

PRE-VIDEOCONFERENCE LESSON PLAN

Pioneers in Science: The World Science Festival



Date:	Thursday, May 29, 2014
Arrival Time	12:15 PM EDT
Broadcast Start Time:	1:00 PM EDT
Dial-in Time:	12:30 PM EDT
Duration:	60 minutes
Testing Date:	Tuesday, May 27, 2014 1:00 -2:00 PM EDT



Pioneer Biography



Lord Martin Rees,

Martin Rees is the United Kingdom's Astronomer Royal and a Fellow (and former Master) of Trinity College, Cambridge. After studying at Cambridge, he held post-doctoral positions in the UK and the USA, before becoming a professor at Sussex University, and subsequently moving to Cambridge as professor and (for ten years) Director of the Institute of Astronomy. He has received numerous international awards including the Balzan Prize, the Crafoord Prize (Swedish Academy), the Bower Prize (Franklin Institute) and the Templeton Prize.

He is a foreign associate of the US National Academy of Sciences, the Russian Academy of Sciences, the Pontifical Academy, and several other foreign academies. He served during 2005-2010 as President of the Royal Society and in 2005 he was appointed to the UK's House of Lords. His research focus has been on black holes, cosmology, the 'multiverse' and extreme physics in the universe. He has written several general books on cosmology, and also one, 'Our Final Hour', addressing possible existential threats from advanced technology and environmental degradation. His most recent book is 'From here to infinity: a vision for 21st century science' (W W Norton).

¹

¹ University of Cambridge. Accessed from <http://www.ast.cam.ac.uk/~mjr/index.html>.

² NASA. (n.d.). Astrophysics. <http://science.nasa.gov/astrophysics/>.



VIDEOCONFERENCE OUTLINE:

The following is the VC format. Please refrain from asking your question until your school is called upon to speak.

I. Opening Remarks (2 minutes)

Moderator opens the videoconference with thanking all participants and introducing all of the interactive sites. Moderator also gives a general breakdown of the conference and reminds students about the basic rules of videoconferencing.

II. Introduction (3-5 minutes)

Moderator will provide a brief overview of the conference; then they will introduce the guest speaker, Lord Rees. WSF will show a short clip to provide an overview of the videoconference.

III. Discussion With Peers (40-45 minutes)

Moderator will facilitate the discussion as students ask questions to Lord Rees. Lord Rees will also have the opportunity to pose questions to the students. The questions will be conducted in a round-robin format.

REFLECTION/PRE-VIDEOCONFERENCE PREPARATION ACTIVITY

Here is your opportunity to ask Lord Rees questions relating to his work. Review the questions you identified in the "What I Want to Know More About" Chart and write them below:

- 1.
- 2.
- 3.

The following are sample questions.

- Why do you think it is important for young people to be interested in pursuing science-related careers?

IV. Conclusion (3 minutes)

Moderator thanks all students, teachers and guest speaker for participating.



VIDEOCONFERENCING TIPS FOR PARTICIPANTS:

- When beginning to speak or pose a question, **state your name and school**.
- **Speak loudly, slowly and clearly** into the microphone. Express your personality but avoid using slang and be concise whenever possible. Remember to mute the microphone when you are finished speaking.
- Please **say “Thank you” when you conclude your statements** or questions.
- **Look into the camera** when speaking. Use slow, smooth, minimal gestures.
- Try to **avoid wearing very bright colors** during the videoconference as this can have a negative impact on the quality of the image.
- **Ask thoughtful questions and respond to all answers with respect**. Express your opinions in a positive manner. Avoid asking off-topic or inappropriate questions. **Stick to the subject**.
- Due to the technological constraints of videoconferencing, please understand **only one person can speak at a time**. Be sure to wait for the delay in audio so that you avoid interrupting others. Do not speak over others; you will be called to present or respond to a question.
- Pay close attention to the speakers and the topic at hand. **Use your facial expressions and nod or smile to express interest**, attentiveness and participation.
- Have **paper and pencil/pen available to jot down notes or ideas** so that you may comment on them when it is your turn.

THANK YOU FOR YOUR PARTICIPATION! 😊

FOLLOW US ON FACEBOOK, TWITTER, AND YOU TUBE FOR THE LATEST UPDATES!



<http://www.facebook.com/globalnomadsgroup>



http://twitter.com/global_nomads



<http://www.youtube.com/user/GlobalNomadsGroup>



LESSON PLAN OVERVIEW AND INSTRUCTIONS

TIME

1-2 Days, depending on structure and length of class

GRADE

9th - 12th Grade

LESSON OVERVIEW

The following activities are designed to prepare students to participate in an informed inquiry with Lord Martin Rees. Activity #1 will broadly introduce students to the world of astrophysics through becoming familiar with significant scientific achievements of the past century. Activity #2 will explore the work of Lord Rees specifically, and his research in astrophysics.

ACTIVITY #1

Astrophysics

TIME

1 hour

MATERIALS

Appendix 1; Questions No One Knows The Answers To Video

INSTRUCTIONS

Introduction

Introduce concept of astrophysics to students by saying: ²Astrophysics is the study of the physical and chemical properties and structures of stars, planets and other objects in outer space. The scientific study of Astrophysics seeks to discover how the universe works, explore how the universe began and developed into its present form and search for Earth-like planets. Which question is most important to you? Can each of these questions be answered?

1. There are countless questions that no one knows the answers to.
Watch video: <https://www.youtube.com/watch?v=7SWvDHvWXok>
2. Although there are many questions we as humans may never know the answers to, scientists over the last 100 years have made many discoveries to uncover the mysteries of the Universe. Read through the Discovering the Universe Timeline in small groups (Appendix 1, p. 8-10). Individually choose the most interesting event within each category: "How does the Universe work?", "How did we get here?", "Are we alone?". which you found most interesting. Individually answer the following questions and share your answers with your group members:
 - **Why is this event interesting?**
 - **How does this influence my life today?**
 - **How many it influence my life in the future?**
3. As a group, come to a consensus on one significant event in any category to share with the class. Explain the significance of the event to the whole class. In your explanation, be sure to answer the above three questions.
4. Class Discussion:
Engage in a discussion about the events selected, their importance, and their impact on

² NASA. (n.d.). Astrophysics. <http://science.nasa.gov/astrophysics/>.



you as a teenager, on your school, and on your community.

- ***Do you agree or disagree with one another?***
- ***What would you like science to accomplish in the near future? In your lifetime?***

5. Extension- Challenge Yourself:

Test your memory! In one minute, how much information can you recall from the timeline? (Appendix 2, p. 11).



ACTIVITY #2

Is This Our Final Century?

Time: 1 hour

Materials: Pen/Pencil, Computer with internet access, “Astrophysics Basics (Appendix 3, p. 12), “A Conversation: With Sir Martin Rees; Tracing Evolution of Cosmos From Its Simplest Elements ” (Appendix 4, p. 13 - 15), “What I Know, Learned, Want to Know” Chart (Appendix 5, p. 16).

Instructions:

In this three-part assignment, students will learn more about astrophysics research and the life and work of Lord Rees. In Part I, students will brainstorm what they already know about astrophysics. Part II introduces students to the life and work of Lord Rees on cosmology. Finally, Part III will prepare students for their upcoming conversation with Lord Rees by encouraging them to draft a short list of questions they’ve developed based on what they’ve learned.

Part I

1. Create definitions for each of the following terms:
 - Big Bang Theory
 - Universe
2. Read “Astrophysics Basics” (see Appendix 3, p. 12)
3. Create a visual (diagram, picture) that shows the relationship between each of the following vocabulary words (see Appendix 3, p. 12):
 - Astrophysics
 - Cosmology
 - Universe
 - Theory of General Relativity
 - Big Bang Theory
4. List 5 things that you now KNOW about astrophysics:

What I KNOW
1.
2.
3.
4.
5.

Part II

Now that you’ve brainstormed all you already know about astrophysics research, it’s time to deepen your understanding!

1. **Read** the following article and **Watch** the following video clip to learn more about the Universe and the work of Lord Rees:
 - Read: A Conversation: With Sir Martin Rees; Tracing Evolution of Cosmos



- Watch: Sir Martin Rees TED Talk: Earth in its final century
<https://www.youtube.com/watch?v=3qF26MbYgOA>
- In pairs or small groups, discuss the following questions:
 - *What motivated Lord Rees to pursue a career in the field of research?*
 - *Why is the study of astrophysics important to Sir Rees?*
 - *Lord Rees mentions that understanding the Universe is a simple task, however understanding the origins of life is much more difficult. Why does he say this?*
 - *What role do you think astrophysics research plays in helping further scientific research?*
- List 5 things that you LEARNED about astrophysics and the work of Lord Rees:

What I LEARNED
1.
2.
3.
4.
5.

Part III

1. On Thursday, May 29th you and your classmates will have the opportunity to engage with Lord Rees about his research and his work. List 5 questions that you WANT TO KNOW related to the work of Lord Rees.

What I WANT TO KNOW
1.
2.
3.
4.
5.

Final Activity

At this point, you have gathered three lists (What I know, What I learned, What I want to know). Gather your three lists together into one chart (see Appendix 5, p. 16). From the final column (What I want to know more about), select 3 questions that you would like to ask Lord Rees.

REFLECTION/PRE-VIDEOCONFERENCE PREPARATION ACTIVITY

Here is your opportunity to ask Lord Rees questions relating to his work. Review the questions you identified in the “What I Want to Know” Chart and write them below:

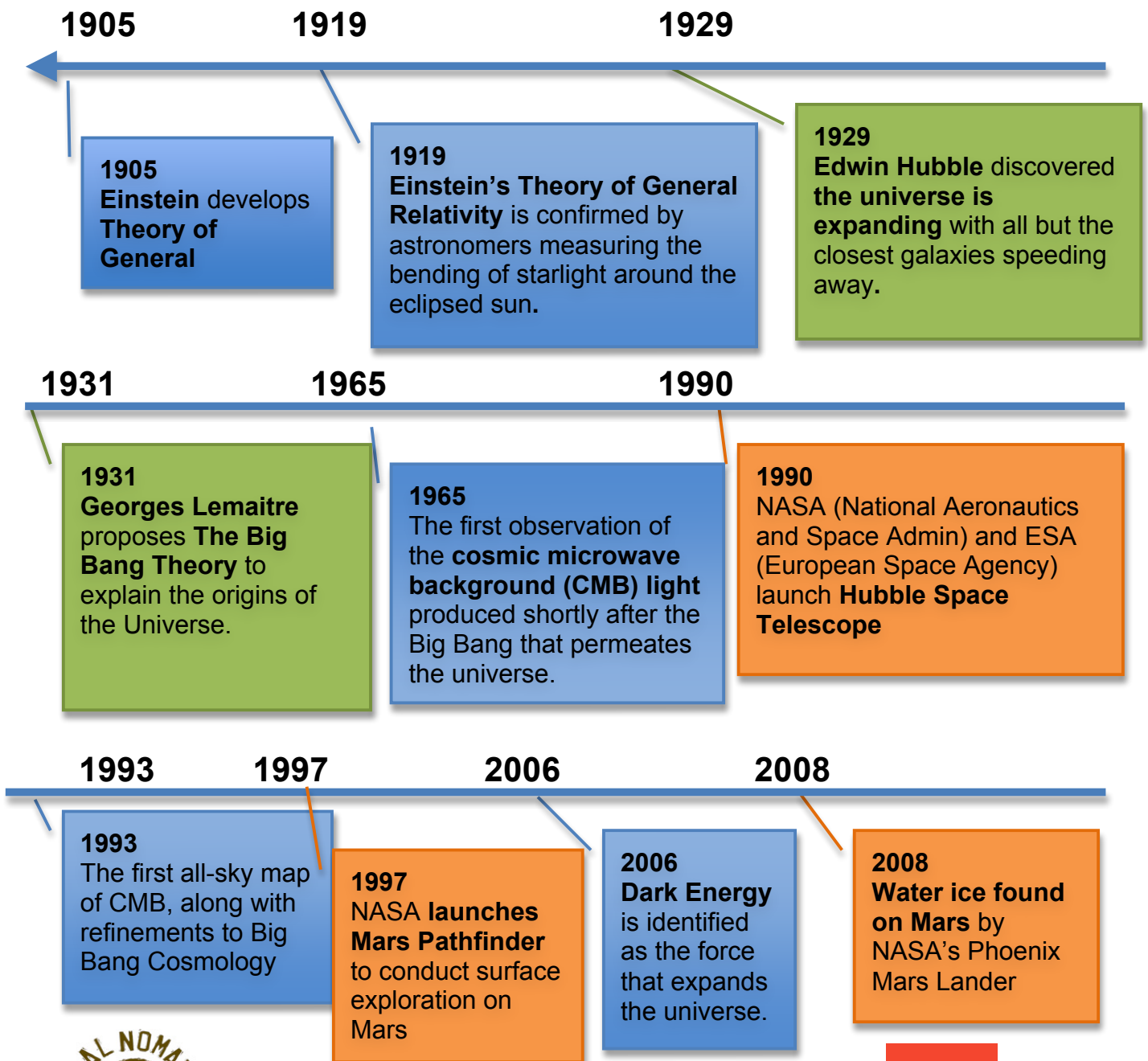
- 1.
- 2.
- 3.



Discovering the Universe Timeline

Directions: Use the timeline to identify how scientists have been able to answer each of the questions listed below over the last 100 plus years. Which questions remain unanswered?

Categories	Related Questions
1. How does the Universe work?	How do matter, energy, space, and time behave under the extraordinarily diverse conditions of the cosmos?
2. How did we get here?	How did the universe originate and evolve to produce the galaxies, stars and planets we see today?
3. Are we alone?	What are the characteristics of planetary systems orbiting other stars, and do they harbor life?



Discovering the Universe Timeline

1905

Einstein develops **Theory of General Relativity**. Einstein determined that the laws of physics are the same for all non-accelerating observers, and that the speed of light in a vacuum was independent of the motion of all observers. This was the theory of special relativity. It introduced a new framework for all of physics and proposed new concepts of space and time.

Resources: <http://www.space.com/17661-theory-general-relativity.html>
http://science1.nasa.gov/science-news/science-at-nasa/2004/26mar_einstein/

1919

Einstein's Theory of General Relativity is confirmed by astronomers measuring the bending of starlight around the eclipsed sun. According to Einstein's Theory of General Relativity, the sun's gravity causes starlight to bend, shifting the apparent position of stars in the sky. Relativity explains gravity and motion by uniting space and time into a 4-dimensional, dynamic, elastic fabric of reality called space-time, which is bent and warped by the energy it contains. (Mass is one form of energy, so it creates gravity by warping space-time.)

Resources: http://science1.nasa.gov/science-news/science-at-nasa/2004/26mar_einstein/

1929

Edwin Hubble discovered **the universe is expanding** with all but the closest galaxies speeding away.

Resources: http://www.spacetelescope.org/about/history/the_man_behind_the_name/

1931

Georges Lemaitre proposes **The Big Bang Theory** to explain the origins of the universe. Building on Hubble's discovery he realized there must have been an instant in time (now known to be about 14 billion years ago) when the entire Universe was contained in a single point in space. The Universe must have been born in this single violent event which came to be known as the "Big Bang." Astronomers combine mathematical models with observations to develop workable theories of how the Universe came to be. The mathematical underpinnings of the Big Bang theory include Albert Einstein's general theory of relativity along with standard theories of fundamental particles.

Resources: http://science1.nasa.gov/media/medialibrary/2010/03/31/dark_expansion.jpg
<http://science1.nasa.gov/astrophysics/focus-areas/what-powered-the-big-bang/>

1965

The first observation of the **cosmic microwave background (CMB) light** produced shortly after the Big Bang that permeates the universe. According to scientists, CMB is background radiation left over from the Big Bang. Scientists argue that CMB offers proof of the Big Bang Theory and provides insight into the composition of the Universe.

Resources: <http://www.space.com/20330-cosmic-microwave-background-explained-infographic.html>



Appendix 1 (continued)

1990

United States National Aeronautics and Space Administration (**NASA**) and the European Space Agency (**ESA**) launch **Hubble Space Telescope**. The telescope measures the expanding universe.

Resources: http://www.nasa.gov/mission_pages/hubble/story/index.html
http://science1.nasa.gov/science-news/science-at-nasa/1999/ast25may99_1/

1993

The first all-sky map of **CMB**, along with refinements to Big Bang Cosmology

Resources: http://science1.nasa.gov/science-news/science-at-nasa/2000/ast27apr_1/

1997

Launched by **NASA**, **Mars Pathfinder** lands on Mars to conduct surface exploration and data collection.

Resources:
http://news.bbc.co.uk/onthisday/hi/dates/stories/july/6/newsid_4105000/4105727.stm;
<http://www.nasm.si.edu/etp/mars/explore.html>

1998

Dark energy discovered. In 1998, Hubble Space Telescope (HST) observations of very distant supernovae showed that the Universe is expanding faster today than ever before. These observations proved that the expansion of the Universe has not been slowing due to gravity, as everyone previously thought, it has been accelerating. Theorists don't know what the correct explanation for acceleration is but they have given the solution a name. It is called dark energy.

Resources: <http://science1.nasa.gov/astrophysics/focus-areas/what-is-dark-energy/>

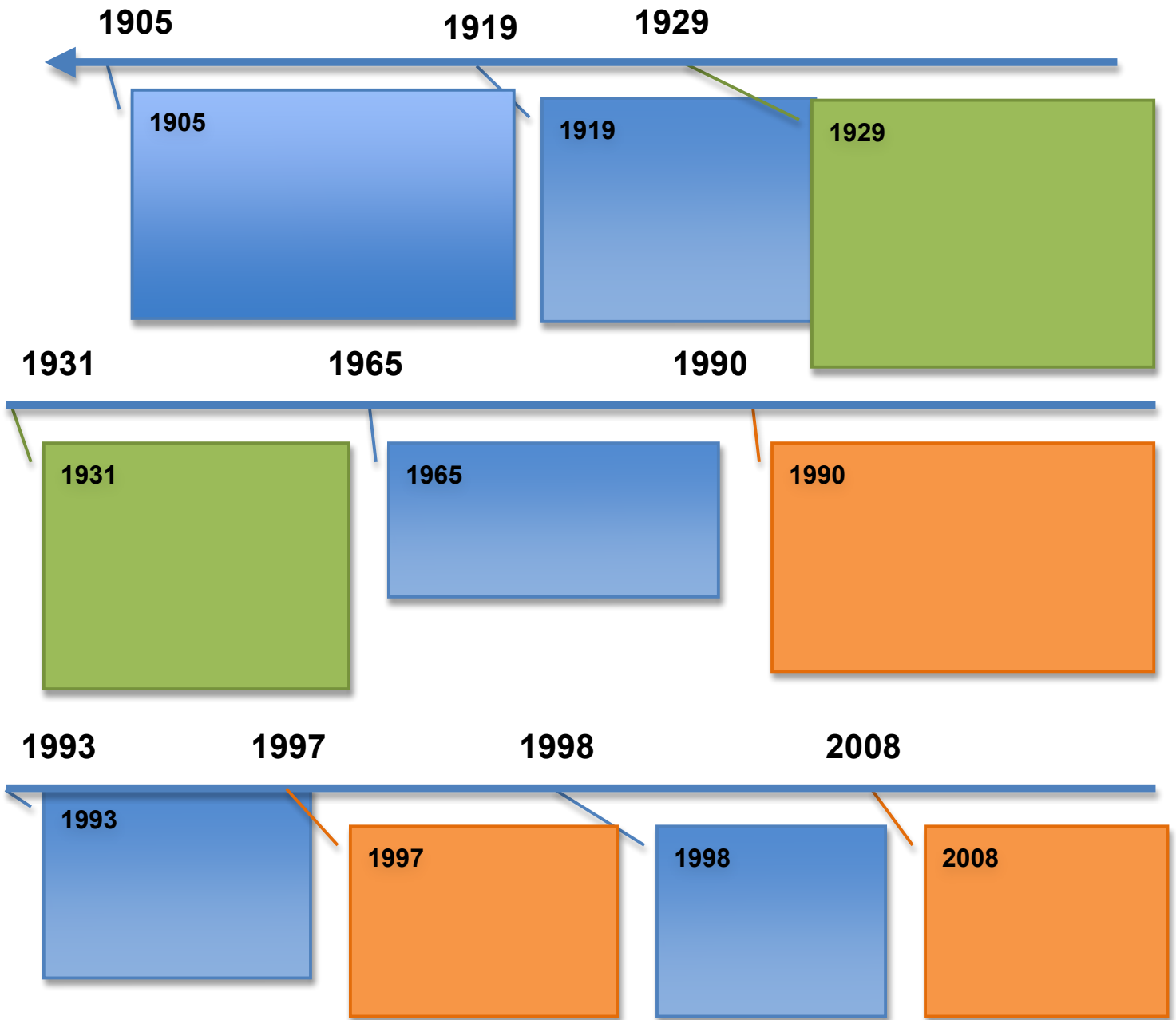
2008

Scientists confirm that they “found proof” of water ice on Mars away from the polar ice caps, a discovery made by **NASA's Phoenix Mars Lander**.

Resources: http://science.nasa.gov/science-news/science-at-nasa/2002/28may_marsice/



Discovering the Universe



Astrophysics Basics

Astrophysics

³Astrophysics is the study of the physical and chemical properties and structures of stars, planets and other objects in outer space. The scientific study of Astrophysics seeks to discover how the universe works, explores how the universe began and developed into its present form and searches for Earth-like planets.

Cosmology

Cosmology is a branch of astrophysics that specifically studies the origin, evolution, and eventual fate of the universe.

Universe

Everything that exists, including the Earth, planets, stars, galaxies, and all that they contain; the entire cosmos.

Albert Einstein's Theory of General Relativity

⁴This theory states that the laws of physics are the same for all non-accelerating observers, and the speed of light in a vacuum is independent of the motion of all observers. This theory introduced a new framework for all of physics and proposed new concepts of space and time.

The Big Bang Theory

The big bang theory is the theory that the universe started from a single point, and has been expanding ever since.

Instructions: Create a visual (diagram, picture) that shows the relationship between each of the vocabulary words listed above.



³ NASA. (n.d.). Astrophysics. Retrieved on April 12 from <http://science.nasa.gov/astrophysics/>.

⁴ NASA. (2004). Evicting einstein. Retrieved on April 12 from http://science1.nasa.gov/science-news/science-at-nasa/2004/26mar_einstein/



A CONVERSATION: With Sir Martin Rees; Tracing Evolution of Cosmos From Its Simplest Elements

By CLAUDIA DREIFUS
Published: April 28, 1998

SIR Martin Rees, 55, one of the world's leading theorists on cosmic evolution, the Astronomer Royal of England and the author of "Before the Beginning: Our Universe and Others" (Addison-Wesley, 1997), was in the United States this month to receive the Franklin Institute's \$250,000 Bower Award for "achievement in science." Sir Martin spoke with Science Times over lunch in the cafeteria at the Institute for Advanced Study in Princeton, N.J.

Q. Nietzsche once wrote, "If you gaze long into an abyss, the abyss will gaze back into you." When Sir Martin Rees, Astronomer Royal, looks into the abyss, what does he see?

SIR MARTIN First off, I should mention that Astronomer Royal is a purely honorary post, rather like Poet Laureate. The Astronomer Royal's duties are so exiguous that they could be performed posthumously. Therefore, I have a day job as a research professor at Cambridge where I interpret astronomy data, rather than observe. Other people do the gazing.

What I do is to try to understand how our universe has evolved from simple beginnings to the complex cosmos we see around us, of which we are a remarkable part ourselves.

Q. When it comes to astrophysics, many of us are perplexed because the cosmos seems too complex to understand. Why should the ordinary Joe or Jane know their astrophysics?

A. Because there's a fascination with our origins and astrophysics is the key to it. If we are to understand an everyday question like "Where did the atoms we are made of come from?" we must understand the stars. Did the creator magically turn 92 different knobs to make the different elements? Or is there a reason why the earth contains a lot of carbon, oxygen and iron, but not much gold and uranium?

The explanation is that all the atoms were once inside a star. When our Milky Way galaxy was first formed about 10 billion years ago, it contained the simplest atoms: hydrogen and helium.



Then, the first stars were formed and the nuclear fuel that kept those stars shining converted hydrogen into helium through nuclear fusion and then converted helium into other atoms: carbon, oxygen and the rest of the periodic table.

Later, the stars ran out of fuel, they exploded, threw back all that debris into interstellar space and it all eventually condensed into new stars. One of which was our sun.

Q. So when the poets sing, "You are the sun and the stars and the moon," they are being literal?

A. We are the dust of long dead stars. Or, if you want to be less romantic, we are nuclear waste. Sometimes people ask me, "Are we presumptuous to think we can understand anything as big as a star, or a galaxy, or the Big Bang?" The response I give is that what makes things hard to understand is not how big they are but how complicated. Inside a star, everything is broken down to its simplest constituents. Ditto, in the Big Bang. On the other hand, it is much, much more difficult to understand the simplest living organism. The most wonderful thing we know about in the universe is life, and that's the most complicated emergent phenomena we know of.

I'm always amazed when we study these simple beginnings, one has not just understood how the chemical elements have been made but how they've forged themselves into something complicated enough to develop into life.

Another motive for studying the cosmos is that it is a cheap way to understand and test the basic laws of nature under extreme conditions. We can't simulate strong gravity or the physics of the Big Bang in our laboratories. So astronomers can complement the knowledge gained by scientists on earth about the fundamental laws.

Q. Getting back to Nietzsche, how do you think "gazing out into the abyss" changes a person?

A. It gives one a slightly different perspective on time scales. From astronomy, one learns the immense time spans involved in cosmic evolution -- billions of years. And for me, a much more important realization is that we are still at the beginning of cosmic evolution, not the culmination. Even our sun is less than halfway through its life. That makes me feel we should regard ourselves as part of the natural order, rather than the culmination of it.

What was it that D. H. Lawrence wrote? "I am part of the sun as my eye is part of me. That I am part of the earth my feet know perfectly and my blood is part of the sea." And that understanding leads to the question "Is life as we know it unique to the earth?"



The origin of life is a harder problem than most astronomical problems and therefore you don't really have enough evidence to say whether the evolution of life is likely or unlikely. One of the developments in astronomy in the last two or three years is that we've realized that there are certainly planets around many other stars and almost certainly many of these planets have the environment of the young earth.

What we don't know is whether given the right conditions, the emergence of life is automatic or a rare accident. Still less do we know whether simple life automatically evolves toward something we recognize as intelligent. So we don't know whether life is unique to the earth.



Lord Martin Rees Cosmology and Astrophysics

What I know about astrophysics	What I learned about Lord Rees and astrophysics	What I want to know more about Lord Rees and astrophysics

REFLECTION/PRE-VIDEOCONFERENCE PREPARATION ACTIVITY

Here is your opportunity to ask Lord Rees questions relating to his work. Review the questions you identified in the “What I Want to Know” Chart and write them below:

- 1.
- 2.
- 3.



Pioneers in Science 2014-Classroom Participant Release

1. I have agreed to participate in an educational program entitled "*Pioneers in Science*" (the "Program"), [as part of the 2014 World Science Festival (the "Festival"),] presented by The Science Festival Foundation ("SFF") in collaboration with Global Nomads Group ("GNG").
2. I understand that SFF and/or GNG may film/videotape, record, photograph or otherwise document the Program (such documentation, the "Footage"), and agree that my participation may be included in the Footage.
3. I understand that part of SFF and GNG's educational mission is to make their programs widely available to a diverse audience through different media. In support of this mission, I grant to SFF and GNG, their successors and other entities they may designate from time to time (such as licensees, broadcasters, and other content distributors) the exclusive right to edit, distribute, broadcast or otherwise disseminate the Footage, in whole or in part, throughout the world, in perpetuity, in any manner or media now known or hereafter developed, including the live streaming of the event over the internet. This grant to SFF and GNG includes the right to use my name, voice, biography and image in connection with the foregoing. I understand that I will receive no compensation for the above.
4. In consideration of my being permitted to participate in the Program, I irrevocably release SFF, GNG, and their respective officers, directors, employees, agents, licensees or assigns, from any claims I may have, now or in the future, arising from (i) any use of the Footage, and (ii) any use of my name or image for the purposes permitted herein.
5. GNG and SFF are not obligated to use any or all of the Footage from the Program.
6. This Release is governed by the laws of the State of New York and may not be modified except in writing signed by both parties.

Signature	Name (print)
Address	Date
Email Address	Phone Number

**** For Minors Under 18 years, the following must be signed by the parent or guardian**

I represent that I am the parent/guardian of _____, a minor, and I hereby consent to the foregoing on behalf of the minor and myself.

Date _____, 2014

Name (print) _____	Phone number _____
Signature _____	Address _____
Relationship _____	Email Address _____

