Extra! Extra!
Read All About the Universe!

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Outline

• What is Cosmic Times?
• A taste of Cosmic Times
  ▪ 1955 – Big Bang versus Steady State
  ▪ 1965 – Breaking the Stalemate
  ▪ 1993 – Cosmology’s End?
  ▪ 2006 – Continuing Story
• Tools for tailoring Cosmic Times to your classroom
What is Cosmic Times?

- Suite of curriculum support materials tracing our understanding of the expanding universe
- Includes:
  - 6 posters resembling front page newspapers 1919 to 2006
  - 3 newsletter versions of each poster, two at differentiated reading levels
  - 4-5 lesson plans for each poster exploring fundamental science, social context, and reading skills

You will receive the Cosmic Times posters and a DVD containing materials at the end of this workshop.
Nature of supernovae
Quick notes on 1919

- The universe was believed to be:
  - 300,000 light years (size of Milky Way)
  - Static
  - Timeless

- Einstein’s General Theory of Relativity (1916) revolutionized scientists’ view of gravity

- Observations of the 1919 total solar eclipse supported Einstein’s theory

Fundamental science concepts: motions of the Earth, Moon & Sun, solar eclipse, gravity, curved space-time
Quick notes on 1929

- Edwin Hubble discovers:
  - Milky Way is but one of many galaxies
  - Universe is expanding

Fundamental science concepts: redshift, distance to galaxies, Cepheid variables (patterns in data)
1955 – Origin of the Universe

- Scientists debate: is the universe:
  - ageless and infinite?
  - finite, with hot “bang” beginning?
Reading Strategies

Use one of the reading strategies to understand the CT article “Origin of Everything”
Reading Strategy: 'Reciprocal Teaching'

- Pair up
- Both partners read the same paragraph (aloud or to yourselves)
- One partner summarizes the paragraph for the other
- The other partner “checks and perfects” – state what you agree with, question parts you don’t understand, add more information, connect ideas
- Read the next paragraph and switch roles
- Continue with each paragraph until you’ve read and understood the article

“Origin of Everything” article on pages 3-4
Do Paragraphs 2, 4, 5, 6, 7
Summarize the Article

**Steady State Universe**

- ' Unchanging situations need not be static
- ' New matter can be created spontaneously as the universe expands (a few hundred atoms per year per galaxy)
- ' The universe is constant in its overall density

**Evolutionary Universe**

- ' Universe is expanding from a state of high density and pressure.
- ' Hydrogen & Helium were formed as universe cooled.
- ' There should be left over a background radiation with a temperature of ~ 5 Kelvin
- ' Hoyle scoffed at this theory and coined the term “Big Bang”
The Evidence is Clear

Bowl of Evidence

Scientists sort through theories by examining evidence and making inferences.
Steady State vs. Big Bang

- Resolution of Steady State vs Big Bang won’t come until the mid-to-late 1960s
- But as a competing theory, the Steady State provides the impetus to make observations to test the theories
- Note that this lesson can be adapted for any science topic where there are two (or more) competing theories
1955 – Origin of the Universe

- Scientists debate: is the universe:
  - ageless and infinite?
  - finite, with hot “bang” beginning?
- Both theories account for observations
- Deadlock!

Fundamental science concepts: nature of science, origin of the universe
1965 - Breaking the Stalemate

- A hot “bang” should leave left-over heat
- Data and theory came together in 1965
  - Penzias and Wilson found a 3 K residual noise while making radio observations of the Milky Way
  - Peebles and Dicke (Princeton) had just calculated an estimate for the temperature of the residual background in the microwave region

Fundamental science concepts: spectra, electromagnetic spectrum, origin of the Universe
1993 - Cosmology’s End?

• By the mid-90s, cosmologists thought that they had only to “fill in the details”

• Remaining questions:
  - Will the expansion continue forever, or will universe eventually collapse back on itself?
  - What is the mass-density of the universe (which would answer the above)?
Brief diversion …

- Things may not be what they seem
- When we see odd behavior, we look 'more carefully at what’s going on'
Cosmologists get very excited!

In 1997...

- Gravity is the longest-reaching force according to physics.
- So, the expansion of the universe should be slowing down...
- By observing supernovae in distant galaxies, researchers determine that the expansion is **speeding up**.
History of the Universe’s Expansion'

Video clip from DVD Beyond the Solar System: Expanding the Universe in the Classroom, produced for NASA by the Harvard-Smithsonian Center for Astrophysics. © Smithsonian Institution
2006 – Cosmologists are busy

- Dark energy is well-established, having been detected in many ways
- Still, the nature of dark energy is largely a mystery
- Stay tuned to this continuing science story…

Fundamental science concepts: expanding universe, distances in the universe, supernovae, gravity
It is now 2014…

• What is our view of the universe?'
  - Finite
  - Changing
  - 13.7 billion years old
Cosmic Times'

Classroom Resources: 'A Brief Tour'

- A variety of tools are available to help you navigate Cosmic Times and find the right resources for your classroom.
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Classroom Resources: 'Guide to the Articles'
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• Here you will find further information organized by year/issue of Cosmic Times
Classroom Resources: 'Guide to the Articles'

• Here you will find further information organized by year/issue of Cosmic Times
  - Downloads
    - Poster
    - Newsletters
    - Glossary
    - Questions for understanding
  - Additional information about each article
  - Classroom lesson plans
Classroom Resources: 'Curriculum Tools'
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- Here you will find tools to help you find the right lessons and articles for your curriculum needs
  - Sortable list of lessons
  - National Education Standards for each lesson
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  - Keyword clouds
Classroom Resources: 'Curriculum Tools'

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  - Sortable list of lessons
  - National Education Standards for each lesson
  - Keyword clouds
  - Master download page
In the capstone lesson plan, students are asked to look to the future.

Students speculate what we will know on the 100th anniversary of the Cosmic Times, what technology we will have, and what questions are still unanswered.

We’re inviting submissions for a possible “student gallery” of 2019 Cosmic Times creations.

See the website for more.
Cosmic Times'

Century Timeline

Compare the Cosmic Times timeline with events in:

- Other Science
- Arts/Entertainment/Culture
- World History/Politics

Opportunities for cross-disciplinary collaboration
Cosmic Times Timeline

- 1912 - Henrietta Leavitt determines Cepheid Period-Luminosity relationship
- 1916 - Einstein’s Theory of Gravity
- 1929 - Hubble’s Law
- 1934 - “Super-nova” identified by Baade & Zwicky
- 1949 - Alpher & Gamow discuss nucleosynthesis
- 1952 - Baade recalibrates Cepheid P-L relationship
- 1965 - Penzias & Wilson discover CMB
- 1970 - Vera Rubin makes case for Dark Matter
- 1981 - Guth proposes Cosmic Inflation
- 1993 - COBE measures anisotropies in CMB
- 1998 - Dark Energy discovered
- 2003 - WMAP refines anisotropies in CMB