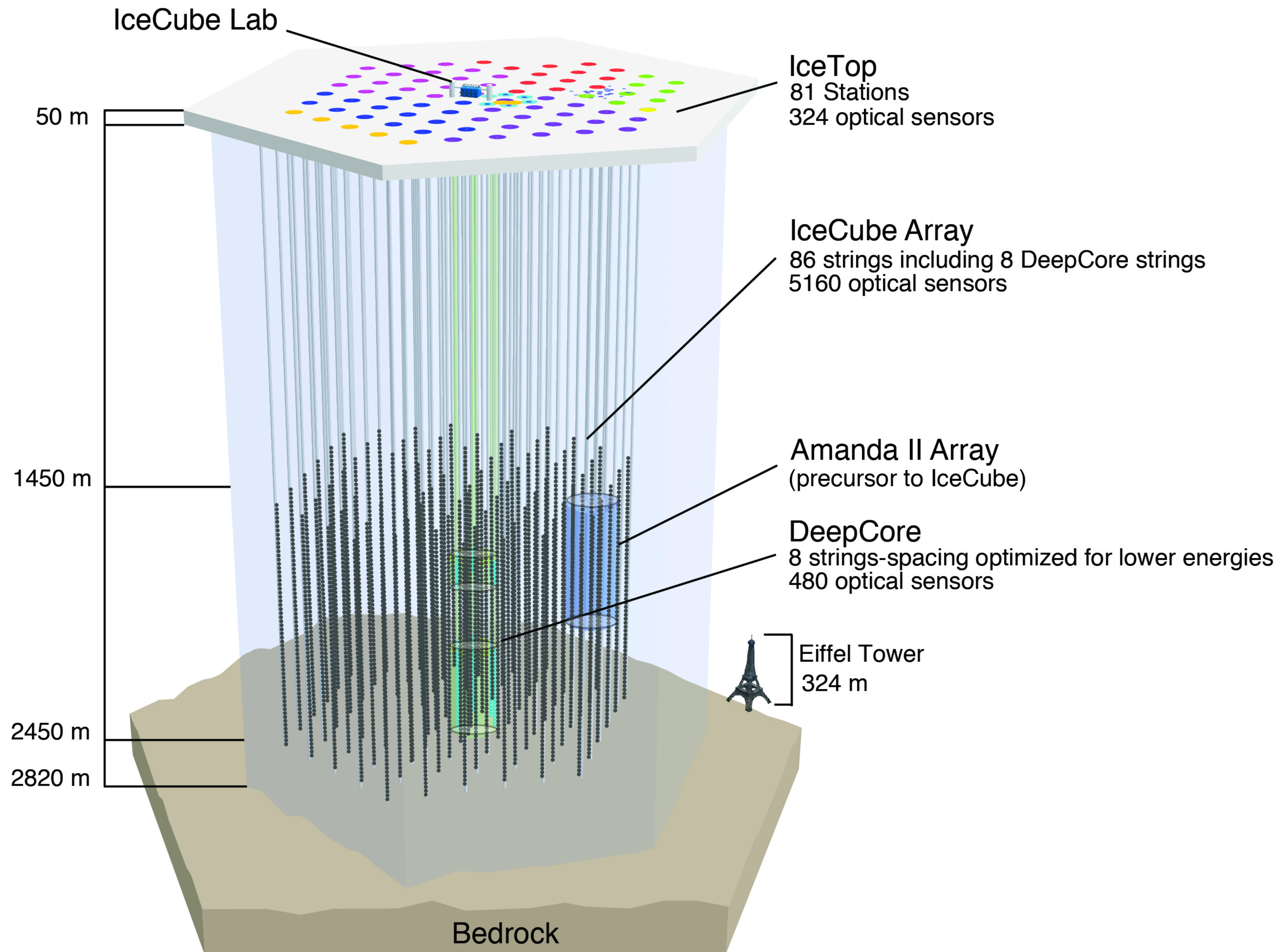
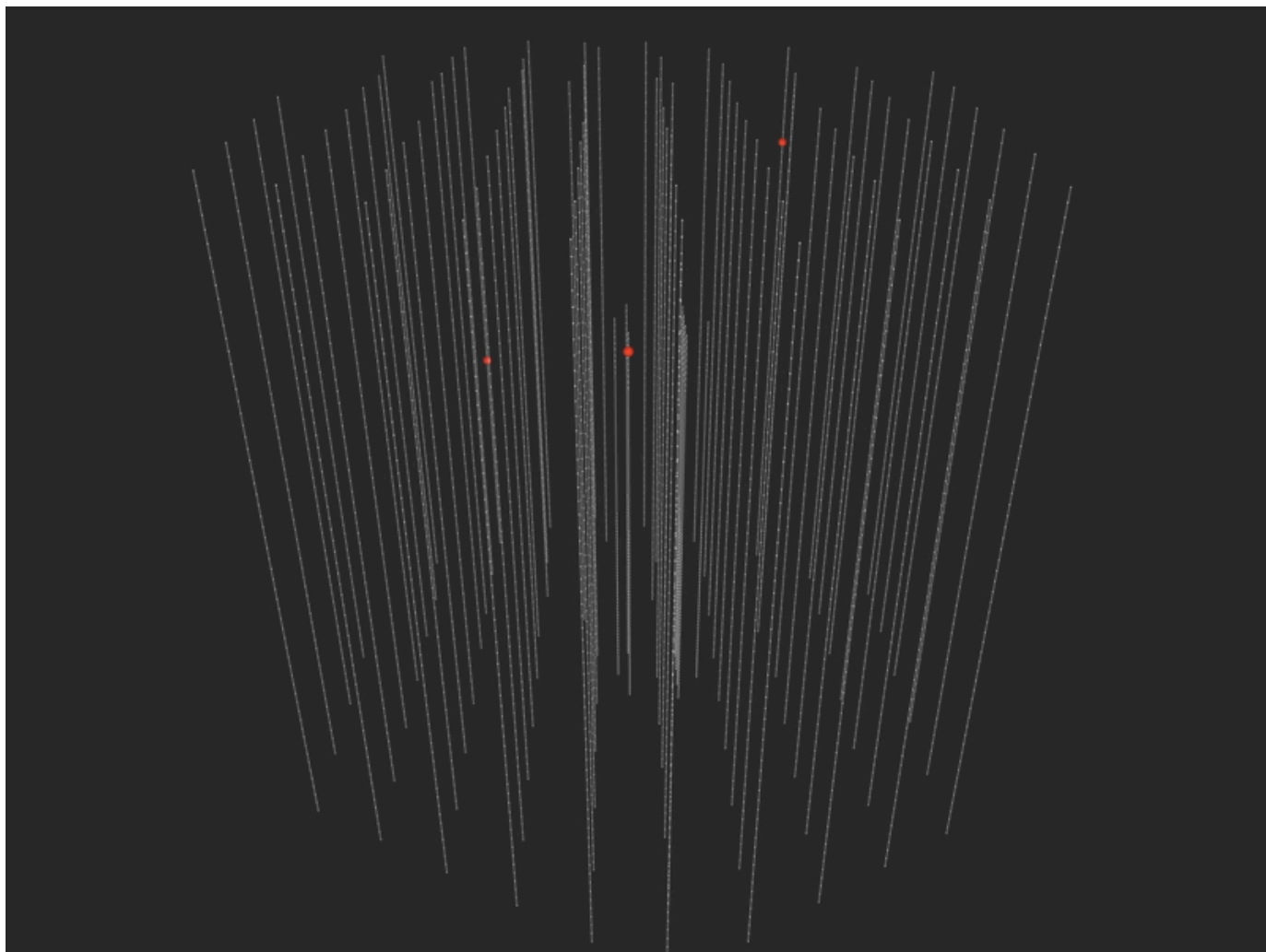


Observations

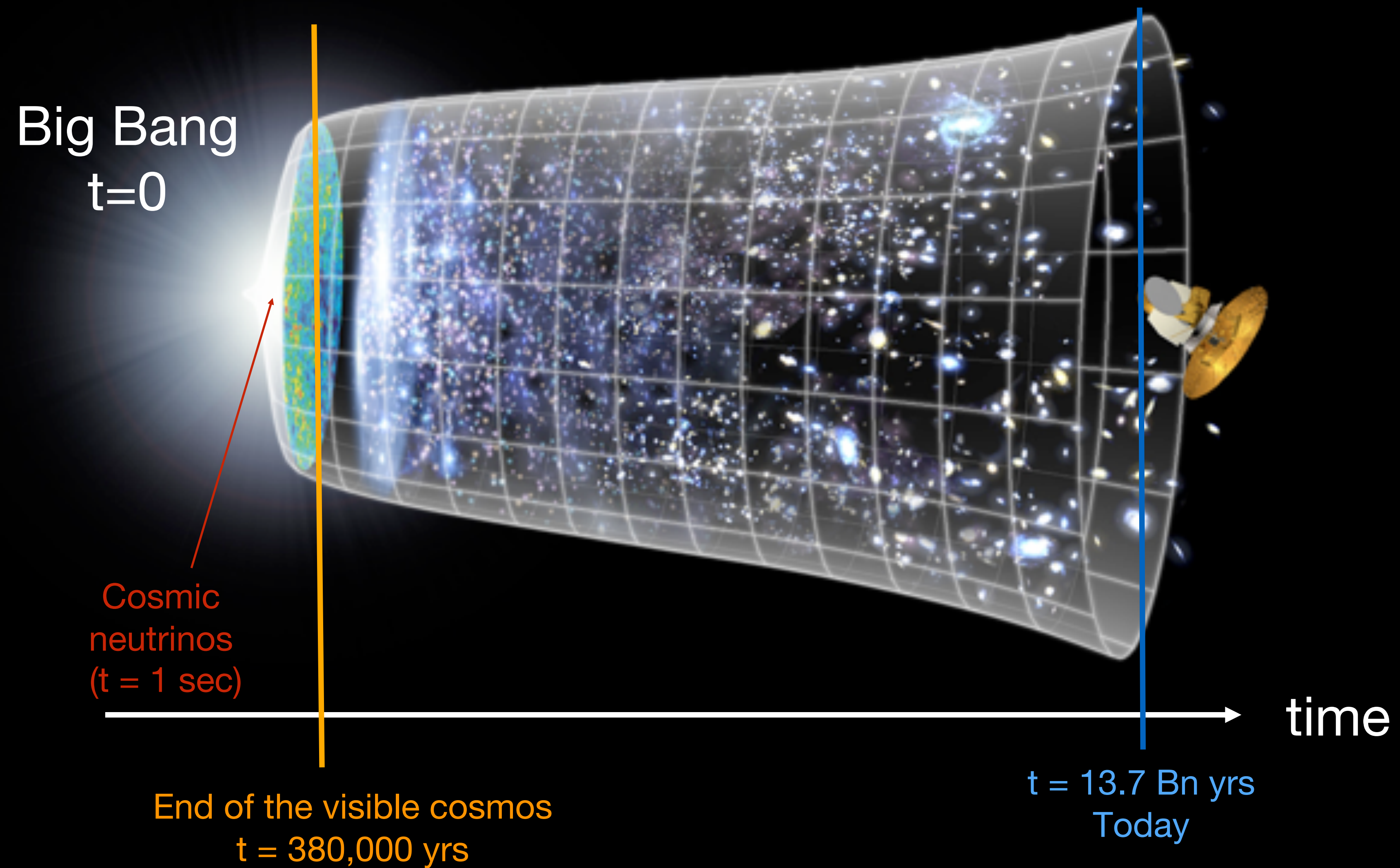


Credit: SDDS-
III/Daniel Eisenstein

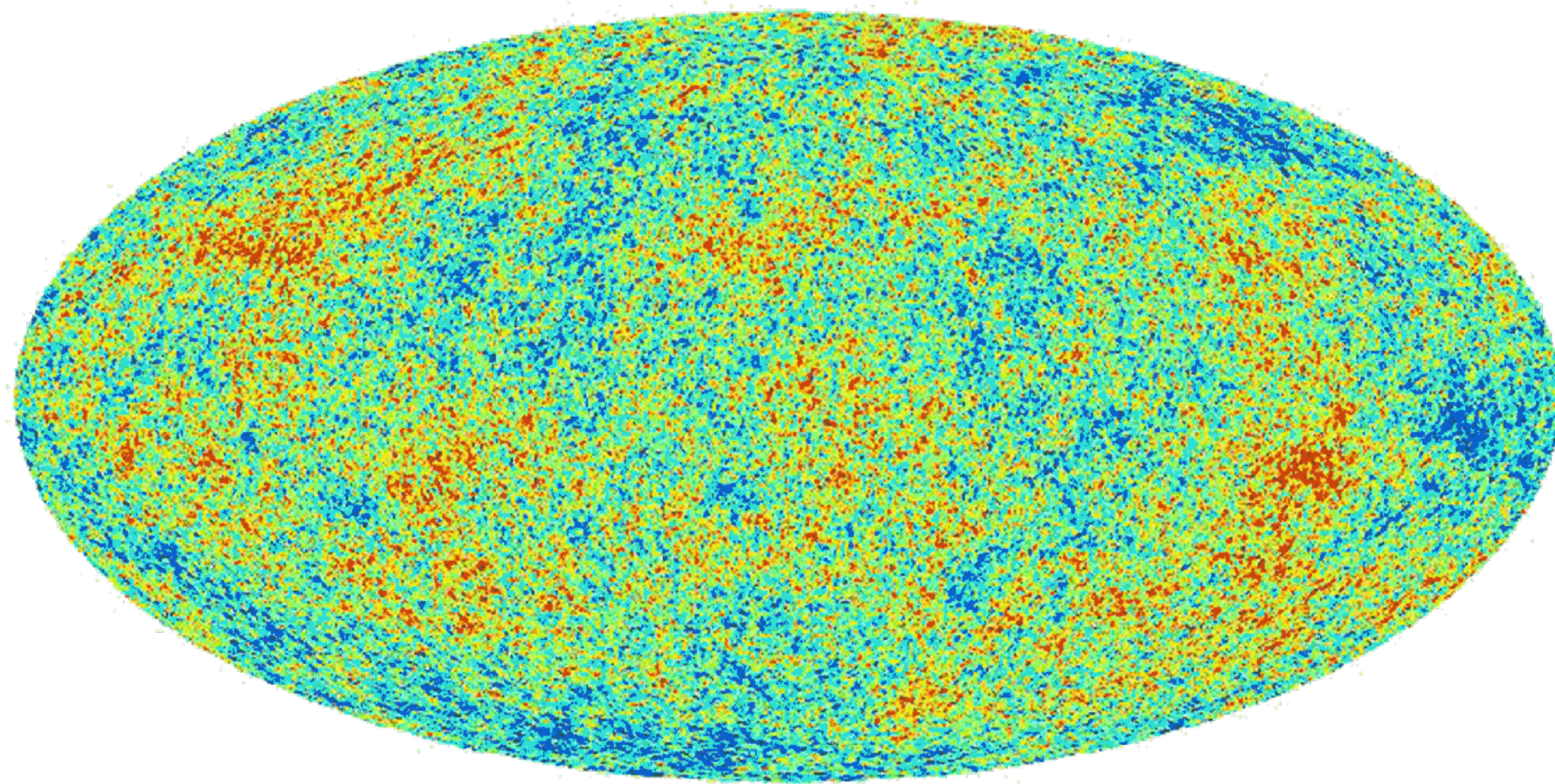




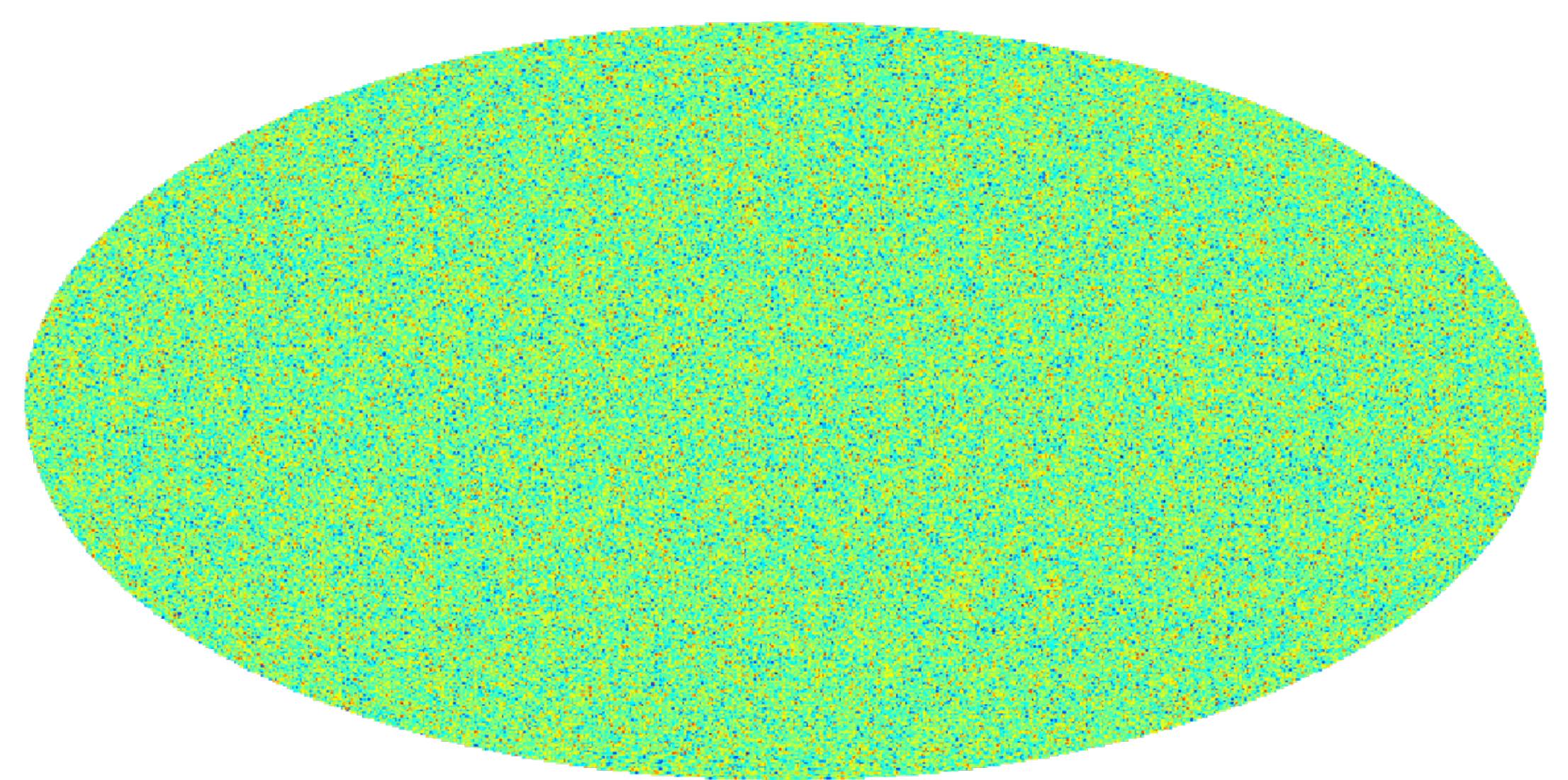
Credit: IceCube Collaboration



Cosmic Microwave Background
(photons emitted 380,000 yrs after the Big Bang)



Influence of cosmic neutrinos
(Emitted 1s after the Big Bang)



Thank you!

 @R_Trotta

www.robertotrotta.com

$$V_{\tau}^2$$

$$V_{\tau}^2$$

$$V_{\mu}^2$$

$$V_e^2$$

$$V_{\mu}^2$$