

# Nuclear Power Plant's Eerie Glow Spotted 150 Miles Away

### Description

In a groundbreaking achievement, a subterranean tank of exceptionally pure water, encased beneath several kilometers of rock in Ontario, Canada, registered an ephemeral flash as a scarcely detectable particle traversed its molecular structure. This marked the inaugural occasion on which water was employed to discern an antineutrino, emanating from a nuclear reactor located over 240 kilometers (150 miles) away.

The remarkable findings, elucidated in a 2023 study, herald a new era for neutrino investigations and the development of monitoring technologies utilizing cost-effective, readily available, and inherently safe materials.

Neutrinos, among the universe's most prolific particles, exhibit intriguing properties that offer profound insights into the cosmos. However, their almost negligible mass, lack of charge, and minimal interactions with other particles render them elusive—consequently, these particles have earned the moniker "ghost particles."

Antineutrinos serve as the antiparticle counterparts to neutrinos. Unlike other particle-antiparticle pairs, which possess opposite charges—consider the negatively charged electron and its positively charged counterpart, the positron—the distinction between neutrinos and antineutrinos is evidenced solely by their interactions during decay processes.

Fermions and bosons known Particles in the Standard Model of physics have antiparticle equivalents. (ScienceAlert)

Electron antineutrinos are products of nuclear beta decay—an inherently radioactive process wherein a neutron transmutes into a proton, electron, and antineutrino. In this interaction, an antineutrino can subsequently engage with a proton, resulting in the generation of a positron and another neutron, a phenomenon referred to as inverse beta decay.

Detection of this decay typically necessitates large tanks filled with liquid scintillators, outfitted with photomultiplier tubes designed to capture the faint illumination produced by Cherenkov radiation—analogous to a sonic boom but in the realm of light. Despite their prolific generation in nuclear reactors, antineutrinos are low in energy, complicating the detection process.

The SNO+ laboratory, situated over 2 kilometers (1.24 miles) underground, offers an environment remarkably shielded from cosmic interference, enabling the acquisition of exceptionally high-resolution signals. In the calibration phase of 2018, the lab's 780-tonne tank, originally filled with ultrapure water, identified evidence of inverse beta decay after analyzing 190 days of collected data.

This discovery indicates that water-based detectors could potentially serve as instruments for monitoring nuclear reactor power outputs and enhances our comprehension of neutrinos and antineutrinos—two entities that, due to their illusive nature, remain poorly understood.

As physicist Logan Lebanowski from the SNO+ collaboration has remarked, "The ability to utilize pure water



for the detection of antineutrinos from reactors at such substantial distances is profoundly intriguing." This research was subsequently published in *Physical Review Letters*.

An earlier version of this article was published in April 2023.

# **Vocabulary List:**

- 1. **Subterranean** /,s^b.tə'reI.ni.ən/ (adjective): Existing occurring or done under the earth's surface.
- 2. Ephemeral /I'fɛm.ər.əl/ (adjective): Lasting for a very short time.
- 3. Elucidated /I'lu:.sI.deI.tId/ (verb): Made (something) clear; explained.
- 4. Transmutes /trænz'mju:ts/ (verb): Changes in form nature or substance.
- 5. Cherenkov /'tfɛr.ɛn.kof/ (adjective): Relating to the radiation produced when a charged particle moves through a medium faster than the speed of light in that medium.
- 6. Illusive /I'lu:.siv/ (adjective): Deceptive; based on illusion; tending to mislead.

# **Comprehension Questions**

#### **Multiple Choice**

ESL-NEWS.COM 1. Where was the subterranean tank of exceptionally pure water located for the groundbreaking achievement described?

Option: Ontario, Canada Option: California, USA **Option:** Paris, France Option: Sydney, Australia

2. What marked the inaugural occasion in the detection of an antineutrino described in the text?

Option: A flash in the water tank Option: A seismic event Option: A solar flare **Option: A chemical reaction** 

3. What does the term "ghost particles" refer to in the context of neutrinos?

Option: Their almost negligible mass Option: Their lack of charge Option: Their minimal interactions with other particles



Option: All of the above

4. What is the antiparticle counterpart to a neutrino?

Option: Antineutrino Option: Electron Option: Positron Option: Photon

5. Which laboratory is mentioned in the text as being situated over 2 kilometers underground?

Option: SNO+ laboratory Option: CERN Option: NASA Jet Propulsion Laboratory Option: Harvard-Smithsonian Center for Astrophysics

6. What process results in the generation of a positron and another neutron when an antineutrino engages with a proton?

Option: Inverse beta decay Option: Alpha decay Option: Fission Option: Gamma decay

#### **True-False**

7. Neutrinos and antineutrinos possess opposite charges.

8. Detection of antineutrinos typically requires large tanks filled with liquid helium.

9. The SNO+ laboratory identified evidence of inverse beta decay in its 780-tonne tank after analyzing 100 days of collected data.

10. Antineutrinos have high energy levels making their detection process straightforward.

11. Photomultiplier tubes are used to capture Cherenkov radiation in the detection of decay processes.

12. Pure water was found to be ineffective in detecting antineutrinos from nuclear reactors according to the text.



#### Gap-Fill

14. The lab's 780-tonne tank identified evidence of inverse beta decay after analyzing				
days of collected data.				
15. Neutrinos and antineutrinos are entities that remain poorly understood due to their				
nature.				
16. Logan Lebanowski is a physicist from the SNO+ collaboration group who remarked on the intriguing				
ability to detect antineutrinos using pure water at distances.				
17. This groundbreaking achievement in neutrino detection occurred in a subterranean tank of exceptionally				
pure water beneath several kilometers of in Ontario, Canada.				
18. The ability to monitor nuclear reactor power outputs using water-based detectors enhances our				
understanding of				

# Answer

Multiple Choice: 1. Ontario, Canada 2. A flash in the water tank 3. All of the above 4. Antineutrino 5. SNO+ laboratory 6. Inverse beta decay True-False: 7. False 8. False 9. False 10. False 11. True 12. False Gap-Fill: 14. 190 15. illusive 16. substantial 17. rock 18. neutrinos and antineutrinos

# **Vocabulary quizzes**

### Multiple Choice ( Select the Correct answer for each question. )

1. Which term refers to the ability of a treatment to provide a beneficial effect?



**Option: Efficacy Option:** Misleading **Option: Skepticism Option:** Correlation

### 2. Which term is used to describe the study of diseases?

**Option: Profound Option:** Cognitive **Option: Pathology Option: Hypothesis** 

3. Which term refers to a division or contrast between two things that are represented as being opposed or entirely different?

**Option: Skepticism Option: Dichotomy Option: Desiccated Option: Resilience** 

4. Which term is related to the processes of thought and understanding? SSL-NEWS.

**Option: Pharmacological Option:** Cognitive **Option: Ecclesiastical Option:** Subterranean

### 5. Which term refers to urgent needs or demands?

**Option: Hypothesis Option: Ecclesiastical Option: Exigencies Option:** Corpus

6. Which term refers to a collection of written texts especially the entire works of a particular author or a body of writing on a particular subject?

**Option:** Prohibition **Option:** Correlation **Option:** Interventions **Option:** Corpus

7. Which term describes something that is short-lived or lasts for a very brief time?

**Option:** Deterioration **Option:** Transmutes **Option: Ephemeral Option: Illusive** 

8. Which term refers to a proposed explanation made on the basis of limited evidence as a starting point for



further investigation?

Option: Hypothesis Option: Profound Option: Cannibalism Option: Cherenkov

9. Which term refers to the act of one individual of a species consuming all or part of another individual of the same species?

Option: Cannibalism Option: Remnants Option: Ecclesiastical Option: Cherenkov

10. Which term relates to the treatment or healing of a disease or disorder?

Option: Desiccated Option: Therapeutic Option: Interventions Option: Exigencies

### Gap-Fill (Fill in the blanks with the correct word from the vocabulary list.)

11	effects of the medication w	ere observed during the clir	nical trial.	
12	may lead to unnecessary m	edical interventions.		
13. Her	and determination help	ed her overcome the challe	nges.	
14. The speaker's words had a impact on the audience.				
15. Archaeologists uncovered	ancient pottery	at the site.		
16. The professor the complex theory in a simple manner.				
17. The garden was in full blo	oom displaying a	of colorful flo	owers.	
18. The blue glow observed in	n the nuclear reactor is due	to	radiation.	
19. The mirage created an	арр	earance of water in the dese	ert.	
20. The advertisement was c	onsidered	as it did not accura	tely represent the	

product.

### Matching Sentences ( Match each definition to the correct word from the vocabulary list. )

21. Medical procedures or strategies carried out to improve health outcomes.

22. Doubt or questioning regarding the validity or truth of something.

23. Dried out dehydrated or lacking vitality.

24. Relating to the study or use of drugs in treating diseases.

25. Existing or occurring beneath the surface of the earth.

26. A statistical measure indicating the extent to which two or more variables fluctuate together.

27. The process of becoming progressively worse or less valuable.

28. Relating to the Christian Church or its clergy.

29. This statistical technique determines the degree of relationship between two variables.

30. The team explored the depths of the cave system.

### Answer

**Multiple Choice:** 1. Efficacy 2. Pathology 3. Dichotomy 4. Cognitive 5. Exigencies 6. Corpus 7. Ephemeral 8. Hypothesis 9. Cannibalism 10. Therapeutic

**Gap-Fill:** 11. Adverse 12. Overdiagnosis 13. Resilience 14. Profound 15. Remnants 16. Elucidated 17. Profusion 18. Cherenkov 19. Illusive 20. Misleading

**Matching sentence:** 1. Interventions 2. Skepticism 3. Desiccated 4. Pharmacological 5. Subterranean 6. Correlation 7. Deterioration 8. Ecclesiastical 9. Correlation 10. Subterranean

### CATEGORY

1. Health - LEVEL6

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