Astronomy & Physics Resources for Middle & High School Teachers

Gillian Wilson

http://www.faculty.ucr.edu/~gillianw/K12

Outline

- Overview of NASA, NSF & Other Educational Links
- Short summary of my research (cosmology) with reference to State Standards Science Content Sections

EVERYTHING I will show / say today is linked to my webpage

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In State Standards “Science Framework for California Public Schools”, Astronomy falls under Earth Sciences

Are there any Earth Sciences Teachers present?

Are there any General Science Teachers present?

Are there any Middle School Teachers present?

UNIVERSITY of CALIFORNIA Riverside

Department of Physics & Astronomy

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Riverside, California

PEOPLE

Gillian Wilson

Associate Professor of Astronomy
Ph.D. 1996, University of Durham, UK

Galaxy Clusters and Mapping Dark Matter

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- Personal Home Page
- Selected Publications

Research Interests

Observational Cosmology
Dark Matter and Dark Energy
1 < z < 2 Clusters of Galaxies
Galaxy Evolution
Structure Formation
Extremely Red Objects
Weak Gravitational Lensing
Spitzer Space Telescope Infrared Studies

Selected Publications

"AEGIS: A Panchromatic study of IRAC-Selected Extremely Red Objects with Confirmed Spectroscopic Redshifts", Wilson, G et al., 2007, Ap.J., **660**, L59.

"Clusters of Galaxies at 1 < z < 2", Wilson, G. and SpARCS Collaboration, 2006, Spitzer Space Telescope: Infrared Diagnostics of Galaxy Evolution (astro-ph/06

Extremely Red Objects in the Lockman Hole", Wilson, G. et al., 2004, Ap.J.S., **154**, 147.

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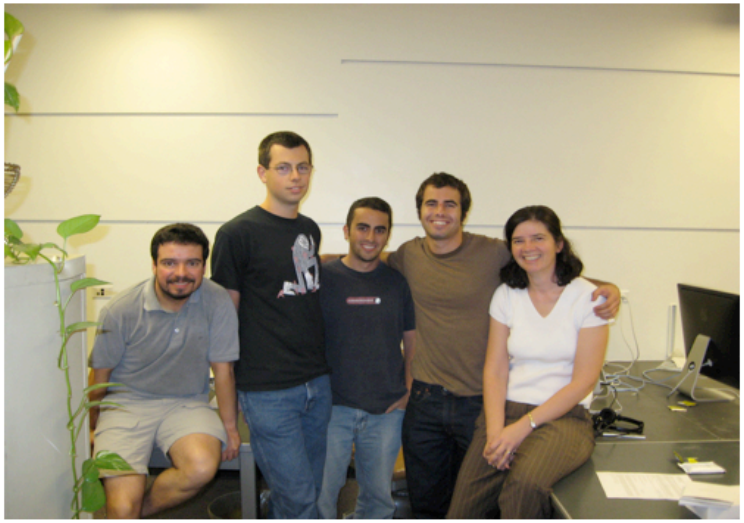

Wilson Group Summer 2008

L to R : Ricardo Demarco, Wojciech Karas, Alex Garabedian, Daniel Seisun and me.

Curriculum Vitae

Postdocs & Students

Publications

Teaching

Travel Schedule

Links for K-12 Educators

Research Opportunities

I welcome Graduate Students. If you are in the UCR Physics & Astronomy Graduate Program and considering studying for a Masters or Ph.D. degree under my supervision, please contact me.

I also offer Undergraduate Research Experience e.g., (paid) summer research and/or (unpaid) term-time research for credit or senior thesis.

Research

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Resources for Middle and High School Teachers

"Cool Cosmos"
The Infrared Universe

NASA's "The Teachers's Corner" website
Includes Lesson Plans, Posters and Information/Activity Booklets, DVD-ROMS, Data Suitable for Students to Analyze, Links to Education Resources

NASA's Science Mission Directorate Space Science Education Resource Directory
NASA searchable database of space science products for use in classrooms, science museums, planetariums, and other settings.

NSF Astronomy and Space Classroom Resources
A variety of Astronomy resources including Hands-on Labs.

NSF Physics Classroom Resources
A variety of Physics resources including Hands-on Labs.

"The Physics Classroom"
Online High School Physics Tutorials

American Astronomical Society (AAS) K-12 Resources
Links to "especially effective astronomy activities designed for K-12 classes and science projects"

National Science Teachers Association
A comprehensive list of resources for science teachers

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Research
(Observational Cosmology)

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State Standards G9-12

Physics 4: Waves

- 4e Students know radio waves, light and X-rays are different wavelength bands.
- 4f Students know how to identify the characteristic properties of waves: interference, diffraction, refraction, Doppler effect, and polarization.

State Standards G9-12

Earth Sciences 2: Earth's Place in the Universe (Stars, Galaxies and the Universe)

- 2b Students know galaxies are made of billions of stars and comprise most of the visible mass of the universe.
- 2g Students know how the red-shift from distant galaxies and the cosmic background radiation provide evidence for the "big bang" model that suggest the universe has been expanding for 10 to 20 billion years.

State Standards G6-8

Grade 8 : Focus on Physical Sciences

Standard Set 4: Earth in the Solar System (Earth Sciences)

- 4a Students know galaxies are clusters of billions of stars and may have different shapes.
- 4b Students know that the Sun is one of many stars in the Milky Way galaxy and that stars may differ in size, temperature and color.
- 4c Students know how to use astronomical units and light years as measures of distance between the Sun, stars and Earth.

Observational Cosmology

- Dark Matter & Dark Energy
- Very distant Clusters of Galaxies
- Galaxy Evolution
- Extremely distant Quasars
- Structure Formation
- Extremely Red Objects
- Weak Gravitational Lensing
- Spitzer Space Telescope Infrared Studies

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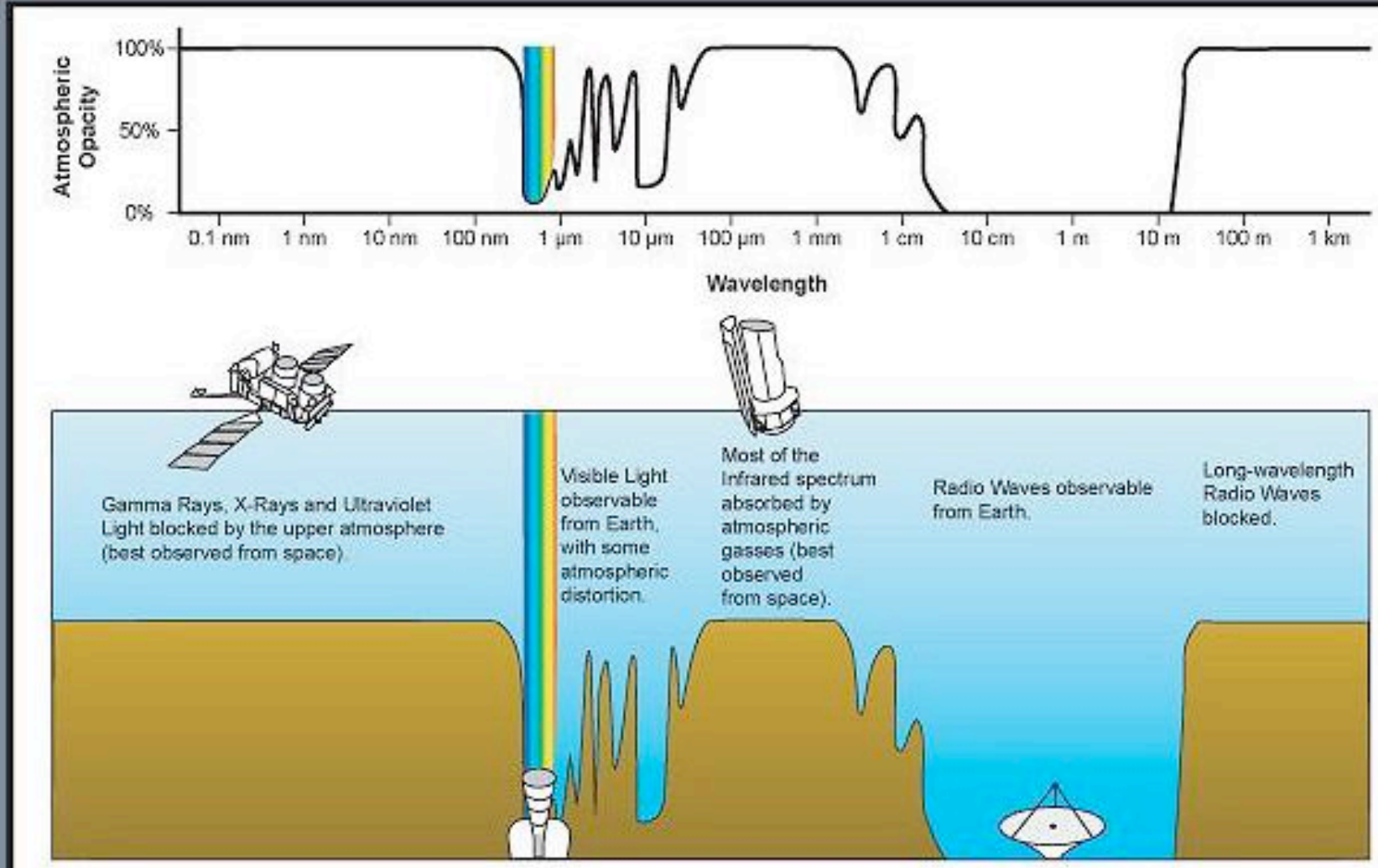
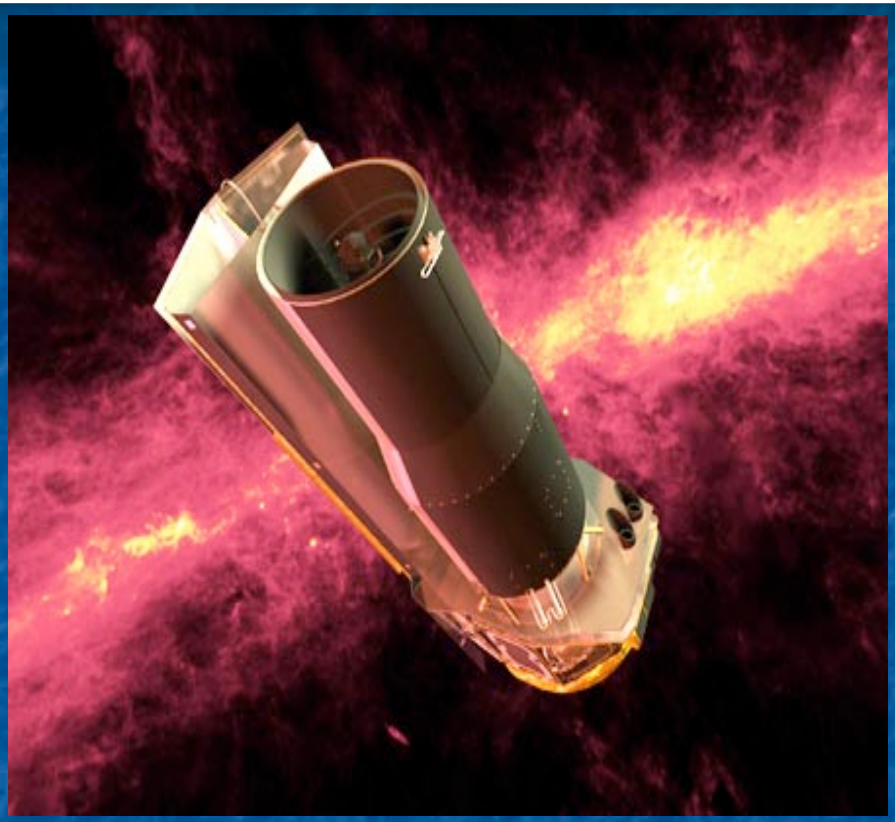
The Electromagnetic Spectrum - Atmospheric windows



The Spitzer Space Telescope

Infrared (3.6 - 160) microns



Mirror = 85cm Diameter

Can find and study much more Distant Galaxies than before
Visible Light is Redshifted into IR

New tool/window for understanding Galaxy Evolution
Dusty Galaxies Radiate in the IR

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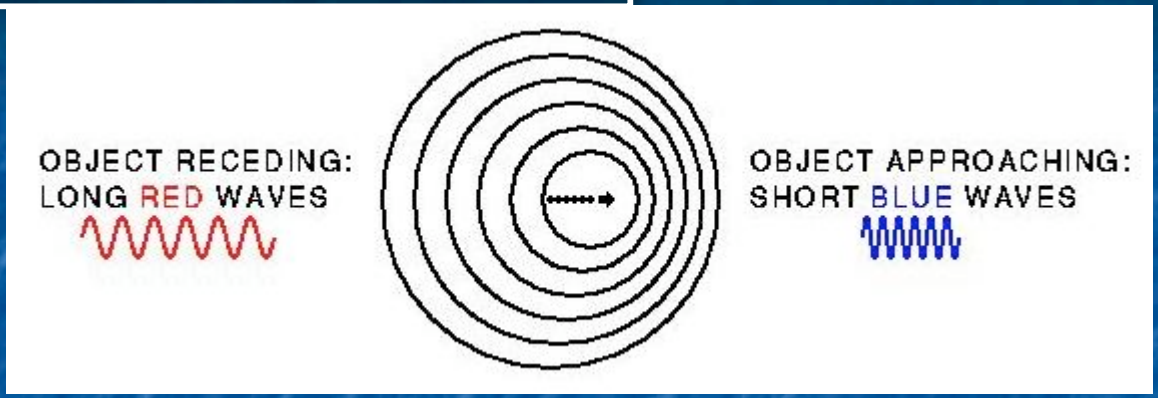
Redshift (z)

See Ned Wright's tutorial
http://www.astro.ucla/cosmol.htm

Doppler red
and blue shifts



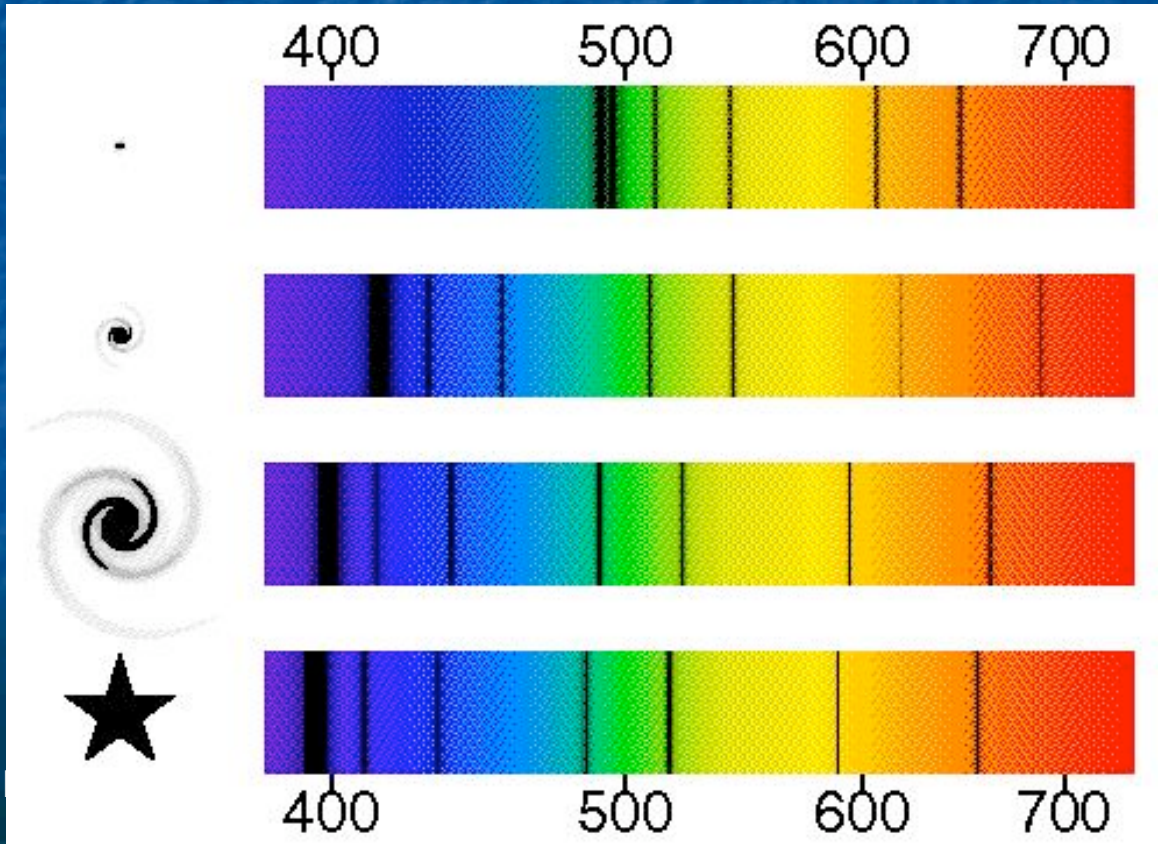
For Even More Distant
Galaxies need IR!!

Most Distant Galaxy

More Distant Galaxy

Nearby Galaxy

Star



The SpARCS Survey

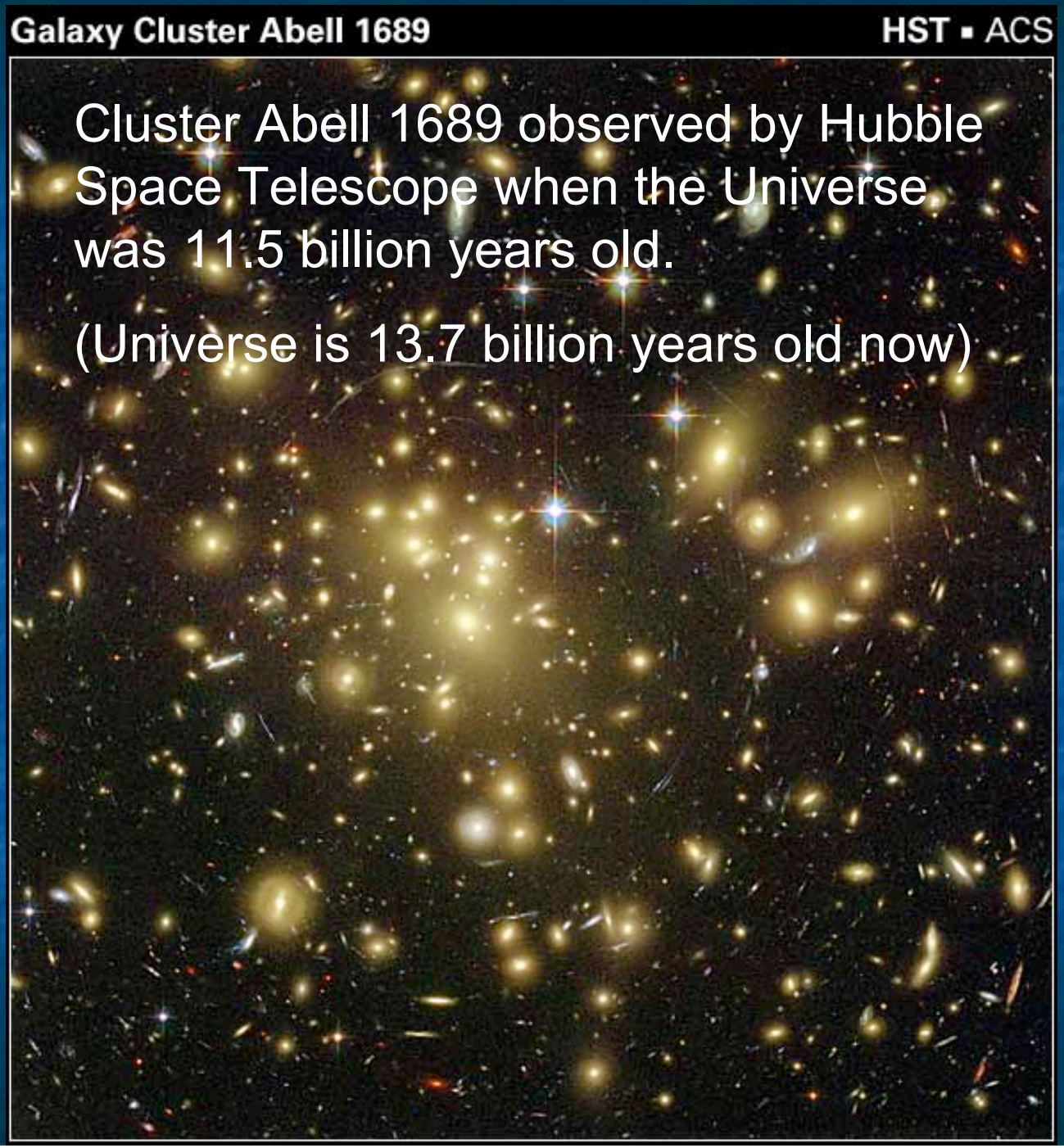
largest every survey of very distant
(< 6 billion years old) Clusters of Galaxies

Example of a nearby cluster of galaxies

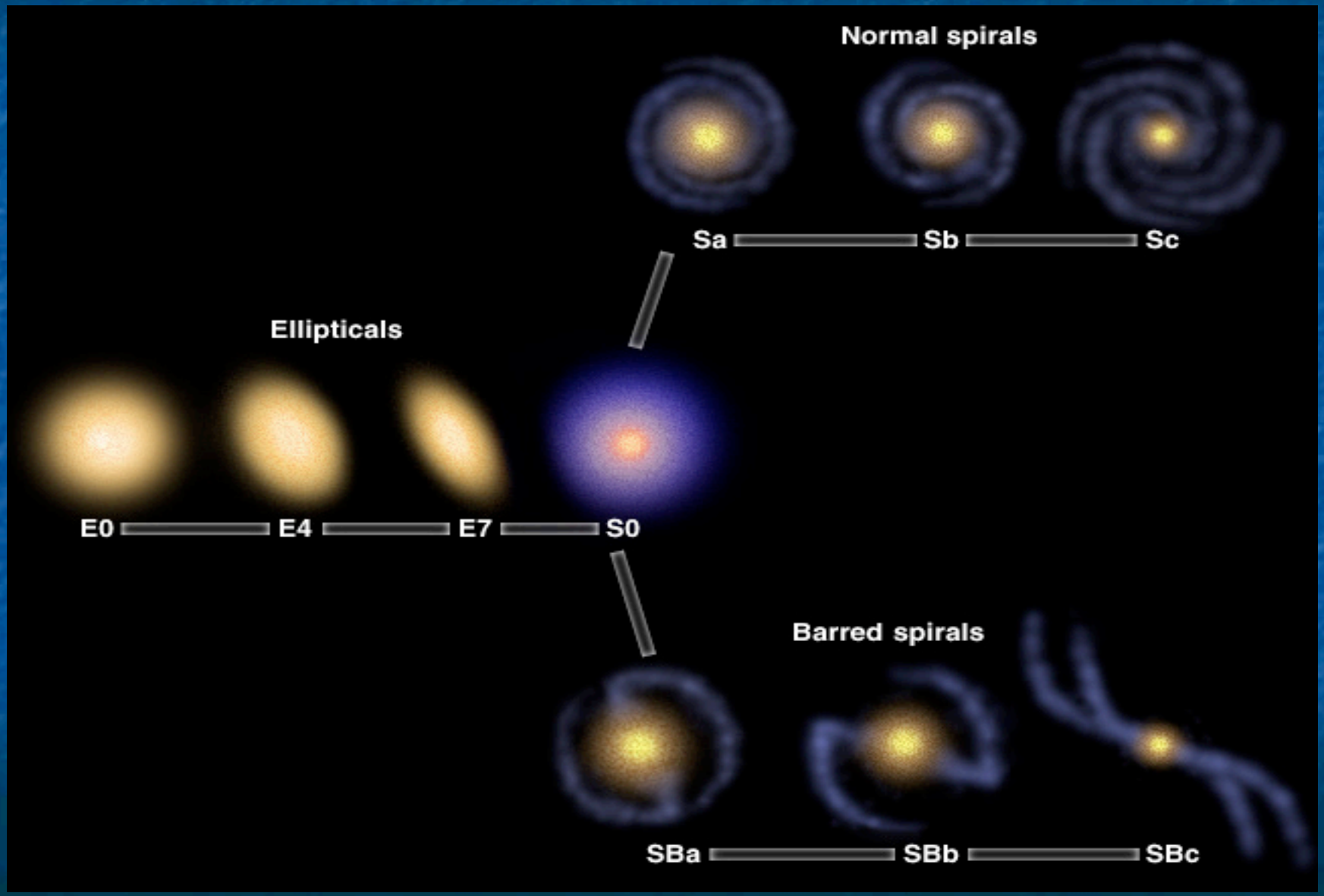
10s-100s of red bulgy "elliptical" galaxies (surprisingly few blue galaxies with "spiral" arms)

+

Dark Matter
Hot Gas



Hubble Tuning Fork Diagram (1926)



The SpARCS Survey

largest every survey of very distant
(< 6 billion years old) Clusters of Galaxies

200 new cluster candidates!

These will be used to study galaxy evolution.

They will also be used measure the amount of dark matter & dark energy in the universe (by counting number of clusters as a function of mass at each epoch).

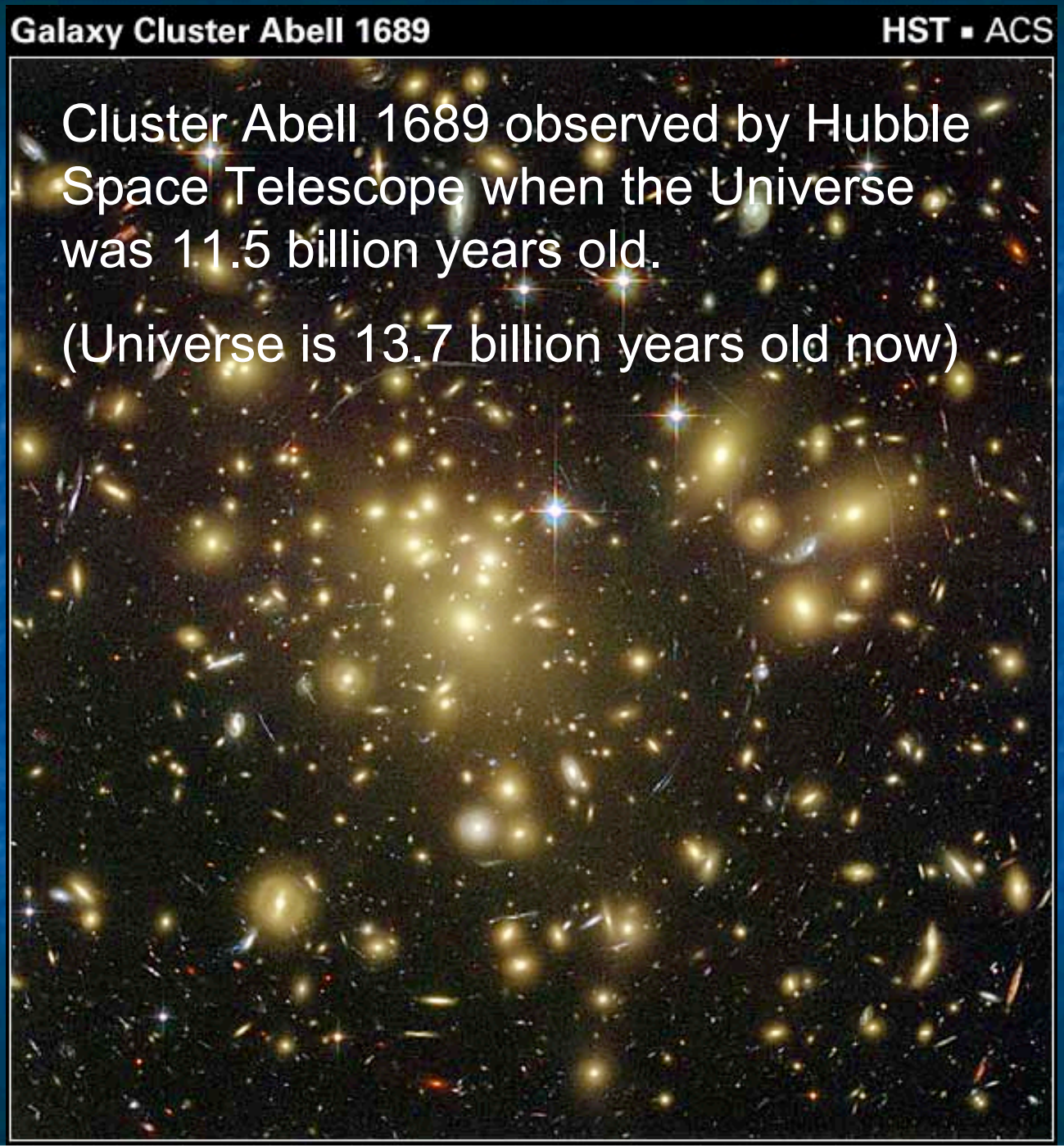
Example of a nearby cluster of galaxies

The more distant the cluster, the younger the cluster.

Why is there such a high fraction of elliptical galaxies?

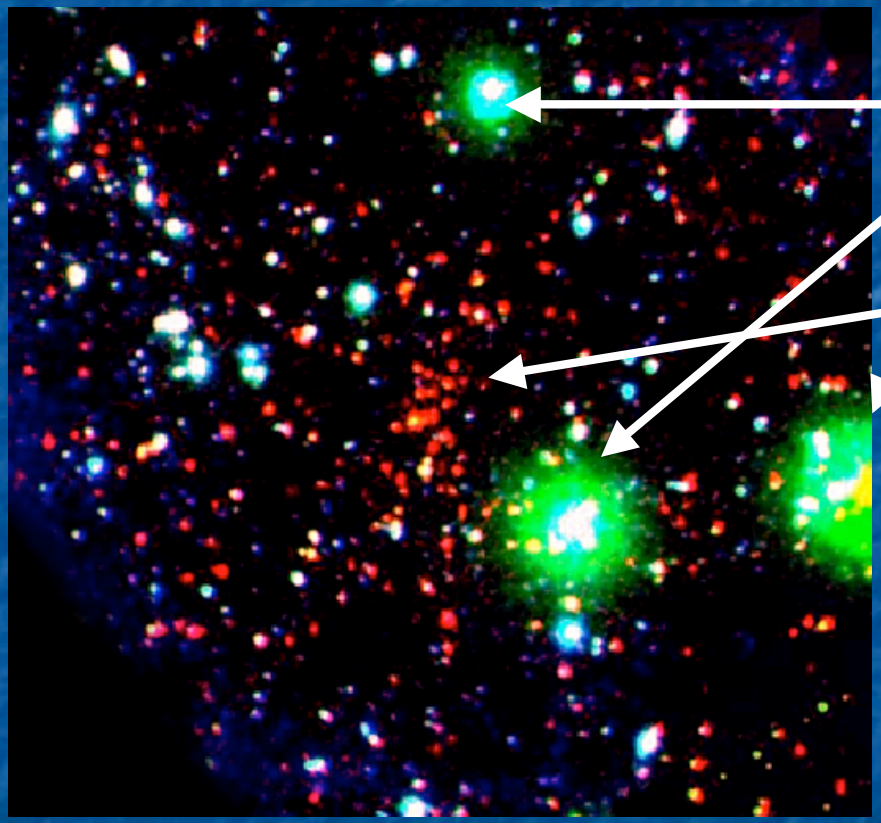
When and how do the elliptical galaxies form?

SpARCS will allow us to study "baby clusters" and answer these questions.



A massive SpARCS cluster observed with Spitzer Space Telescope when Universe was only 4.8 billion years old

This cluster image is blurrier than Hubble Space Telescope image.



Foreground stars in Milky Way Galaxy

These 30 - 50 red galaxies make up the cluster.

We can tell from their velocities (Doppler shift) that they are gravitationally bound.

We can also tell from their red colors that galaxies in this cluster are already very old.

$$M = (9.4 \pm 6.2) \times 10^{14} M_{\mathrm{Sun}}$$

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