Physicists Claim Solution to Proton Size Puzzle

Description

Subsequent measurements by various research teams have produced mixed results regarding the size of the proton. In 2013, an international team confirmed their earlier 2010 measurement, concluding that the proton's radius is 0.84 femtometers, a discrepancy of 7 sigma. Later, in 2016, another experiment replaced the electron with a muon in a deuterium atom—an isotope containing a neutron. This aimed to observe how the presence of a neutron might change the perception of the proton’s charge, and results aligned with the 2010 finding.

However, experiments using regular hydrogen yielded contradictory outcomes. A 2017 study reaffirmed the 2010 measurement, while a 2018 study indicated a larger value that contradicted it. In 2019, scientists from York University conducted an electron-based measurement, seeking to reconcile these differences, and found a proton radius of 0.833 femtometers, consistent with the earlier smaller value.

The latest research involved measurements of hydrogen atoms in a vacuum chamber, where lasers controlled the electrons and tracked energy transitions. These observations suggested that the proton’s radius is approximately 0.84 femtometers, reaffirming the 2010 findings that started this debate.

Juan Rojo, a physicist at Vrije University Amsterdam who was not involved in the studies, commented that the proton radius should be a consistent value across different methods of measurement. He noted that the recent papers offer diverse methods arriving at the same conclusion, contributing valuable insights to an ongoing scientific discussion.

Vocabulary List:

1. **discrepancy** //dɪˈskrepənsi// (noun): a difference between two results or facts
2. **isotope** //ˈaɪsəˌtoʊp// (noun): a type of atom with a different neutron number
3. **muon** //ˈmjuːɑn// (noun): a small particle like an electron but heavier
4. **reconcile** //ˈrɛkənsaɪl// (verb): to make different ideas or results agree
5. **vacuum** //ˈvækjuəm// (noun): a space with almost no air or matter
6. **transitions** //trænˈzɪʃənz// (noun): changes from one state or level to another

Comprehension Questions

Multiple Choice

1. What was the proton's radius confirmed to be by the international team in 2013?

   Option: 0.77 femtometers
   Option: 0.82 femtometers
   Option: 0.84 femtometers
   Option: 0.90 femtometers

2. In which year did the experiment involving a muon take place?

   Option: 2010
   Option: 2013
   Option: 2016
   Option: 2018

3. What did the 2018 study indicate about the proton's radius?

   Option: A smaller value
   Option: The same value
   Option: A larger value
   Option: An inconsistent value

4. Which university's scientists conducted the electron-based measurement in 2019?

   Option: Harvard University
   Option: Stanford University
   Option: York University
   Option: MIT

5. What method was used in the latest research to measure the proton's radius?

   Option: X-rays
   Option: Laser control of electrons
   Option: Magnetic resonance
   Option: Neutron scattering

6. Which physicist commented on the consistency of the proton radius measurements?

   Option: Albert Einstein
   Option: Niels Bohr
   Option: Juan Rojo
   Option: Richard Feynman

True-False

7. The proton's radius was consistently measured to be 0.84 femtometers across all studies.

8. The 2017 study confirmed the measurement made in 2010.

9. A deuterium atom contains two protons.

10. Mixed results have been observed regarding the size of the proton.

11. Lasers were used to control electrons in the vacuum chamber during the latest research.

12. Juan Rojo was involved in the studies discussed in the research.

Gap-Fill

13. The proton's radius was first confirmed to be 0.84 femtometers in _____ 2013.

14. The 2018 study indicated a _____ value that contradicted earlier findings.

15. In a deuterium atom, there is one neutron and one _____ present.

16. The 2019 measurement found a proton radius of _____ femtometers.

17. The recent research helped confirm the 2010 findings that started this _____ .

18. Juan Rojo stated that the proton radius should be a consistent value across different methods of

_____ .

Answer

Multiple Choice: 1. 0.84 femtometers 2. 2016 3. A larger value 4. York University 5. Laser control of electrons 6. Juan Rojo
True-False: 7. False 8. True 9. False 10. True 11. True 12. False
Gap-Fill: 13. December 14. larger 15. proton 16. 0.833 17. debate 18. measurement

Vocabulary quizzes

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

1. Which of the following is commonly associated with data transfer?

   Option: Trailer
   Option: Footage
   Option: Ports
   Option: Playlist

2. What term describes a structured story in literature or film?

   Option: Feature
   Option: Narrative
   Option: Competition
   Option: Simulation

3. What type of marketing approach customizes messages for individual consumers?

   Option: Monetisation
   Option: Personalised
   Option: Significant
   Option: Discrepancy

4. Which term refers to content that can be transferred to a device?

   Option: Downloadable
   Option: Radiation
   Option: Avatar
   Option: Expanding

5. What is the term for a contest between entities for a market share?

   Option: Conflict
   Option: Competition
   Option: Discrepancy
   Option: Transition

6. Which process involves generating revenue from a product or service?

   Option: Monetisation
   Option: Simulate
   Option: Tissue
   Option: Aligns

7. Which term refers to energy that travels through space?

Option: Muon
Option: Isotope
Option: Radiation
Option: Vacuum

8. What term relates to the body's defense against disease?

Option: Tissue
Option: Immune
Option: Avatar
Option: Trailer

9. What word describes a difference that may indicate an error?

Option: Discrepancy
Option: Alignment
Option: Significant
Option: Plunging

10. Which term refers to a graphical representation of a user?

Option: Avatar
Option: Playlist
Option: Feature
Option: Transition

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

11. The movie's _____ provided a sneak peek of the exciting scenes.

12. The documentary included rare _____ from the historical event.

13. The fashion show featured a _____ theme that appealed to many millennials.

14. The new policy _____ with our company's values and mission.

15. The stock prices began _____ dramatically after the announcement.

16. The film's _____ between scenes were very smooth and engaging.

17. The research yielded _____ results that can change the industry.

18. The program can _____ various environments for training purposes.

19. The scientist examined the _____ under a microscope.

20. An _____ is a variant of a particular chemical element which differs in neutron number.

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

21. The laboratory maintained a vacuum to prevent contamination of experiments.
22. The universe is constantly expanding according to modern astrophysical theories.
23. The director was pleased with the new footage they captured during filming.
24. The monetisation strategy outlined how the app would generate revenue.
25. The company registered several trademarks to protect its brand identity.
26. The competition in the tech industry is becoming increasingly intense.
27. Exposure to high levels of radiation can be hazardous to health.
28. The narrative of the book was compelling and well-structured.
29. In the online game, each player can create their own avatar.
30. Vaccination helps the body become immune to certain diseases.

Answer

Multiple Choice: 1. Ports 2. Narrative 3. Personalised 4. Downloadable 5. Competition 6. Monetisation 7. Radiation 8. Immune 9. Discrepancy 10. Avatar
Gap-Fill: 11. trailer 12. footage 13. retro 14. aligns 15. plunging 16. transitions 17. significant 18. simulate 19. tissue 20. isotope
Matching sentence: 1. vacuum 2. expanding 3. footage 4. monetisation 5. trademarks 6. competition 7. radiation 8. narrative 9. avatar 10. immune

CATEGORY

1. Sci/Tech - LEVEL5

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5. physicists
6. proton size puzzle

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