

Article Summary and Research- BEC

1. Before you read your article, read through the assignment below and then **underline, highlight and/or annotate** (notes in the margin) the important statements in the article.

2. State the topic of the text: A few words stating what the text is **about**.

Bose-Einstein Condensation

3. State the main idea of the text: **the author's claim about the topic** in one sentence. **Always include the author name and the title of text in this sentence.**

In the article "New Matter Created Scientists Chill atoms and find holy grail of physics" Author Robert Cooke explains the creation of a new form of matter, Bose-Einstein condensation, at temperatures near to absolute zero.

4. What reasons/evidence does the author use to support the main idea? Provide 3 or more reasons/evidence.

● "By chilling a cloud of atoms down to coldest temperatures ever achieved, physicists have created a form of matter never before existed in nature." explained the author

● "The combination of Magnetic trapping, laser cooling, and evaporate cooling gets the temperature down to near absolute zero. "special beams of laser light were used to slow down the atoms movement, and the the hotter and faster moving atoms were allowed to escape, chilling the cloud further." said the author

● "When gases temperature neared absolute zero, the Bose Einstein condensation - the new form of matter was seen"

● "It exists only at temperatures very near Absolute zero, defined as the theoretical temp -- 4.59 °K at which atom movement would stop altogether"

5. State whether you think the information presented in the article is **reliable** and **explain why**.

I think that at the time the article was written it was reliable but because its been 21 years since the article was released it is outdated. Although the information seems reliable, it is too outdated.

New Matter Created Scientists chill atoms and find holy grail of physics

Robert Cooke Newsday

07-14-1995

New Matter Created

Scientists chill atoms and find holy grail of physics

By Robert Cooke. STAFF WRITER

There is, indeed, something new under the sun. By chilling a cloud of atoms down to the coldest temperatures ever achieved, physicists have created a form of matter that never before existed in Nature. At a temperature just 20-billionths of a degree above absolute zero, the atoms lost their individual identities, condensing to form a coherent, wave-like structure that acts like a single huge atom. This coherence gives the new form of matter "completely different properties" from other materials, said one of its discoverers, Carl Weiman of the University of Colorado at Boulder. Atoms in other, warmer materials move constantly and rapidly, in random directions. "The term Holy Grail seems quite appropriate, given the singular importance of this discovery," said physicist Keith Burnett at Oxford University in England. Physicists have been trying to create this new matter since Albert Einstein and Indian physicist Satyendra Nath Bose predicted it was possible some 70 years ago. Potential uses for the material - known as a Bose-Einstein condensation - could include powerful new laser-like devices using beams of atoms, rather than beams of light, to deliver pulses of energy, to send signals, to drive chemical reactions and, perhaps, etch patterns into materials. Additionally, scientists suspect the new material may be either super-conducting, meaning electricity flows through it without resistance, or superfluid, meaning it might flow, like eddies in a stream, without any signs of friction. It exists only at temperatures very near absolute zero, defined as the theoretical temperature - minus 459 degrees Fahrenheit - at which atom movement would stop altogether.

The result was announced yesterday by researchers at the National Institute of Science and Technology and the University of Colorado, including Weiman, Michael Anderson, Jason Ensher, Michael Matthews, and Eric Cornell. In the new experiments, atoms of the metal rubidium were held in a magnetic trap while being cooled in several steps. Special beams of laser light were used to slow down the atoms' movements, and then the "hotter" or fastest-moving atoms were allowed to escape, chilling the cloud further in a process called evaporative cooling. When the gas' temperature neared absolute zero, the Bose-Einstein condensation - the new form of matter - was seen. Now that the milestone has been reached, experiments can begin defining the new matter's basic properties, how it "interacts with light, how sound and heat are transmitted through it," said physicist Daniel Kleppner at the Massachusetts Institute of Technology. And, he added, "one can start talking now about making an atomic laser." Kleppner, a pioneer in the field, has been working on similar experiments, using chilled hydrogen atoms. As noted by Cornell, the new form of matter - which was maintained in a vacuum chamber for only 15 seconds - "could never have existed naturally anywhere in the universe. So the sample in our lab is the only chunk of this stuff in the universe - unless it's in a lab in some other solar system."

The researchers explained that atoms in a gas at room temperature bounce around at a rate of about 1,000 mph. Atoms chilled to almost absolute zero slow down to about 3 feet per hour. And atoms cooled enough to form a Bose-Einstein condensate "move a lot slower, too slow for us to measure yet," Cornell said. Kleppner, who called the Colorado experiment "so beautiful it's breathtaking; like Venus rising out of the waves," said

New Matter Created Scientists chill atoms and find holy grail of physics

Robert Cooke Newsday

07-14-1995

New Matter Created

Scientists chill atoms and find holy grail of physics

By Robert Cooke. STAFF WRITER

There is, indeed, something new under the sun. By chilling a cloud of atoms down to the coldest temperatures ever achieved, physicists have created a form of matter that never before existed in Nature. At a temperature just 20-billionths of a degree above absolute zero, the atoms lost their individual identities, condensing to form a coherent, wave-like structure that acts like a single huge atom. This coherence gives the new form of matter "completely different properties" from other materials, said one of its discoverers, Carl Weiman of the University of Colorado at Boulder. Atoms in other, warmer materials move constantly and rapidly, in random directions. "The term Holy Grail seems quite appropriate, given the singular importance of this discovery," said physicist Keith Burnett at Oxford University in England. Physicists have been trying to create this new matter since Albert Einstein and Indian physicist Satyendra Nath Bose predicted it was possible some 70 years ago. Potential uses for the material - known as a Bose-Einstein condensation - could include powerful new laser-like devices using beams of atoms, rather than beams of light, to deliver pulses of energy, to send signals, to drive chemical reactions and, perhaps, etch patterns into materials. Additionally, scientists suspect the new material may be either super-conducting, meaning electricity flows through it without resistance, or superfluid, meaning it might flow, like eddies in a stream, without any signs of friction. It exists only at temperatures very near absolute zero, defined as the theoretical temperature - minus 459 degrees Fahrenheit - at which atom movement would stop altogether.

The result was announced yesterday by researchers at the National Institute of Science and Technology and the University of Colorado, including Weiman, Michael Anderson, Jason Ensher, Michael Matthews, and Eric Cornell. In the new experiments, atoms of the metal rubidium were held in a magnetic trap while being cooled in several steps. Special beams of laser light were used to slow down the atoms' movements, and then the "hotter" or fastest-moving atoms were allowed to escape, chilling the cloud further in a process called evaporative cooling. When the gas' temperature neared absolute zero, the Bose-Einstein condensation - the new form of matter - was seen. Now that the milestone has been reached, experiments can begin defining the new matter's basic properties, how it "interacts with light, how sound and heat are transmitted through it," said physicist Daniel Kleppner at the Massachusetts Institute of Technology. And, he added, "one can start talking now about making an atomic laser." Kleppner, a pioneer in the field, has been working on similar experiments, using chilled hydrogen atoms. As noted by Cornell, the new form of matter - which was maintained in a vacuum chamber for only 15 seconds - "could never have existed naturally anywhere in the universe. So the sample in our lab is the only chunk of this stuff in the universe - unless it's in a lab in some other solar system."

The researchers explained that atoms in a gas at room temperature bounce around at a rate of about 1,000 nph. Atoms chilled to almost absolute zero slow down to about 3 feet per hour. And atoms cooled enough to form a Bose-Einstein condensate "move a lot slower, too slow for us to measure yet," Cornell said. Kleppner, who called the Colorado experiment "so beautiful it's breathtaking; like Venus rising out of the waves," said

the discovery "opens a new area for study and experimentation because the basic physics is already understood. There are a lot of new phenomena one can expect to see." For example, Kleppner said, "if one extracts them [from the vacuum chamber] carefully, you'd have a beam of atoms unlike any other" that might be useful in laser-like applications.

Until now, the only phenomena that were close to being Bose-Einstein condensations were seen in super-cold helium, which exhibits super-fluidity, and in super-conducting metals, which allow electric currents to flow without resistance. Both, however, are impure or imperfect forms of the Bose-Einstein condensation.

SOURCE: University of Colorado at Boulder, Dr. Carl Wieman and Dr. Eric Cornell, Seth Wieman.

Copyright 1995, Newsday Inc.

Name Reganne Fornstrom

Period 6

Date 1/26/16

Article Summary and Research- BEC

1. Before you read your article, read through the assignment below and then **underline, highlight and/or annotate** (notes in the margin) the important statements in the article.

2. State the topic of the text: A few words stating what the text is **about**.

Bose - Einstein Condensate

3. State the main idea of the text: **the author's claim about the topic** in one sentence. Always include the **author name and the title of text in this sentence**.

In the article, New Matter Created: Scientists chill atoms and find holy grail of physics, the author Robert Cooke details what the Bose-Einstein condensate is, the process used to create it, and how it can be applied to other scientific experiments.

4. What reasons/evidence does the author use to support the main idea? Provide 3 or more reasons/evidence.

- The author briefly explains what the Bose-Einstein Condensate is.
- "At a temperature just 20-billionths of a degree above absolute zero, the atoms lost their individual identities, condensing to form a coherent, wave-like structure that acts like a single huge atom."
- The article also described the process of creating the condensate. "In the new experiments, atoms of the metal rubidium were held in a magnetic trap while being cooled in several steps. Special beams of laser light were used to slow down the atoms' movements, and then the 'hotter' or faster-moving atoms were allowed to escape [evaporative cooling]."
- After over-viewing the Bose-Einstein condensate, the author mentioned that an atomic laser might be developed from this new form of matter. He quotes, "And," he added, "one can start talking now about making an atomic laser."
- The author also gives other possible uses of the Bose-Einstein Condensate. "Potential uses for the material...could include powerful new laser-like devices using beams of atoms, to deliver pulses of energy, to send signals, to drive chemical reactions and, perhaps, etch patterns into materials."

5. State whether you think the information presented in the article is **reliable** and **explain why**.

I think the information in the article is reliable because there are multiple experts quoted, like Keith Burnett from Oxford University, Daniel Kleppner from MIT Institute of Technology, and Carl Weiman from the University of Colorado. Also, there are multiple websites that present the same information. Finally, the article is from 1995, which is relatively recent and updated.

What the heck is BEC?

Use the following websites and prompts to help you understand Bose-Einstein Condensate and complete the table below.

BEC Homepage at University of Colorado:

<http://www.colorado.edu/physics/PhysicsInitiative/Physics2000.03.99/bec/index.html>

Greg Kuebler, Bose-Einstein Condensate interactive simulator

<http://gregkuebler.com/portfolio-item/bose-einstein-condensate-interactive-simulator/>

Bose-Einstein Condensate: A New Form of Matter at NIST

http://www.nist.gov/public_affairs/releases/bec_background.cfm

<p>What is BEC?</p> <ul style="list-style-type: none"> • When individual atoms meld into a "super atom" which behaves like one entity when the temperature is right above absolute zero • at less than 1-millionth of a degree K, above absolute zero 	<p>How can lasers be used to help form it?</p> <ul style="list-style-type: none"> • atoms slowed and trapped by lasers' light from all directions • cooled the atoms due to lack of kinetic energy • turned off once magnets took over • light hits the atom with some energy, and bounces off with more because it takes some of the atom's energy • color has to match the color that the atom needs to move electrons into higher levels and then back down into lower levels • slows fast atoms (not speed up slow ones because of the Doppler effect)
<p>How can magnets be used to help form it?</p> <ul style="list-style-type: none"> • after the lasers trapped and slowed down the atoms, magnets were arranged to keep the atoms in place • the magnets held the atoms in place during the evaporative cooling • allows for no need for light since light kept it warmer 	<p>How does evaporative cooling help form it?</p> <ul style="list-style-type: none"> • the hottest atoms were kicked out of the magnetic trap, just like steam comes out of hot liquids • they were allowed to "escape" by lowering the sides of the magnetic trap • had to be careful to make sure not all of the atoms escaped
<p>How is it different from solids, liquids, and gases?</p> <ul style="list-style-type: none"> • the super atom has different properties • there are many atoms in a group unlike the other phases which have many atoms moving around • the temperature / kinetic energy is much lower than the other phases 	<p>Other important information ...</p> <ul style="list-style-type: none"> • may contribute to better lasers, and maybe even the invention of an atomic laser

Reganne Fornstrom

New Matter Created Scientists chill atoms and find holy grail of physics

Robert Cooke Newsday

07-14-1995

New Matter Created

Scientists chill atoms and find holy grail of physics

By Robert Cooke. STAFF WRITER

There is, indeed, something new under the sun. By chilling a cloud of atoms down to the coldest temperatures ever achieved, physicists have created a form of matter that never before existed in Nature. At a temperature just 20-billionths of a degree above absolute zero, the atoms lost their individual identities, condensing to form a coherent, wave-like structure that acts like a single huge atom. This coherence gives the new form of matter "completely different properties" from other materials, said one of its discoverers, Carl Weiman of the University of Colorado at Boulder. Atoms in other, warmer materials move constantly and rapidly, in random directions. "The term Holy Grail seems quite appropriate, given the singular importance of this discovery," said physicist Keith Burnett at Oxford University in England. Physicists have been trying to create this new matter since Albert Einstein and Indian physicist Satyendra Nath Bose predicted it was possible some 70 years ago. Potential uses for the material - known as a Bose-Einstein condensation - could include powerful new laser-like devices using beams of atoms, rather than beams of light, to deliver pulses of energy, to send signals, to drive chemical reactions and, perhaps, etch patterns into materials. Additionally, scientists suspect the new material may be either super-conducting, meaning electricity flows through it without resistance, or superfluid, meaning it might flow, like eddies in a stream, without any signs of friction. It exists only at temperatures very near absolute zero, defined as the theoretical temperature - minus 459 degrees Fahrenheit - at which atom movement would stop altogether.

The result was announced yesterday by researchers at the National Institute of Science and Technology and the University of Colorado, including Weiman, Michael Anderson, Jason Ensher, Michael Matthews, and Eric Cornell. In the new experiments, atoms of the metal rubidium were held in a magnetic trap while being cooled in several steps. Special beams of laser light were used to slow down the atoms' movements, and then the "hotter" or fastest-moving atoms were allowed to escape, chilling the cloud further in a process called evaporative cooling. When the gas' temperature neared absolute zero, the Bose-Einstein condensation - the new form of matter - was seen. Now that the milestone has been reached, experiments can begin defining the new matter's basic properties, how it "interacts with light, how sound and heat are transmitted through it," said physicist Daniel Kleppner at the Massachusetts Institute of Technology. And, he added, "one can start talking now about making an atomic laser." Kleppner, a pioneer in the field, has been working on similar experiments, using chilled hydrogen atoms. As noted by Cornell, the new form of matter - which was maintained in a vacuum chamber for only 15 seconds - "could never have existed naturally anywhere in the universe. So the sample in our lab is the only chunk of this stuff in the universe - unless it's in a lab in some other solar system."

The researchers explained that atoms in a gas at room temperature bounce around at a rate of about 1,000 mph. Atoms chilled to almost absolute zero slow down to about 3 feet per hour. And atoms cooled enough to form a Bose-Einstein condensate "move a lot slower, too slow for us to measure yet," Cornell said. Kleppner, who called the Colorado experiment "so beautiful it's breathtaking; like Venus rising out of the waves," said

the discovery "opens a new area for study and experimentation because the basic physics is already understood. There are a lot of new phenomena one can expect to see." For example, Kleppner said, "if one extracts them [from the vacuum chamber] carefully, you'd have a beam of atoms unlike any other" that might be useful in laser-like applications.

Until now, the only phenomena that were close to being Bose-Einstein condensations were seen in super-cold helium, which exhibits super-fluidity, and in super-conducting metals, which allow electric currents to flow without resistance. Both, however, are impure or imperfect forms of the Bose-Einstein condensation.

SOURCE: University of Colorado at Boulder, Dr. Carl Wieman and Dr. Eric Cornell, Seth Wieman.

Copyright 1995, Newsday Inc.