In Search of the Dark Energy

Duties

During my first two weeks I developed a series of documents with lots of questions about:

Dark energy, dark matter, origin of the universe, galaxies, galaxy clusters, surveys, gravitational lensing, probes and cosmology and life at CTIO

Cosmological constant

Cosmological constant problem
- FRW metric
- Vacuum energy

Transformation of energy
- Mechanical energy
- Stretching universe

Expansion of the Universe

Develop analogies and demo & lab

For future development

Other ideas

Teacher point of view

Concepts that we can develop in our classes
- General cosmology
- Origin of the universe
- Relativity
- Gravitation
- Composition of the universe
- Dark energy
- Dark matter

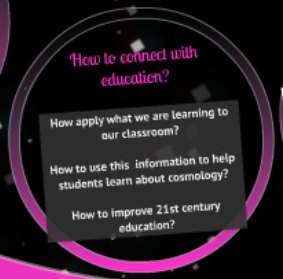

In Search of the Dark Energy

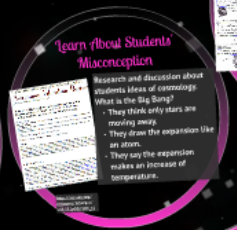
Duties

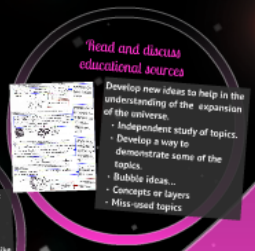
They will be used for:
http://darkenergydetectives.org

During my first two weeks I developed a series of documents with lots of questions about:

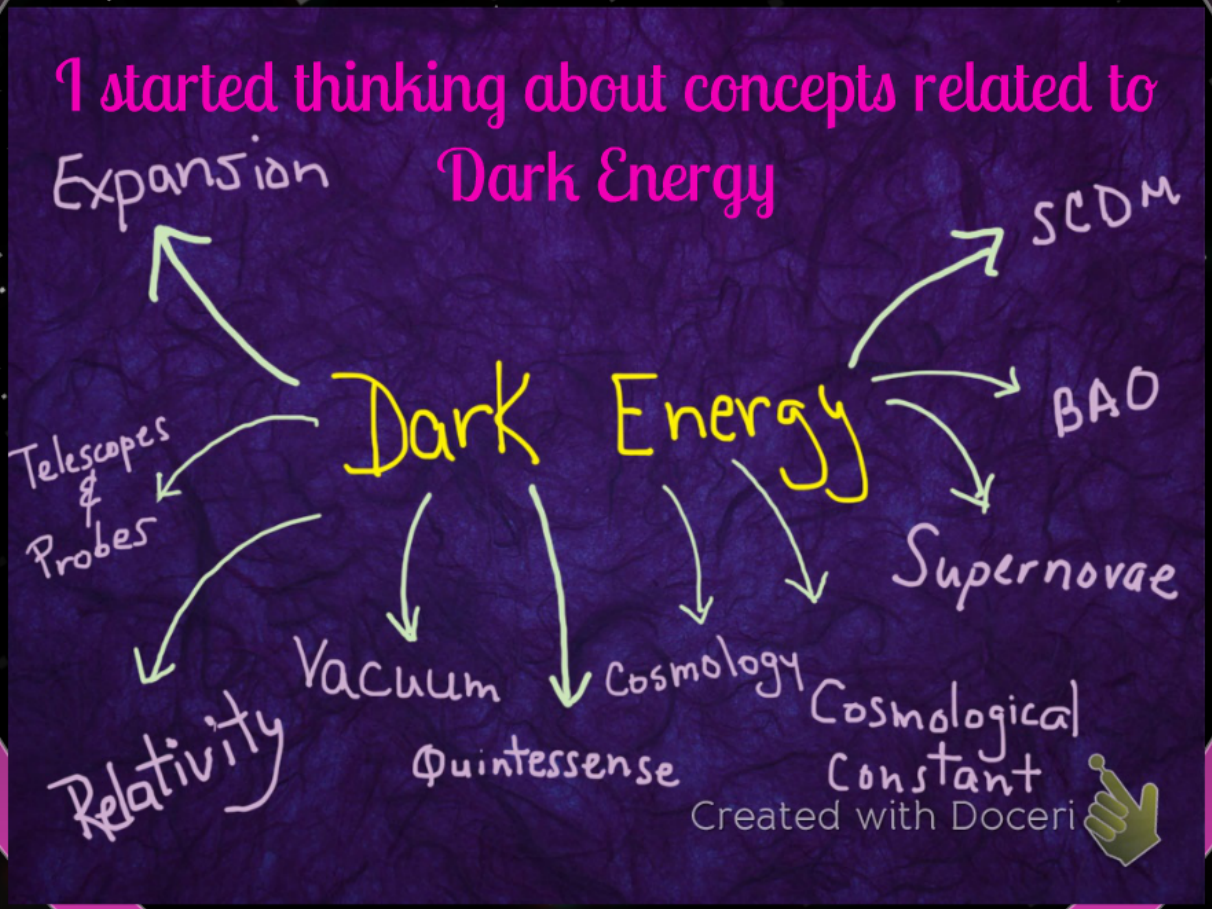
Dark energy, dark matter, origin of the universe, galaxies, galaxy clusters, surveys, gravitational lensing, probes and cosmology and life at CTIO







The Big Picture

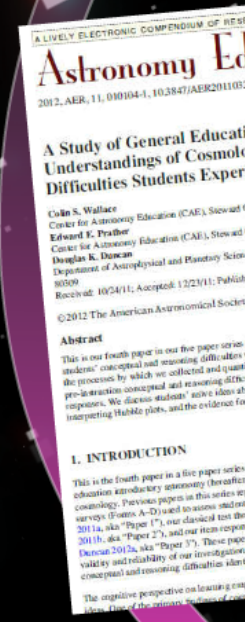


How to connect with education?

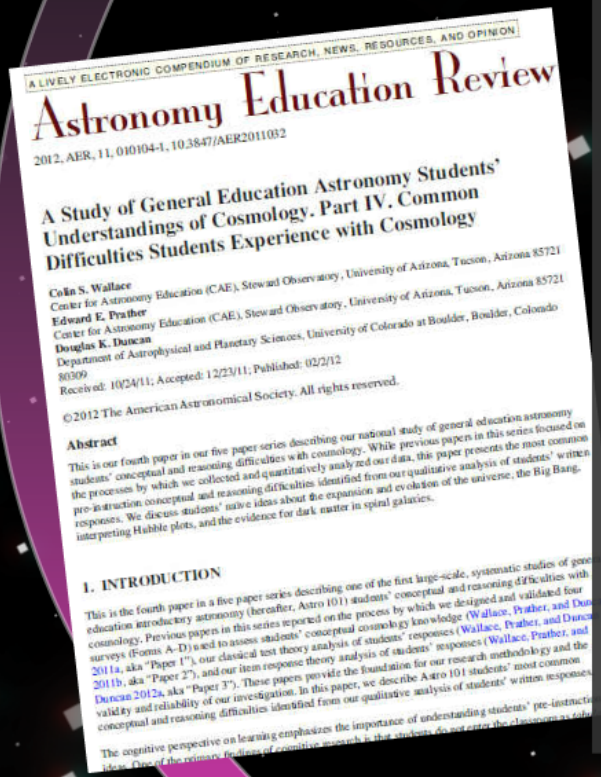
How apply what we are learning to our classroom?

How to use this information to help students learn about cosmology?

How to improve 21st century education?



Learn About Students' Misconception



A LIVELY ELECTRONIC COMPENDIUM OF RESEARCH, NEWS, RESOURCES, AND OPINION

Astronomy Education Review

2012, AER, 11, 010104-1, 10.3847/AER2011032

A Study of General Education Astronomy Students' Understandings of Cosmology. Part IV. Common Difficulties Students Experience with Cosmology

Colin S. Wallace
Center for Astronomy Education (CAE), Steward Observatory, University of Arizona, Tucson, Arizona 85721
Edward E. Prather
Center for Astronomy Education (CAE), Steward Observatory, University of Arizona, Tucson, Arizona 85721
Douglas K. Duncan
Department of Astrophysical and Planetary Sciences, University of Colorado at Boulder, Boulder, Colorado 80309

Received: 10/24/11; Accepted: 12/23/11; Published: 02/2/12

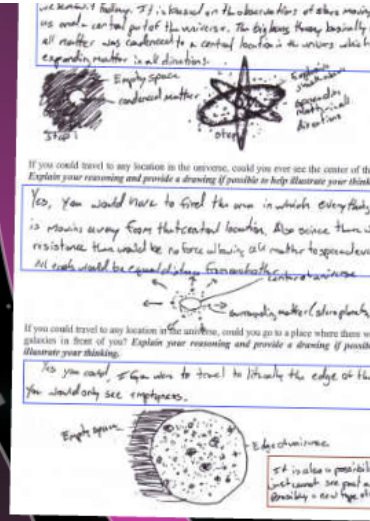
Abstract

This is our fourth paper in our five paper series describing our national study of general education astronomy students' conceptual and reasoning difficulties with cosmology. While previous papers in this series focused on the processes by which we collected and quantitatively analyzed our data, this paper presents the most common pre-instruction conceptual and reasoning difficulties identified from our qualitative analysis of students' written responses. We discuss students' naïve ideas about the expansion and evolution of the universe, the Big Bang, interpreting Hubble plots, and the evidence for dark matter in spiral galaxies.

1. INTRODUCTION

This is the fourth paper in a five paper series describing one of the first large-scale, systematic studies of general education introductory astronomy (hereafter, Astro 101) students' conceptual and reasoning difficulties with cosmology. Previous papers in this series reported on the process by which we designed and validated four surveys (Forms A–D) used to assess students' conceptual cosmology knowledge (Wallace, Prather, and Duncan 2011a, aka "Paper 1"), our classical test theory analysis of students' responses (Wallace, Prather, and Duncan 2011b, aka "Paper 2"), and our item response theory analysis of students' responses (Wallace, Prather, and Duncan 2012a, aka "Paper 3"). These papers provide the foundation for our research methodology and the validity and reliability of our investigation. In this paper, we describe Astro 101 students' most common conceptual and reasoning difficulties identified from our qualitative analysis of students' written responses.

The cognitive perspective on learning emphasizes the importance of understanding students' pre-instructional

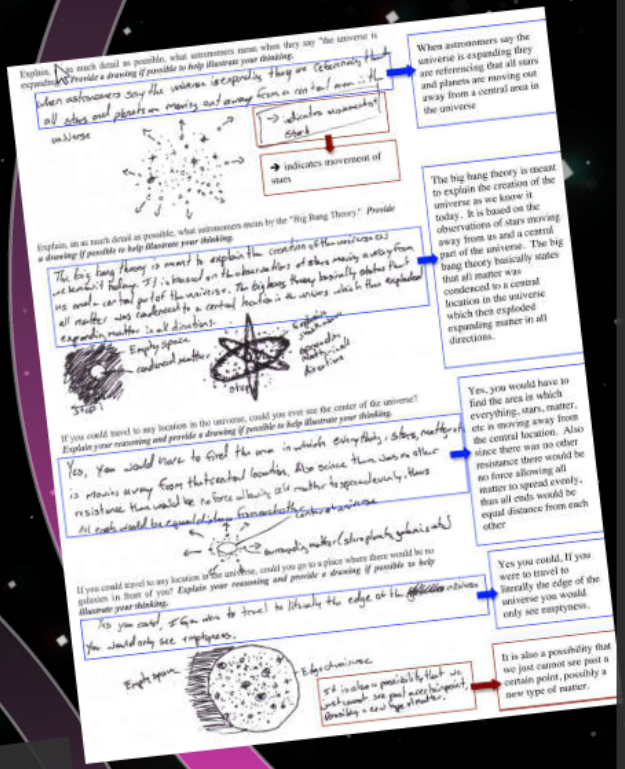


Research and discussion about students ideas of cosmology.
What is the Big Bang?

- They think only stars are moving away.
- They draw the expansion like an atom.
- They say the expansion makes an increase of temperature.

http://aer.aas.org/resource/1/aerscz/v11/i1/p010104_s1

Read and discuss educational sources



Develop new ideas to help in the understanding of the expansion of the universe.

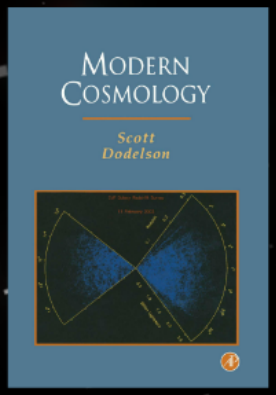
- Independent study of topics.
- Develop a way to demonstrate some of the topics.
- Bubble ideas...
- Concepts or layers
- Miss-used topics

ts'

ussion about
cosmology.
ang?
are

Cosmological constant

Λ



Cosmological constant problem

- FRW metric
- Vacuum energy

Transformation of energy

- Mechanical energy
- Stretching universe

The problem of the cosmological problem is:

The cosmological constant is 120 orders of magnitude smaller than naively expected from quantum gravity.
Using the following equation:
Einstein attempted to apply his new theory about the whole universe.
He thought the universe was static.
Leads to consider Hubble discovery.

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R + g_{\mu\nu}\Lambda = \frac{8\pi G}{c^4}T_{\mu\nu}$$

space-time <=> matter

$$\Omega_\Lambda = \frac{\rho_\Lambda}{\rho_{cr}} = \frac{\Lambda c^2}{3H^2}$$

energy density is related to Hubble constant

Read and discuss educational sources

Develop new ideas to help in the understanding of the expansion of the universe
- Independent study of topics.
- Develop a way to demonstrate some of the topics.
- Bubble ideas...
- Concepts or Layers
- Miss-used topics

The problem of the cosmological problem is:

The cosmological constant is 120 orders of magnitude smaller than naively expected from quantum gravity.

Using the following equation: Einstein attempted to apply his new theory about the whole universe.

$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R + g_{\mu\nu} \Lambda = \frac{8\pi G}{c^4} T_{\mu\nu}$$

space-time <=> matter

He thought the universe was static.

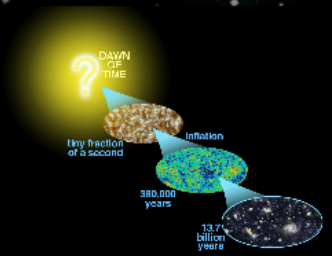
Leads to consider Hubble discovery.

$$\Omega_v = \frac{\rho_v}{\rho_{cr}} = \frac{8\pi G \rho_v}{3H^2}$$

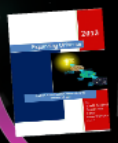
energy density is related to Hubble constant

Expansion of the Universe

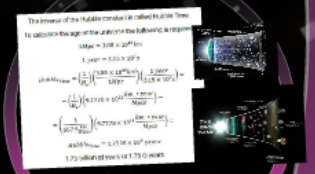
Develop analogies and demo & lab



Module



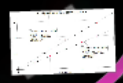
Develop the Expansion of the Universe lab activity. This activity demonstrate two models of the expansion of the universe in two dimension and time.

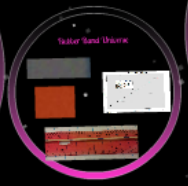


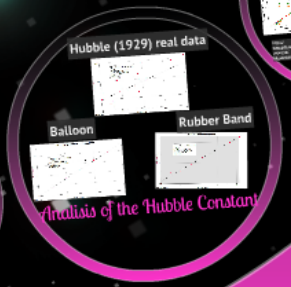
Calculation of the Hubble Time

The Balloon Universe

The purpose of it is to explain how expansion of the universe in a two dimensional model and to calculate the expansion coefficient.







Analisis of the Hubble Constant

Developing the idea of an expansion

Module

Develop the Expansion of the Universe lab activity. This activity demonstrate two models of the expansion of the universe in two dimension and time.

Introduction

According to Sharov, A. S and Novikov, I.D. (1989) the New York Times published in 1924 the announcement that there are other galaxies like ours, containing billion of stars based on Hubble recent research. Later Hubble found that these galaxies were moving away from us with speeds that were proportional to their distance from us. He discovered the relation of

$$v = H_0 d$$

Where v= the receding speed of galaxies or the speed the galaxies are moving away from us, then d=distance from us to the galaxy and H_0 is the Hubble constant. This is a linear relationship between the receding speed and the distance. If you consider that v=d/t then the Hubble constant is related to the time. In other words, this means that the Hubble constant is a way to measure time. Following the relationship between variables we can develop an activity in which you can measure the Hubble constant using a rubber band.

Background information

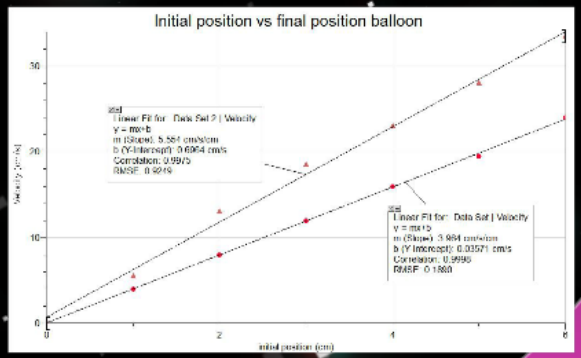
...other galaxies like ours, containing
Later Hubble found that these
that were proportional to their distance

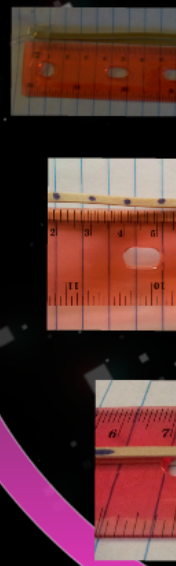
...eed the galaxies are moving away
...d Ho is the Hubble constant. This is a
...d the distance. If you consider that
...e. In other words, this means that
...owing the relationship between
...an measure the Hubble constant

...rmation

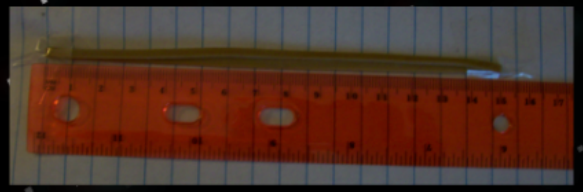
The Balloon Universe

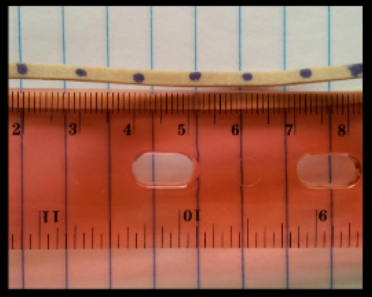
The purpose of it is to explain how expansion of the universe in a two dimensional model and to calculate the expansion coeficient.

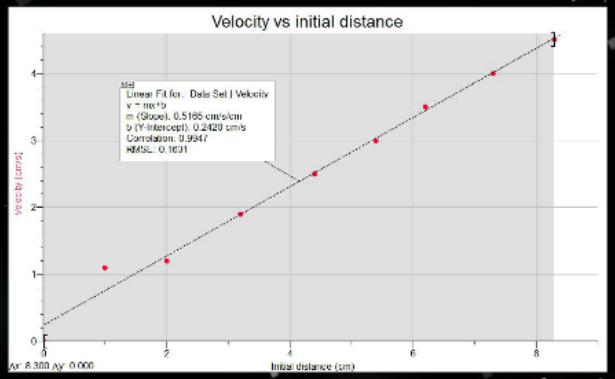


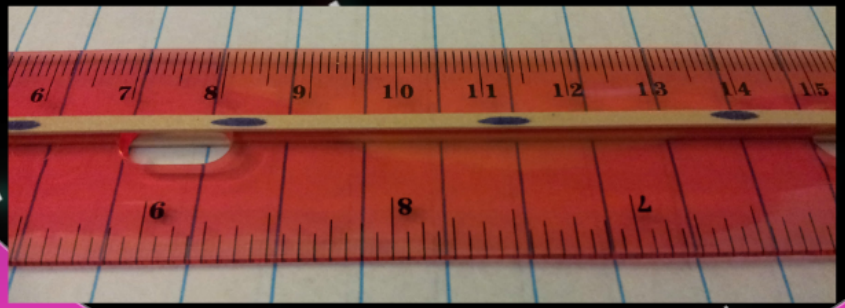


Rubber Band Universe

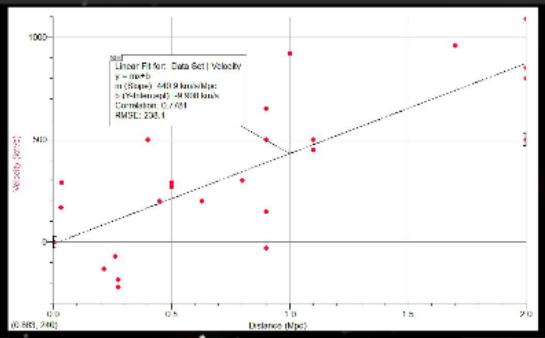


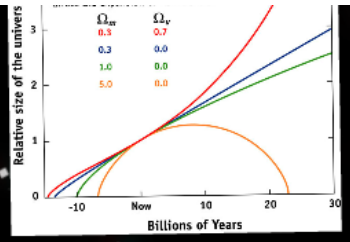






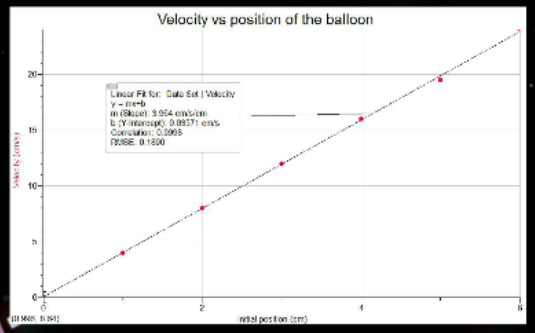
Hubble (1929) real data



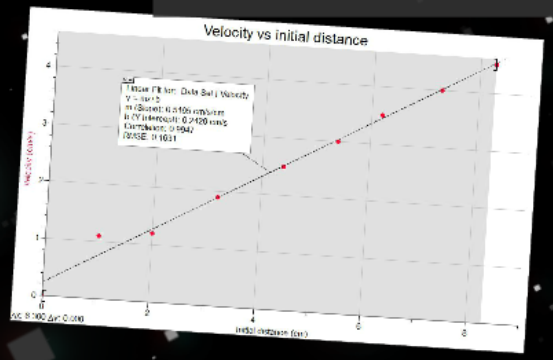


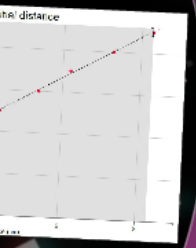
http://
map.gsfc.nasa.gov/
universe/
bb_concepts.html

Balloon



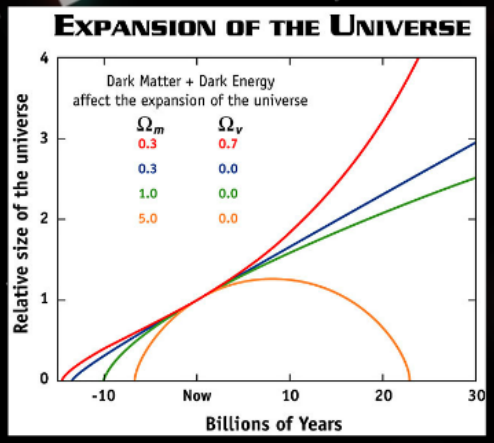
Rubber Band



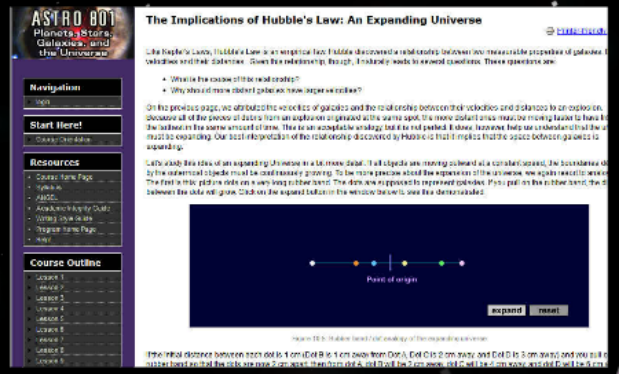


Analisis of the Hubble Constant

Developing the idea of an expansion



http://map.gsfc.nasa.gov/universe/bb_concepts.html



https://www.e-education.psu.edu/astro801/content/l10_p4.html

Calculation of the Hubble Time

The inverse of the Hubble constant is called Hubble Time.

To calculate the age of the universe the following is required

$$1Mpc = 3.08 \times 10^{19} km$$

$$1\ year = 3.15 \times 10^{7} s$$

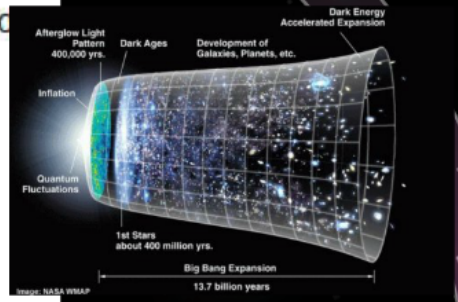
$$Hubble_{Time} = \left(\frac{1}{H_o}\right)\left(\frac{3.08 \times 10^{19} km}{1Mpc}\right)\left(\frac{1\ year}{3.15 \times 10^{7} s}\right) =$$

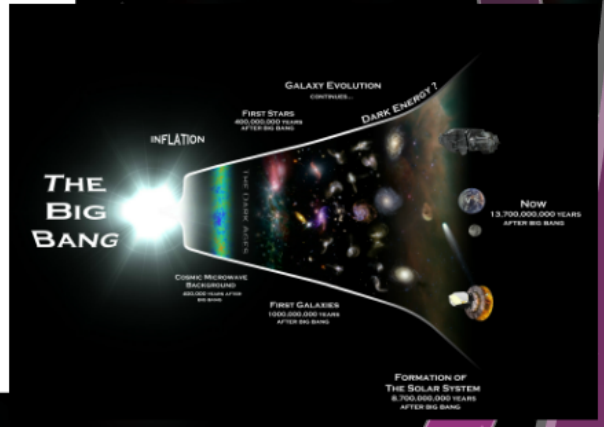
$$= \left(\frac{1}{H_o}\right)\left(9.7778 \times 10^{11} \frac{km\ *\ year}{Mpcs}\right) =$$

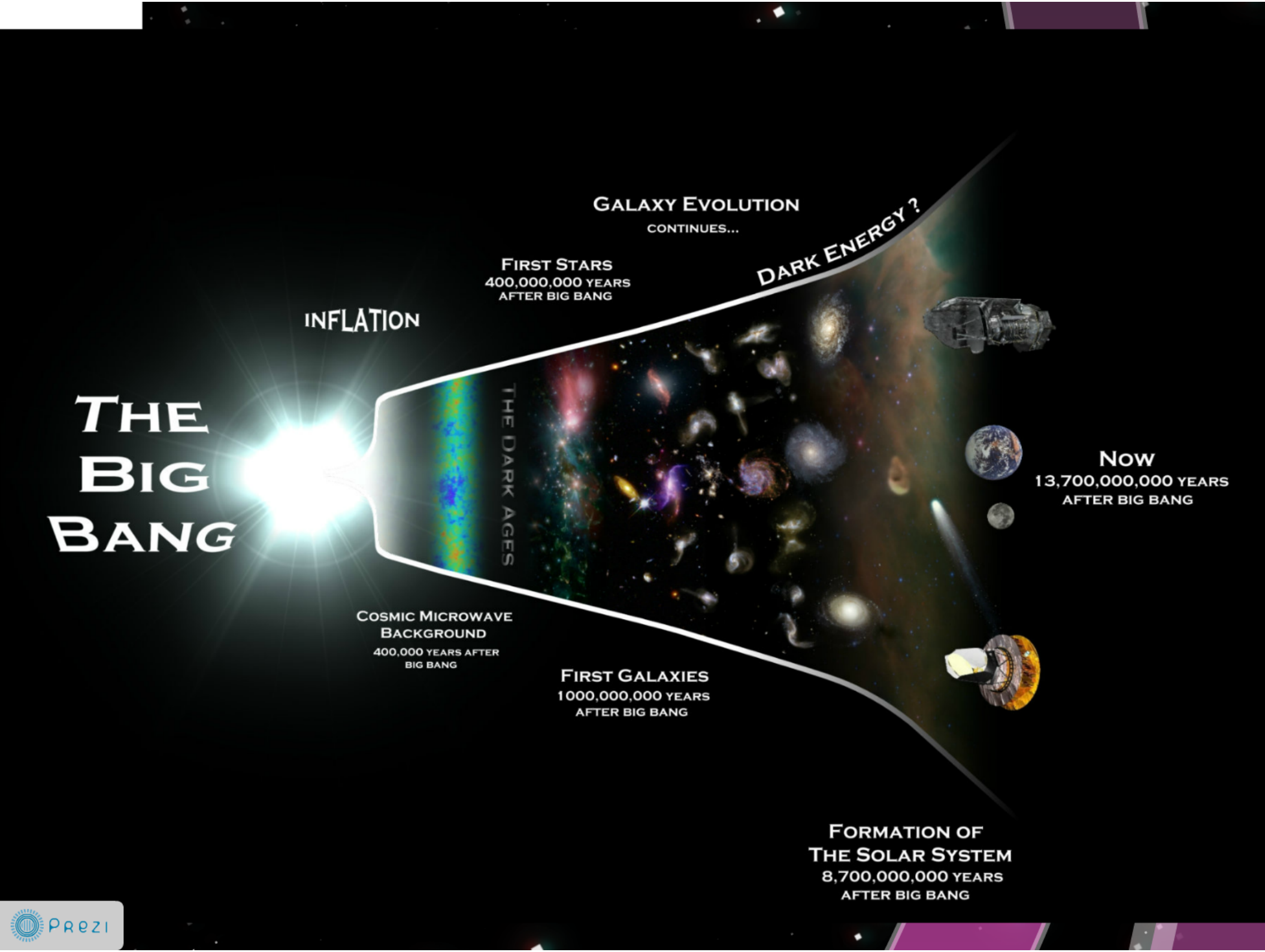
$$= \left(\frac{1}{557.9 \frac{km}{Mpcs}}\right)\left(9.7778 \times 10^{11} \frac{km\ *\ year}{Mpcs}\right) =$$

$$Hubble_{Time} = 1.7526 \times 10^{9}\ years$$

1.75 billion of years or 1.75 G years






THE BIG BANG
INFLATION
FIRST STARS
400,000,000 YEARS
AFTER BIG BANG
GALAXY EVOLUTION
CONTINUES...
DARK ENERGY ?
THE DARK AGES
COSMIC MICROWAVE
BACKGROUND
400,000 YEARS AFTER
BIG BANG
FIRST GALAXIES
1000,000,000 YEARS
AFTER BIG BANG
FORMATION OF
THE SOLAR SYSTEM
8,700,000,000 YEARS
AFTER BIG BANG
NOW
13,700,000,000 YEARS
AFTER BIG BANG

For future development

Other ideas

Probes

DECAM

- Gravitational lensing
- Supernovae
- Cluster of Galaxies
- Galaxy distribution

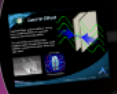
Fate of the universe

- Origin vs present
- Existence
- Present vs future
- Type of universes
- Cosmology constants

Spacetime

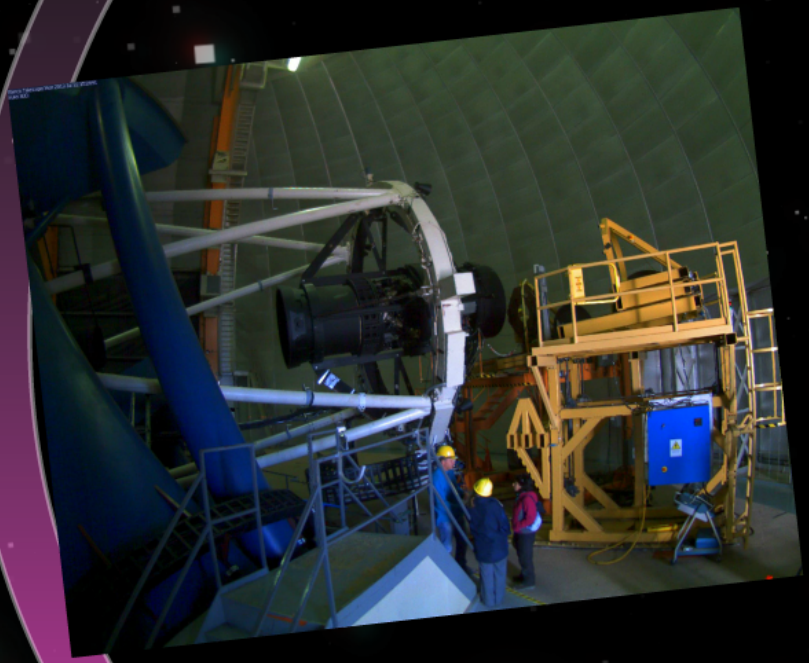
- Equations
- General Relativity
- Weight in space
- Expansion

Types of Dark Energy



- Vacuum energy
- Zero point energy
- Cassimir effect
- Quintessence
- Inflation vs steady state
- Other

Probes



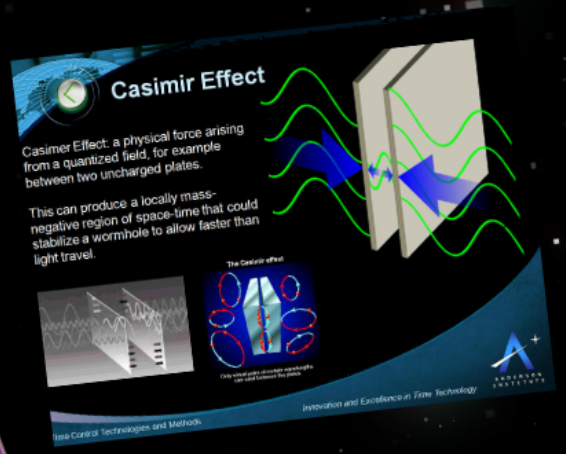
DECAM

Gravitational lensing
Supernovae
Cluster of Galaxies
Galaxy distribution

Spacetime

Equations
General Relativity
Weight in space
Expansion

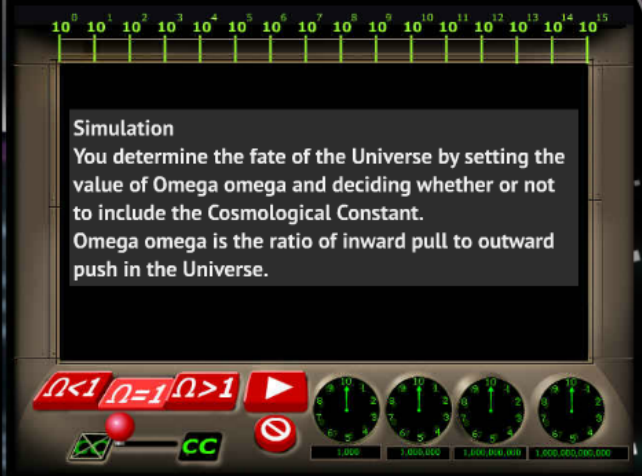
Types of Dark Energy



Vacuum energy
Zero point energy
Cassimir effect
Quintessence
Inflation vs steady state
Other

Fate of the universe

Origin vs present
Existence
Present vs future
Type of universes
Cosmology constants



Instructions

http://www.planetseed.com/files/flash/science/features/airspace/cosmos/universe/en/instructions.htm#explanation

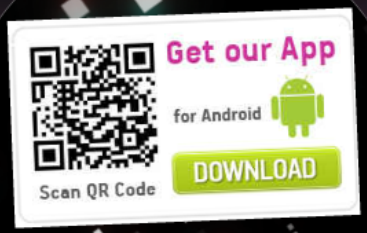
Teacher point of view

Concepts that we can develop in our classroom

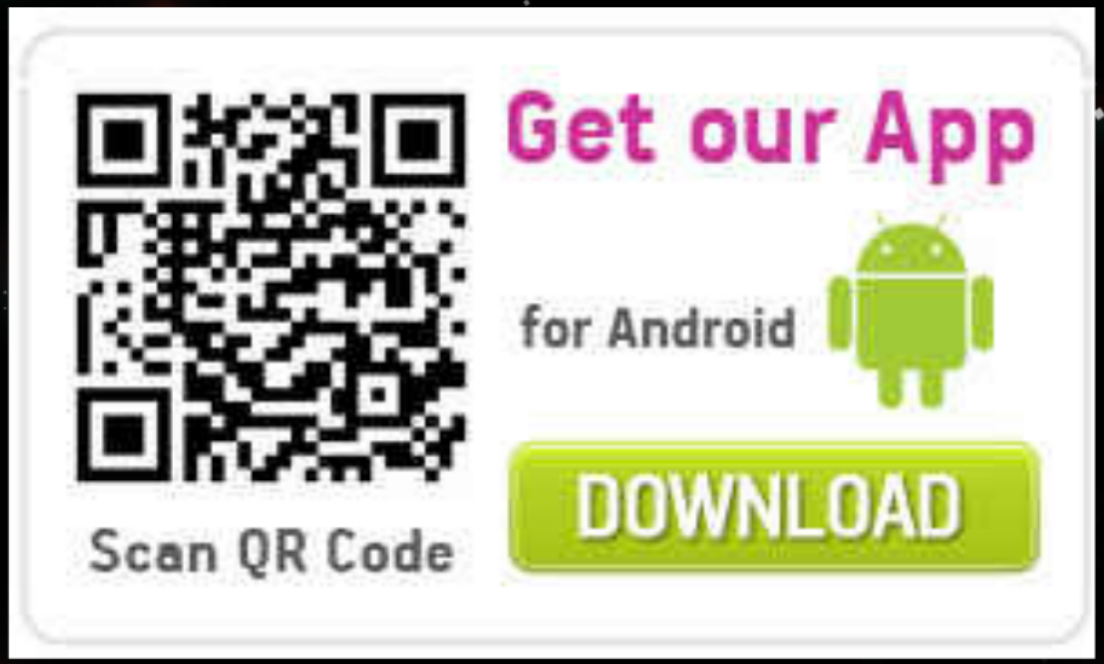
- General cosmology
- Origin of the universe
- Relativity
- Gravitation
- Composition of the universe
  - Dark energy
  - Dark Matter

To have this information

You can link here:
www.fisicaenlinea.com



http://www.appsgeyser.com/382080



http://www.appsgeyser.com/382080

Presentation by:

Prof. Elba M. Sepúlveda
elbas@fnal.gov
Physics Teacher

Mentor: Brian B. Nord
nord@fnal.gov
Fermilab

Dark Energy Survey
2013

For TRAC Program
Teacher Research Associates