How I manage to teach physics in English to 500 students who have no interest

Katsushi Arisaka

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Department of Physics and Astronomy

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Outline

- Overview — 5 min.
- Example of my lectures — 20 min.
  - The very first lecture
  - The lecture on “Eclectic Circuits”
- Technical details — 15 min.
- Open discussion — 10 min.

Total 40 + 10 min.

Brief Introduction to Katsushi Arisaka

- PhD from Tokyo Univ. in 1985
  - Particle physics – Kamiokande Neutrino Experiment
  - Thesis Advisor – Toshi Koshiba, Nobel prize in 2002
- Came to the US with no English training
  - Failed English class as an undergrad student!
- Professor of Physics at UCLA since 1988
  - Research on both Particle Physics & Neuroscience
- Teaching "Electricity and Magnetism"
  - to life science majors (mostly pre-med students) who hate physics
  - ~500 students per year for > 10 years
  - In addition, honors classes (top ~10% students)
- In 2010, awarded the campus-wide "Distinguished Teaching Award"

Mar 24, 2010 · By Wendy Soderburg

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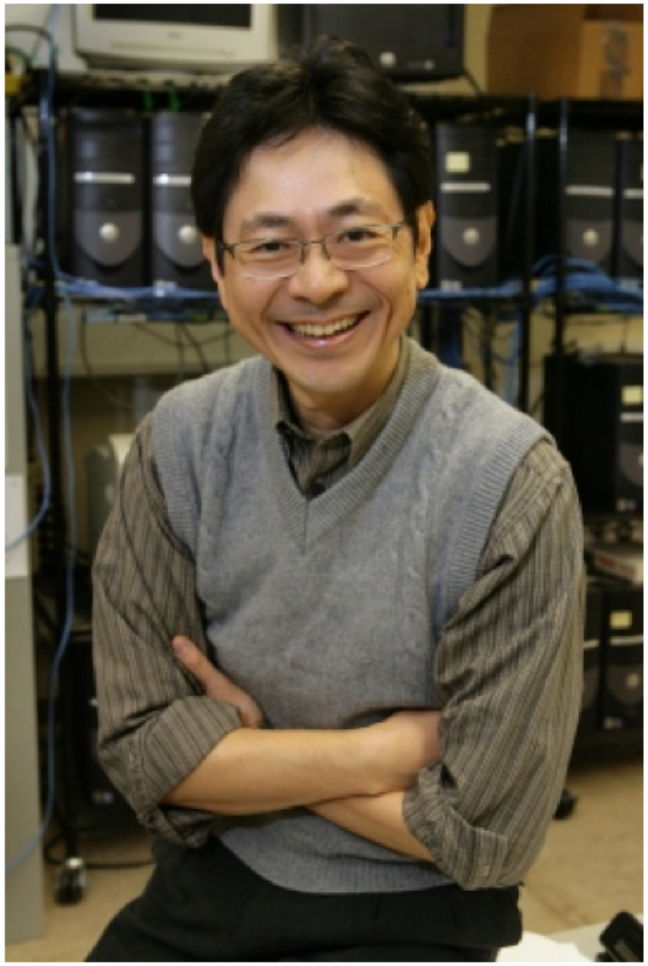
Distinguished Teaching Award Winner

Katsushi Arisaka, professor of physics and astronomy



Undoubtedly, one of the most difficult tasks for an instructor is teaching a subject that many students dread or — worse yet — have no interest in. So it's a special professor indeed who not only manages to get his students to willingly come to class, but also piques their interest in the field.

"I believe that the most critical ingredient of a successful education is the personal relationship between a teacher and a student. I have learned over the years that once I establish a strong personal relationship with the students, they begin to learn by themselves," said Arisaka. "Once students are self-motivated, they start to study in their own way and devote enormous amounts of time because they begin to love physics, rather than hate it."

A high-energy astrophysicist, Arisaka teaches several classes at UCLA, including general astronomy and cosmology; undergraduate and graduate particle physics and cosmology for physics majors; and Physics 6B for life science majors, the class that probably garners Arisaka the most praise.

"Professor Arisaka was in a very interesting position as he taught our physics class for life science students," wrote undergraduate Nora Bardakjian in her letter supporting Arisaka's award nomination. "He had the difficult task of teaching students a subject matter that was not their passion. Yet he strove to integrate the life sciences into his physics class

Interview on "teaching honors students"

A message from a student a few days ago

Dear Professor Arisaka,

As I am sitting here studying for my final, I am just overwhelmed with how grateful I am that I was given the opportunity to take Physics 6B with you this quarter. I just wanted to let you know how much I enjoyed your Physics 6B course throughout this entire quarter! As a Life Science student, I am completely intimidated by the world of physics and tend to perform poorly in all of my physics efforts. Your class is the first physics class I have ever taken that I have thoroughly enjoyed- and actually performed decently as a student!!! I am going to highly recommend you to all of my friends that share my same fear of physics! I sincerely appreciate all of your enthusiasm and encouragement. I have never had a professor care as deeply about their students as you do- and every single one of your students feels the same! I think THAT in itself is the highest testament of your teaching credibility. You are without a doubt the BEST physics professor at UCLA as well as one of my favorite professors I have ever had! Thank you for your hard work and dedication to the class. Thank you for your constant support and words of encouragement. I honestly cannot express how grateful I am that I was able to take a class with you!

Again, thank you so very much! If only UCLA had more Professor Arisaka's on staff!!!! I hope you have a wonderful spring break!

Another message from a student a few days ago

Hi Professor,

I just wanted to send this email to thank you for a truly wonderful quarter and excellent class. Before this quarter, I was not really interested in physics and came into this course with caution. However, I did not expect to enjoy this class so much and learn so many things not only about physics but about nature and the world around us. I sincerely hope that I will be able to take another course with you at some point in my life and highly recommend you to anyone that asks!

In addition, given the recent events in Japan and the other countries, I really hope that all of your families and friends are safe and healthy and express my well wishes to all of them.

Thank you again for such an amazing class!

> 10 mails like this, shortly after the last lecture

Key points of today's talk

- How to create the excitement of learning physics, when students actually hate it?
- Time is short, but even within 10 weeks, there is a way to accomplish the mission.
- It is NOT a question of English, but a question of communication skills with students.

Important Goals

- Connect the topics with students' own daily life and their interests
- Instructor's personal relation with students
- Define the concrete goal of learning clearly

- Ultimate purpose : Change their life and their way of thinking forever.

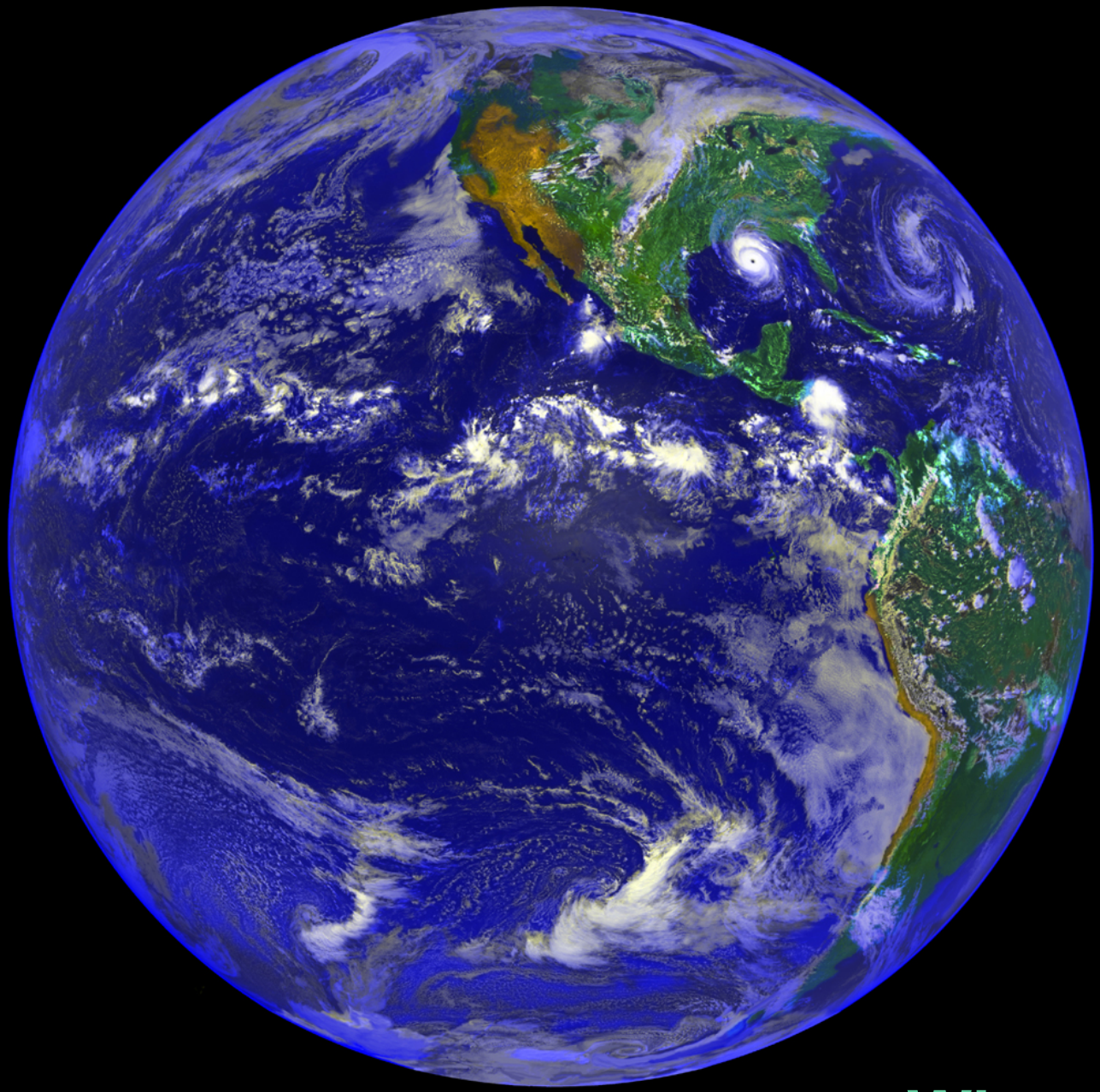
Physics 6B -- Physics for Life Science Majors: Waves, Electricity and Magnetism

Winter 2011, Lecture 2 & 3

Lectures:	Mon/Wed/Fri	PAB 1425
	Lecture 2: 12:00-12:50PM	Lecture 3: 1:00-1:50PM
Instructor:	**Katsushi Arisaka**, Professor of Physics and Astronomy	
Office:	Knudsen Hall 4-145	Phone: (310) 825-4925
	E-mail: mailto:arisaka.6b@gmail.com	
Home Page:	http://ccle.ucla.edu/course/view/11W-PHYSICS6B-2	
Secretary:	Cassandra Gonzalez	
	Knudsen Hall 4-144	Phone (310) 825-3441
	E-mail: mailto:gonzalez@physics.ucla.edu	
Text Book:	Giancoli (9780558824518) Forth edition	
	Physics for Scientists & Engineers	
	Volume 1 (Chapter 14 – 16)	
	Volume 2 (Chapter 21 – 31)	
Supplement:	Physics 6B Laboratory Workbook	
	Mastering Physics	
Grading:	1st Midterm	10%
	2nd Midterm	15%
	Final	45%
	Lab	15%
	Home works	15%

The Very First Lecture (Jan 3)

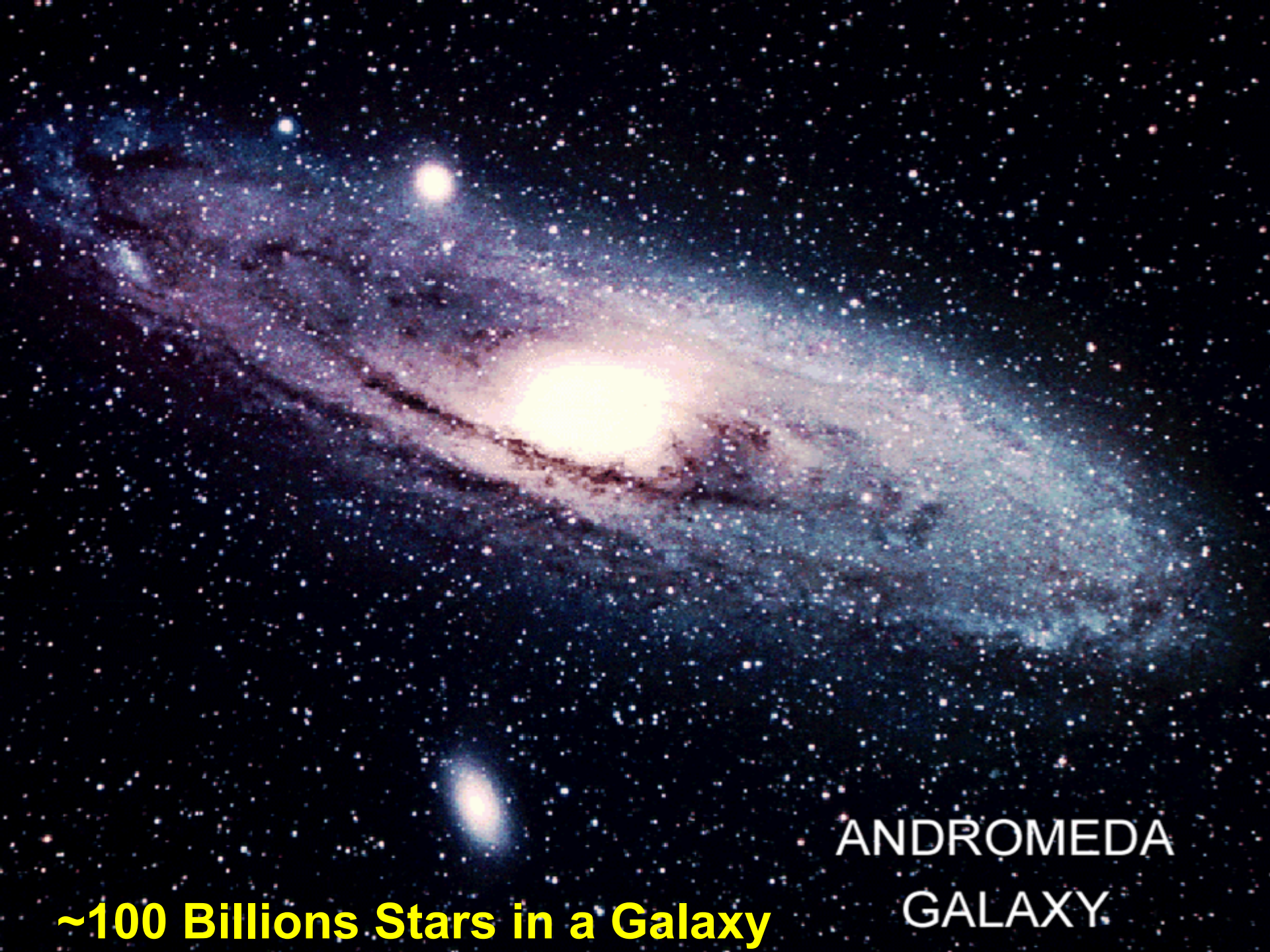
- Connect physics with student's their own interests
- Show instructor's own excitement in physics



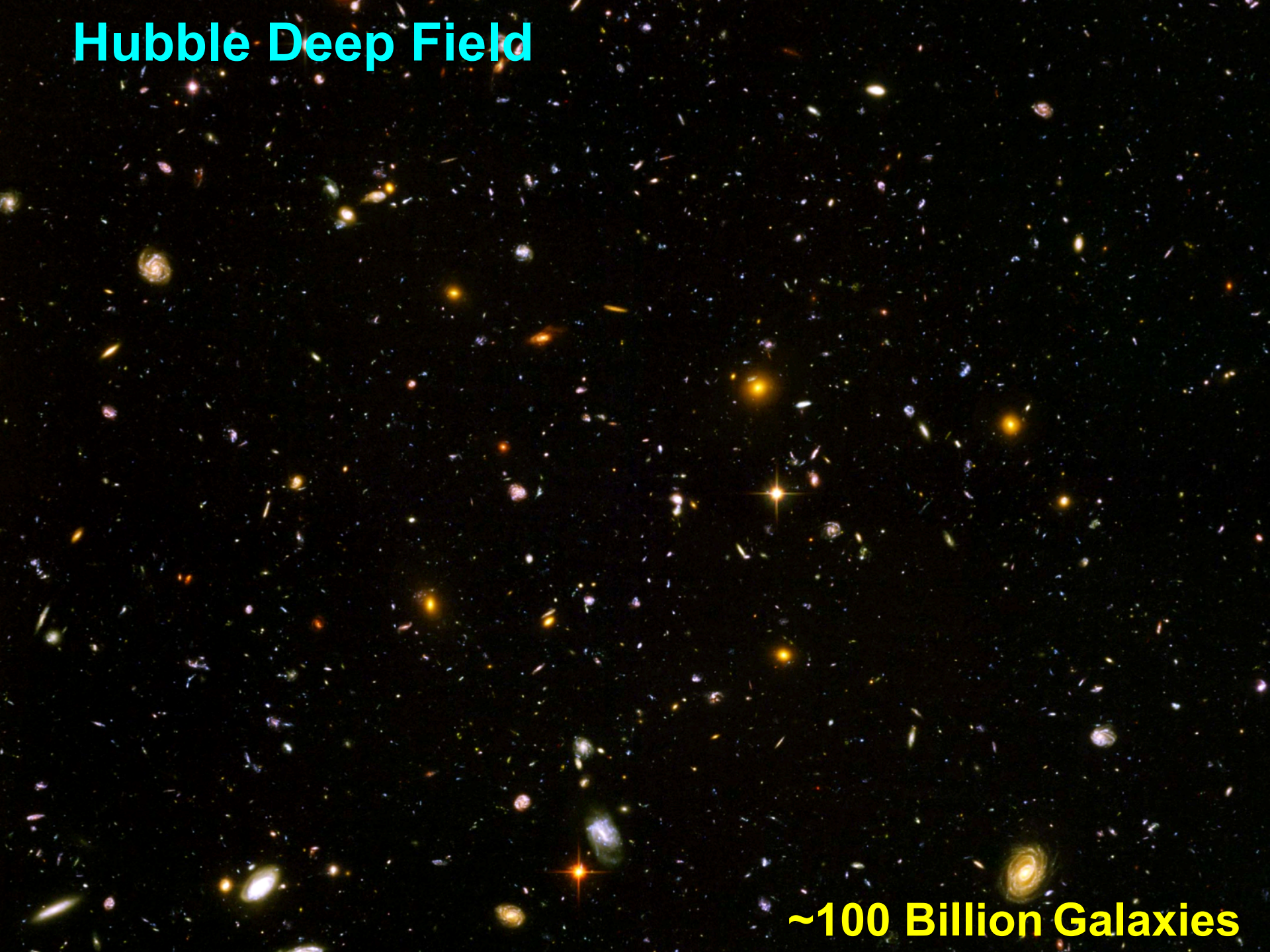
Why are we here?

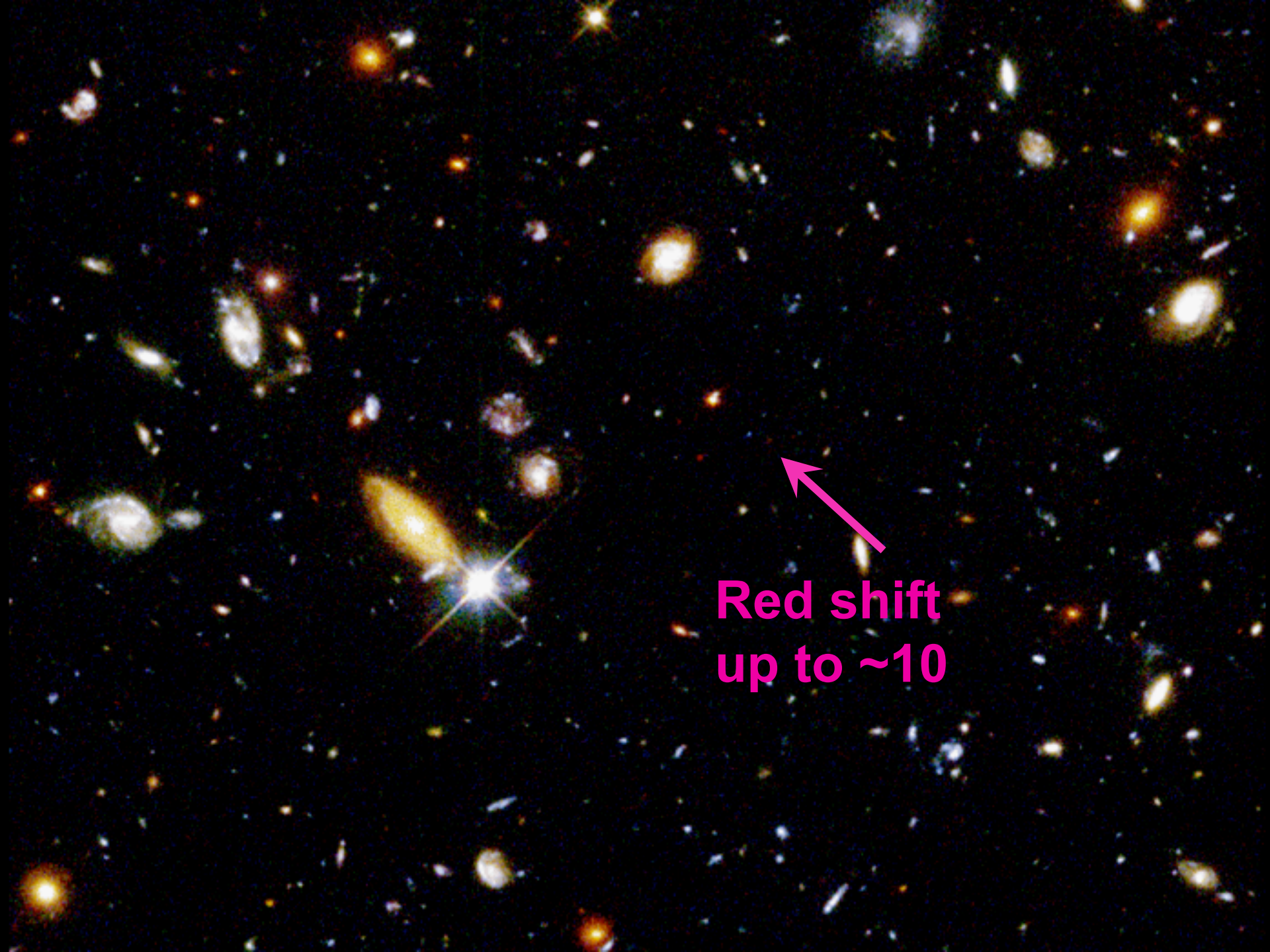
Central Theme

- **Why are we here?**
  - Origin of Ourselves — History
  - Origin of Life — Biology
  - Origin of the Solar System — Astronomy
  - …
  - Origin of Atoms — Particle Physics
  - Origin of the Universe — Cosmology
- **What is the most fundamental laws in nature?**



~100 Billions Stars in a Galaxy


Hubble Deep Field
~100 Billion Galaxies


Red shift
up to ~10

Hubble's Law: Expansion of the Universe

Horizon of Universe

14 Billon Light Years

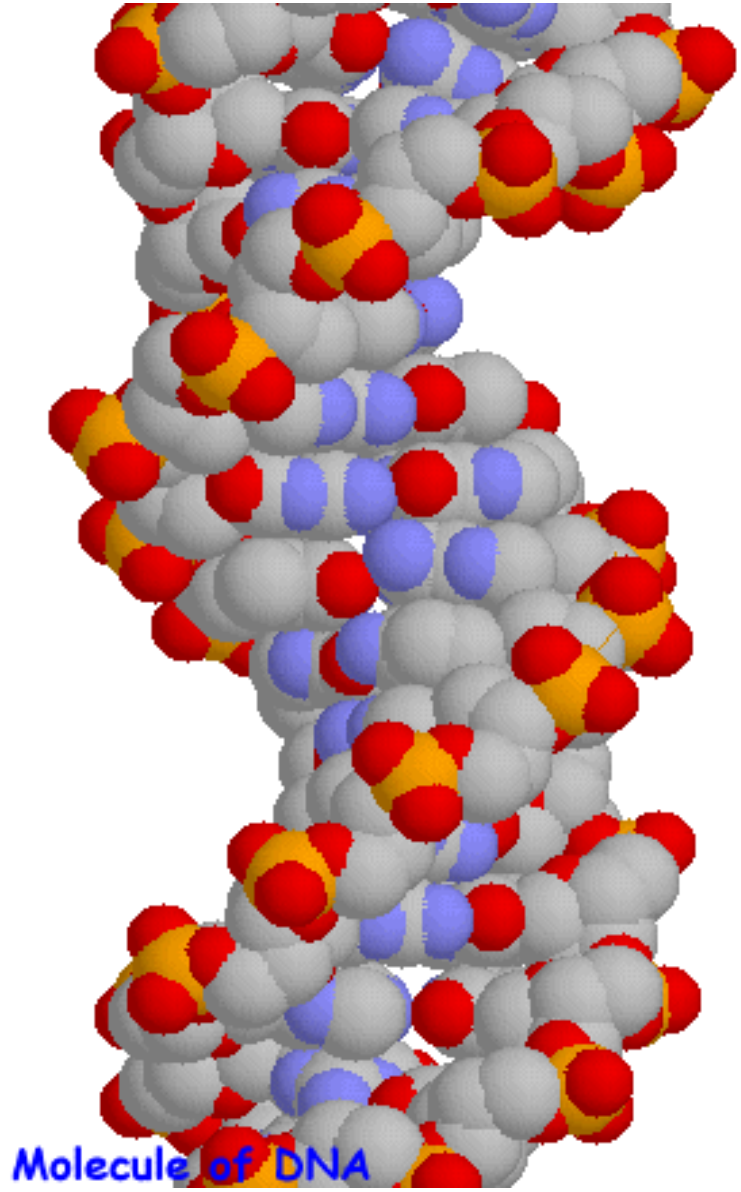
Moving Away at Speed of Light

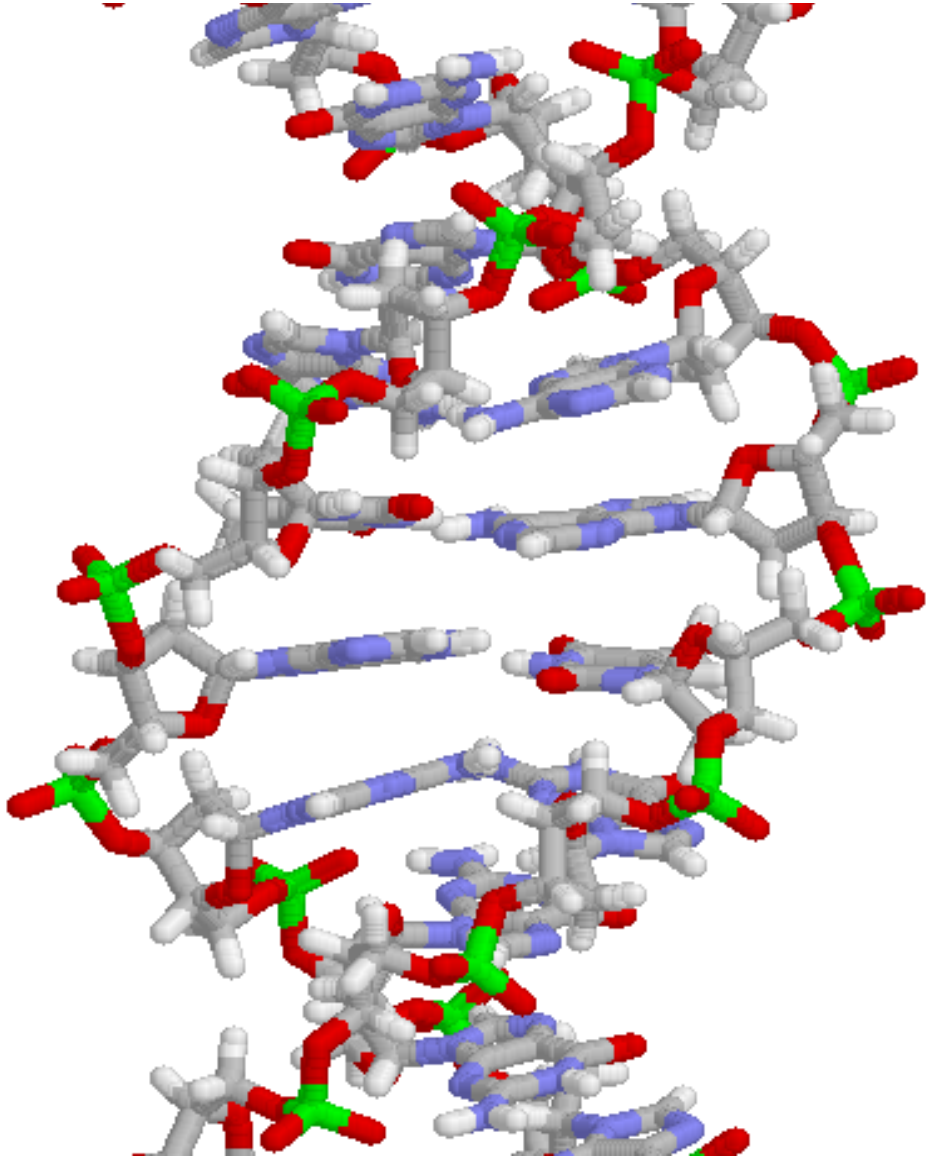
Physicists' View of Early Universe

Fiat lux

Let there be light

Structure of DNA





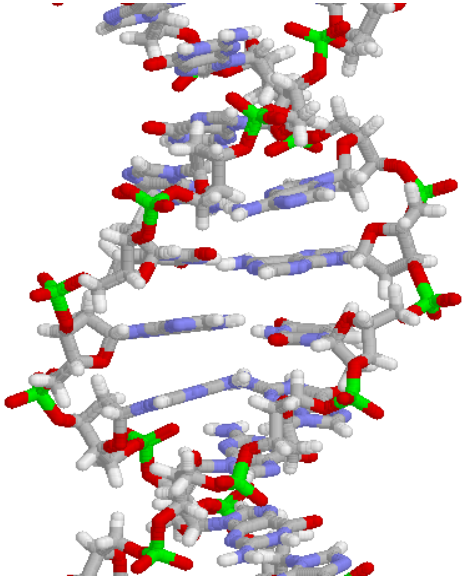
Symmetry Breaking

Time
0
1B years
2
3
4
5
6
7
8
9
10
11
12
13
14

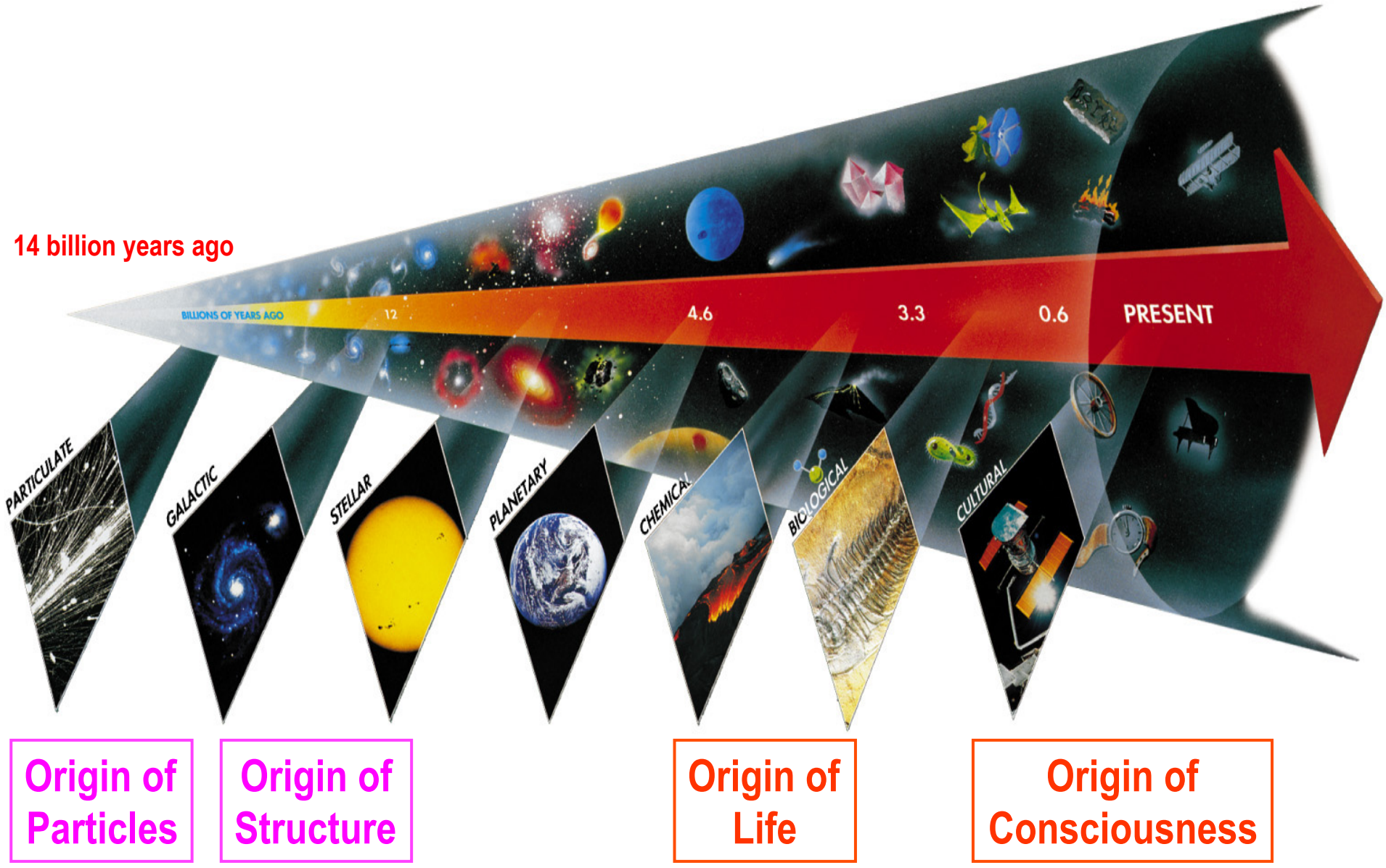
Simple

Symmetry Break Down

Complex



Seven Phases of Cosmic Evolution



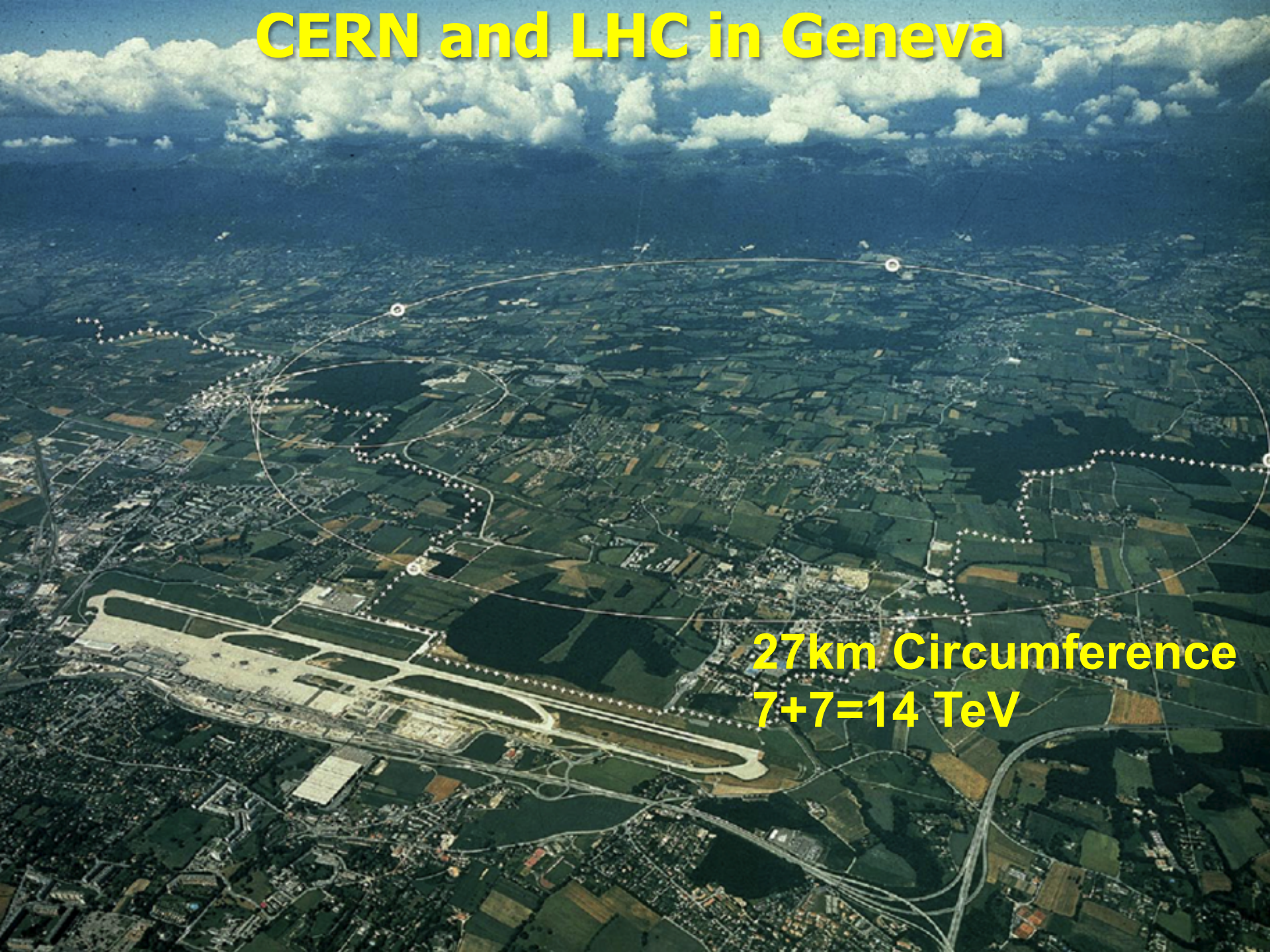
Origin of Particles

Origin of Structure

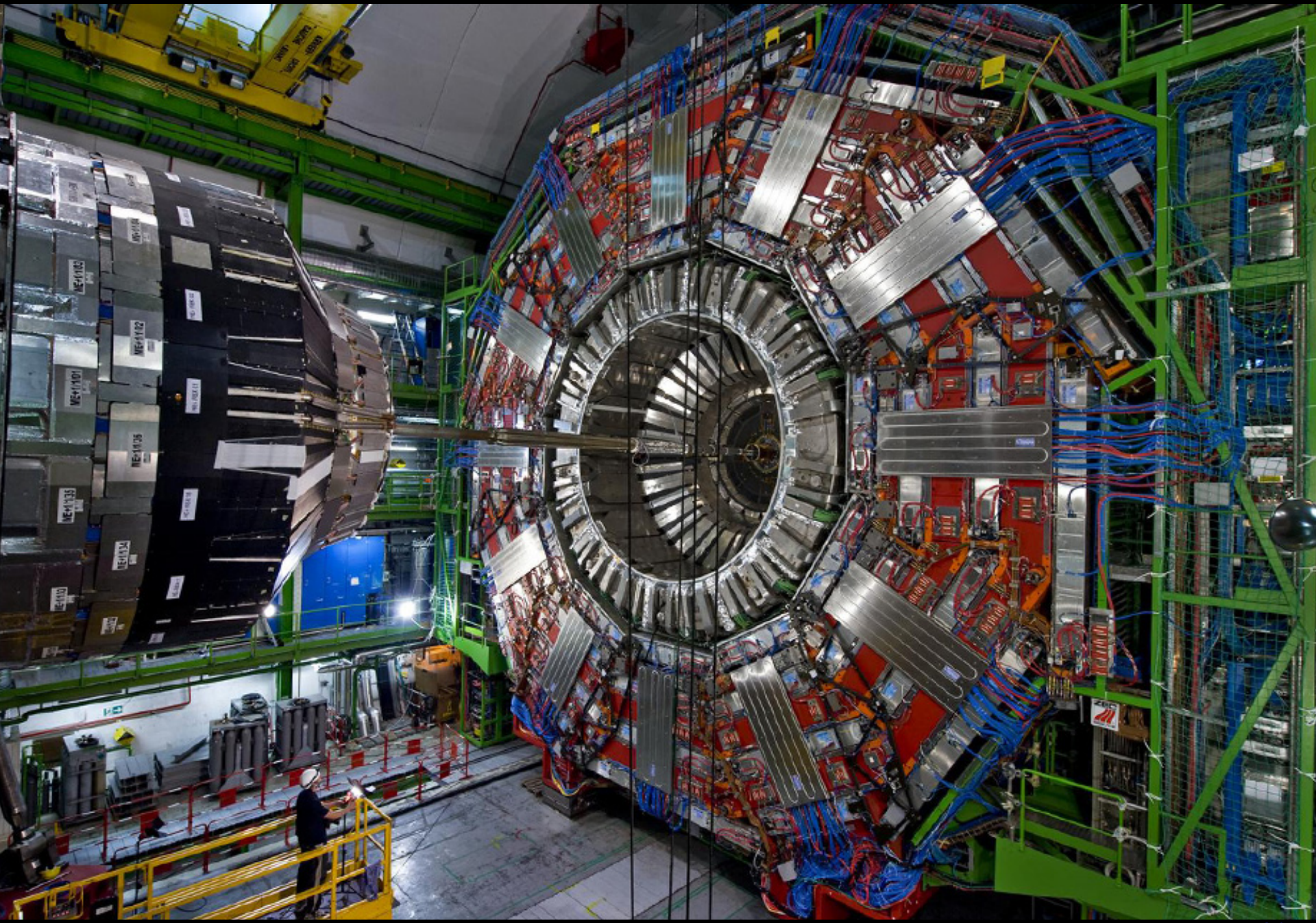
Origin of Life

Origin of Consciousness

CERN and LHC in Geneva



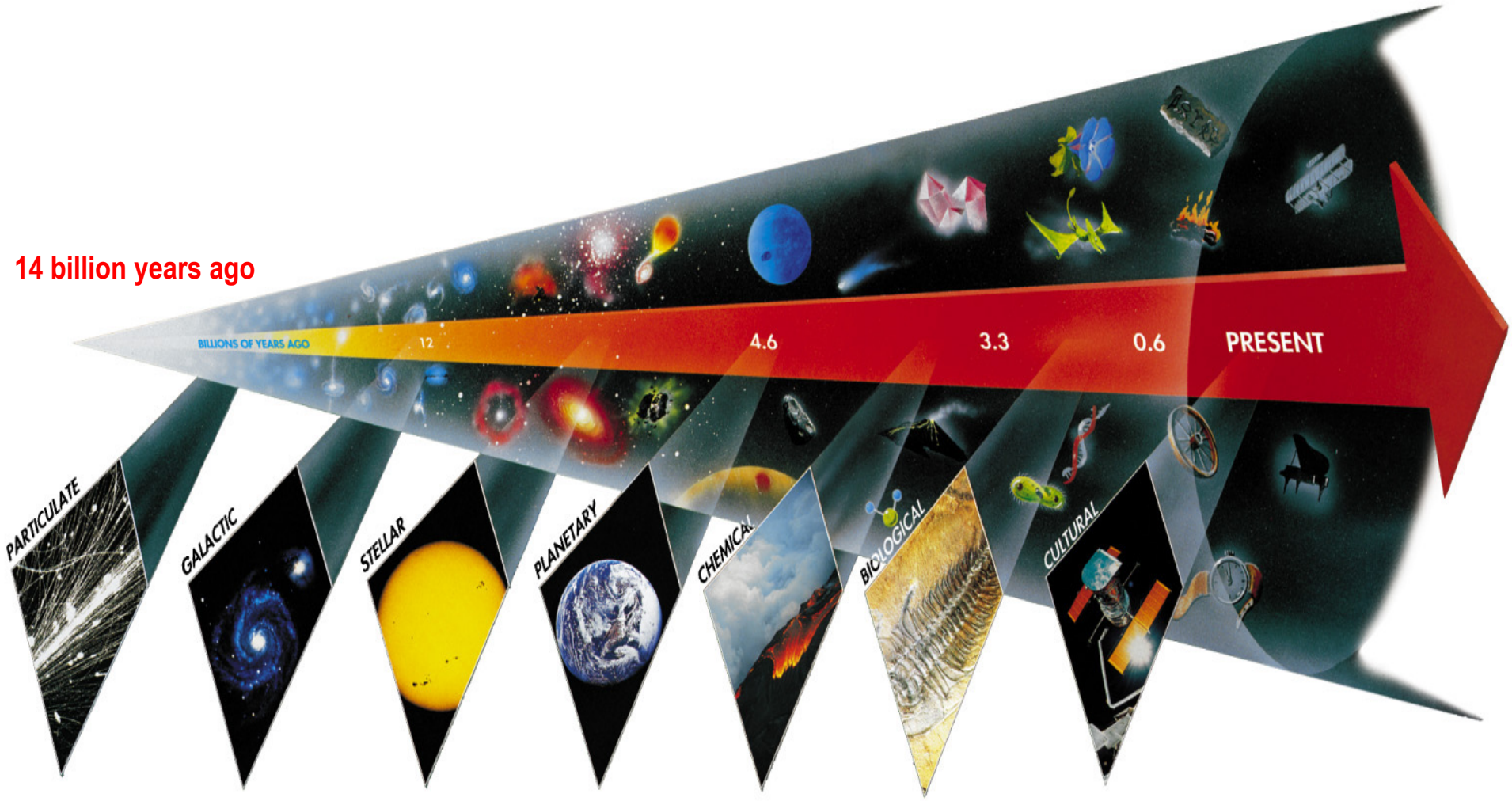

LHC Tunnel with Magnets



Particle detectors constructed at UCLA Now at LHC, CERN

Sept 15, 2008 Issue

Seven Phases of Cosmic Evolution



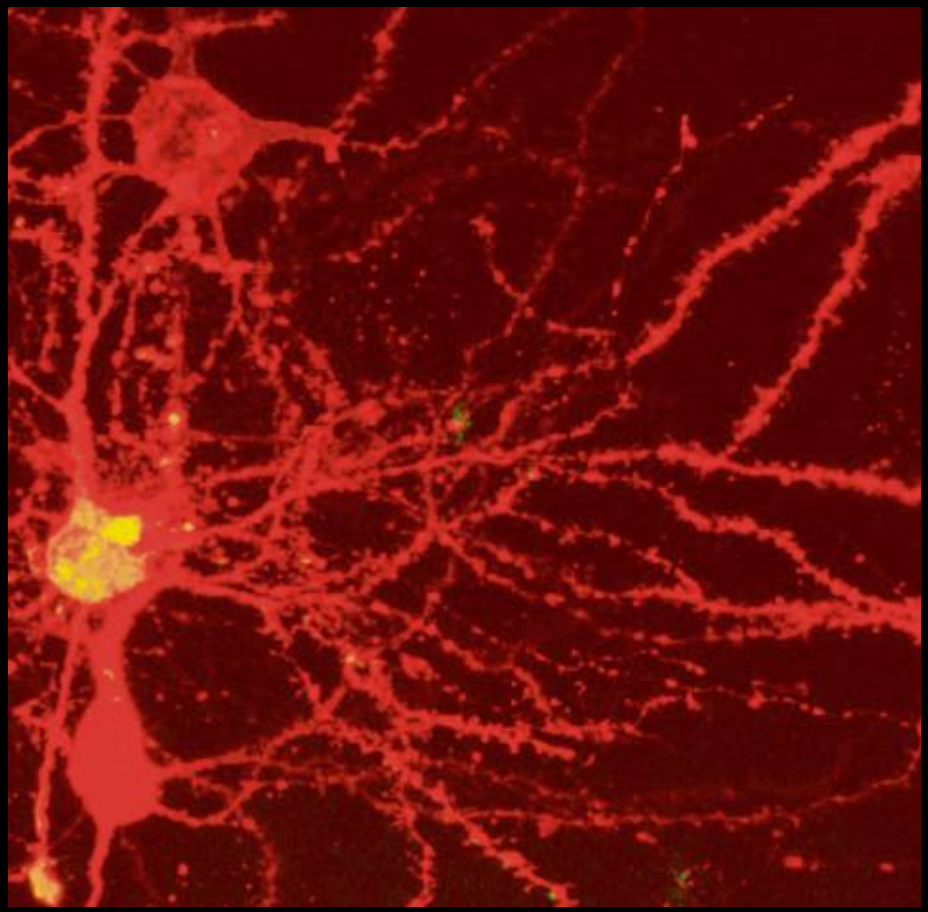
Origin of Particles

Origin of Structure

Origin of Life

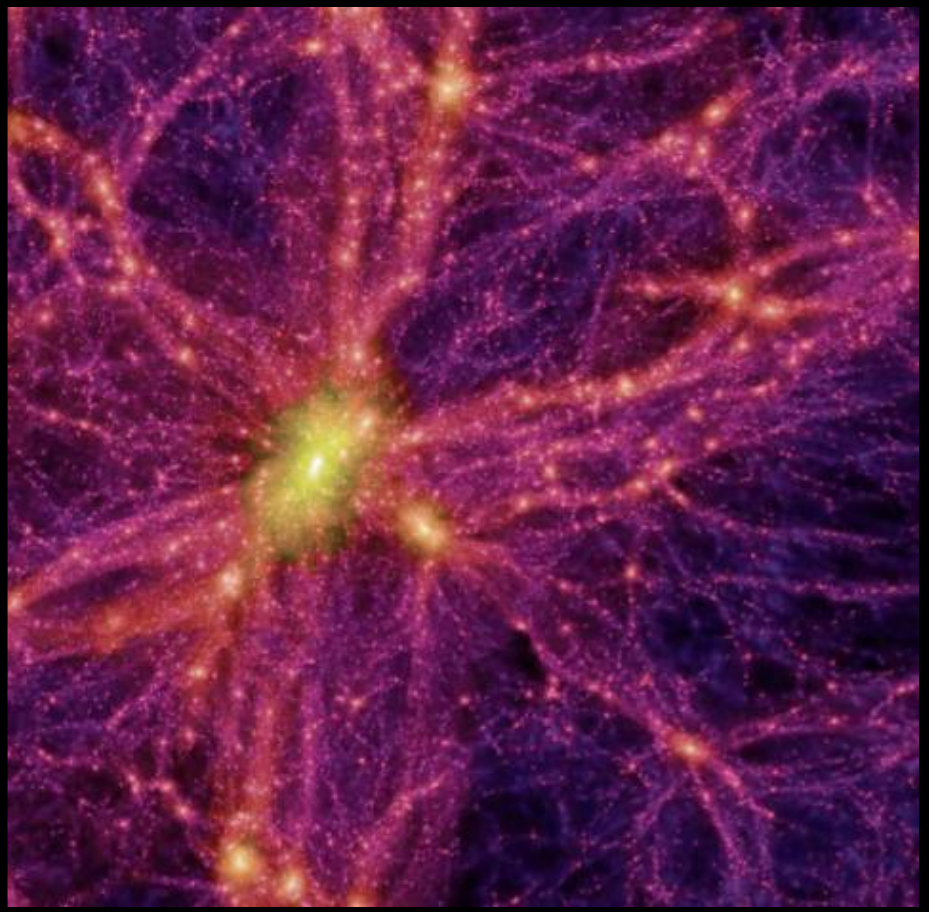
Origin of Consciousness

Brain



100 Billions Neurons

Universe



100 Billions Galaxies

New York Times 8/21/2006

Lecture on Electric Circuits (Feb 18)

- Connect "boring circuits" to
  - The most advanced computer system – IBM's Watson
  - The most advanced circuits in nature – our own brain
- Introduce my own researches when appropriate:
  - Brain imaging by high-speed optical microscopes

IBM's Watson on 'Jeopardy': The machine has won

February 16, 2011 | 9:11 pm (42) (19) Comments (2)

The machine has won.

Watson defeated the two biggest "Jeopardy" winners of all time: Ken Jennings and Brad Rutter.

The IBM computer finished the final round of competition on Wednesday night with $77,147 in winnings over Jennings' $24,000 and Rutter's $21,600.

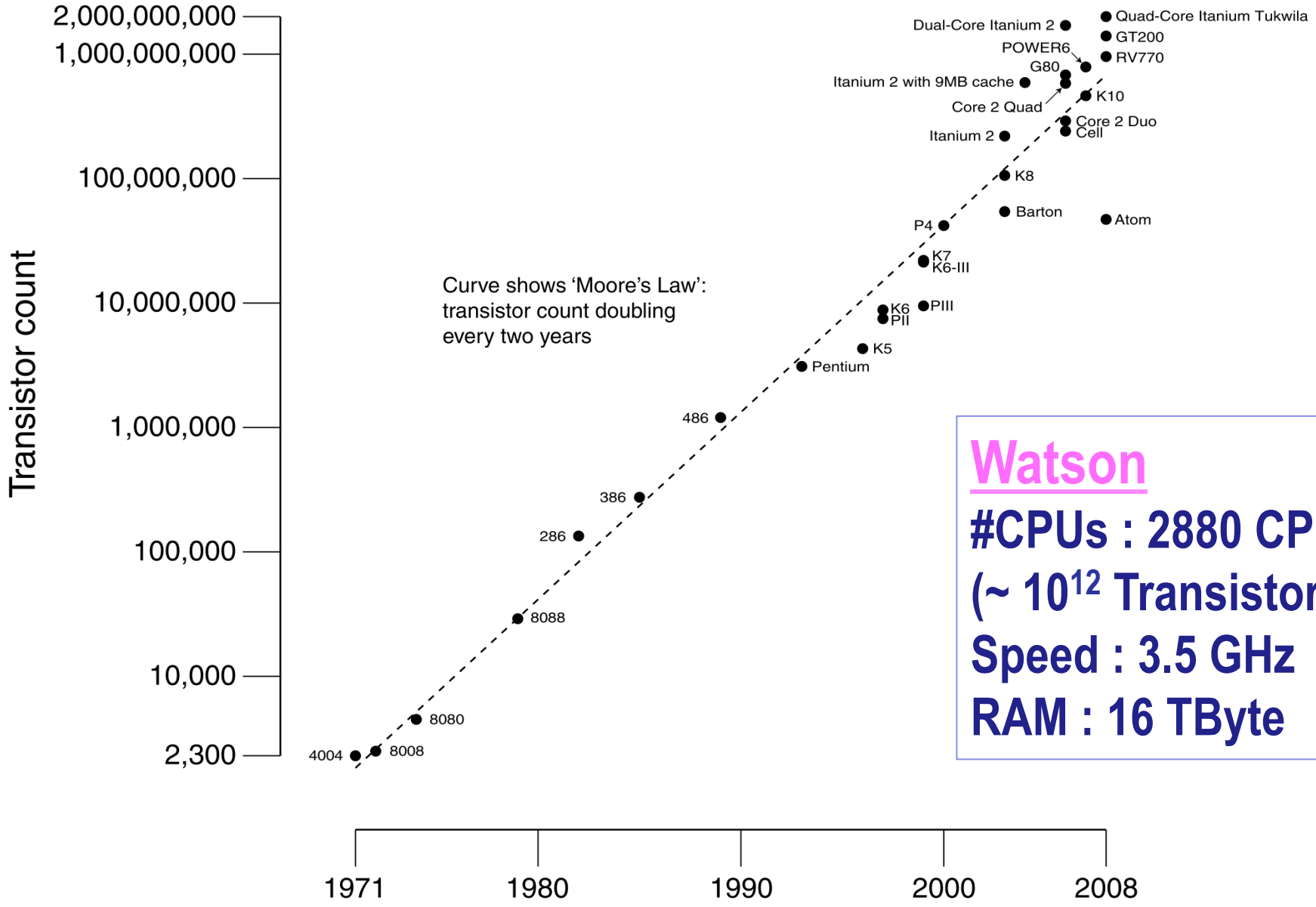
Jennings holds the record for number of consecutive Jeopardy matches won, with 74. Rutter has won more money than anyone else on Jeopardy.

The two men competed against each other in a 2005 tournament that resulted in a Rutter victory.

Since Watson won, IBM is awarded $1 million -- all of it going to charities World Vision (an anti-poverty group) and World Community Grid (which builds computer grids to address social issues such as water shortages).

Transistors in Computer

Watson



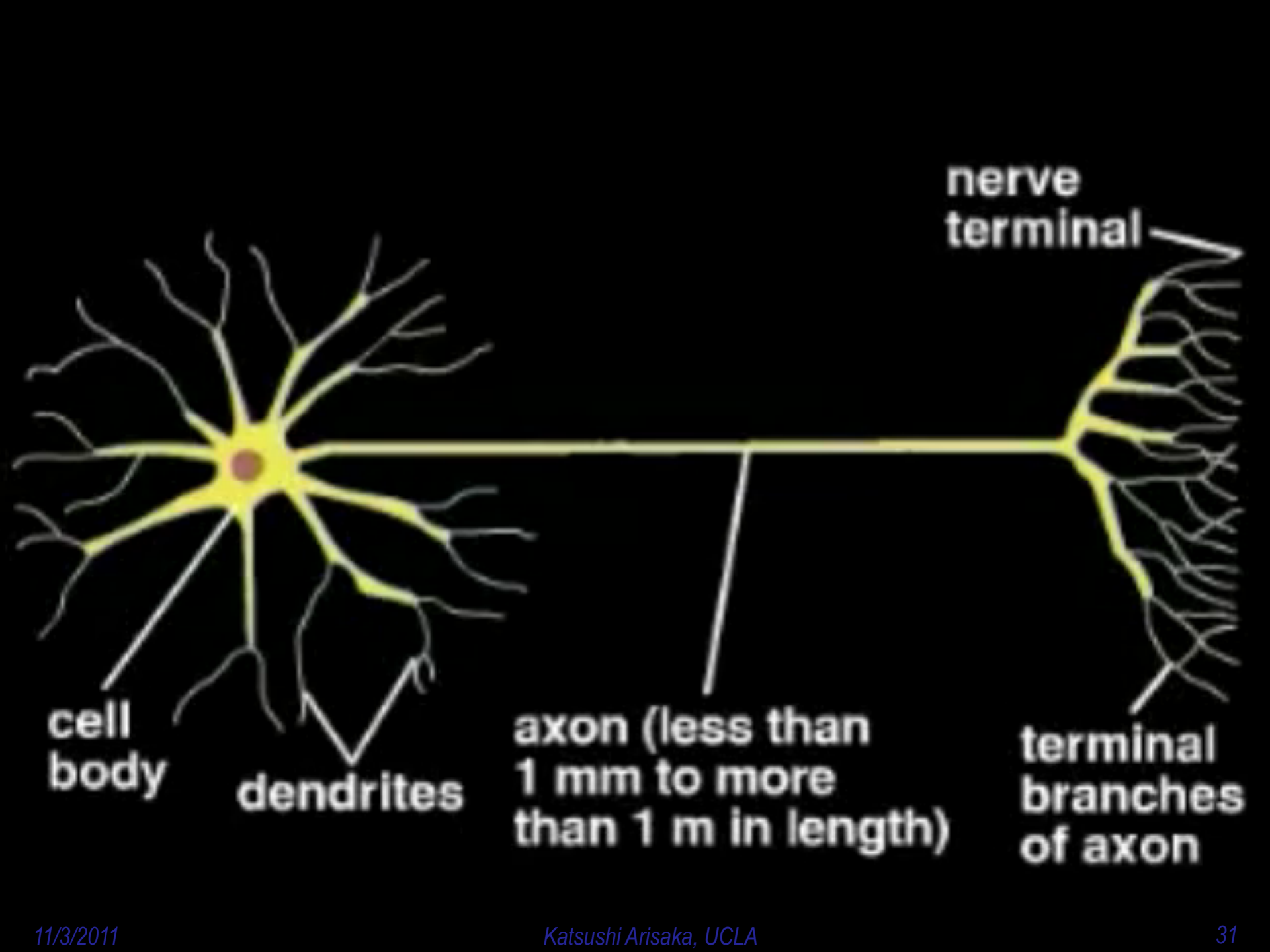
Watson

#CPUs : 2880 CPU

(~ 10^{12} Transistors)

Speed : 3.5 GHz

RAM : 16 TByte


nerve terminal
cell body
dendrites
axon (less than 1 mm to more than 1 m in length)
terminal branches of axon

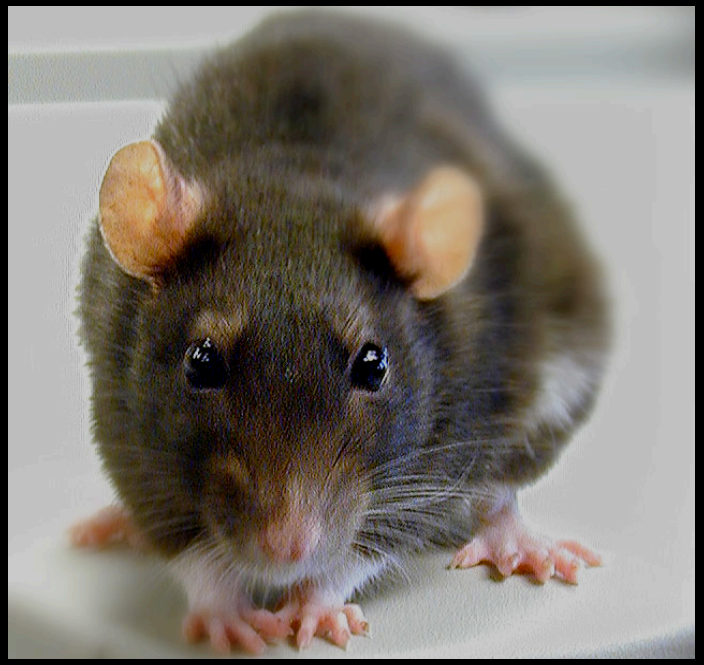
From No Brain to Big Brain

Paramecium (Single Cell)

Lymnaea (~1,000 neurons)

Zebrafish (~10,000 neurons)

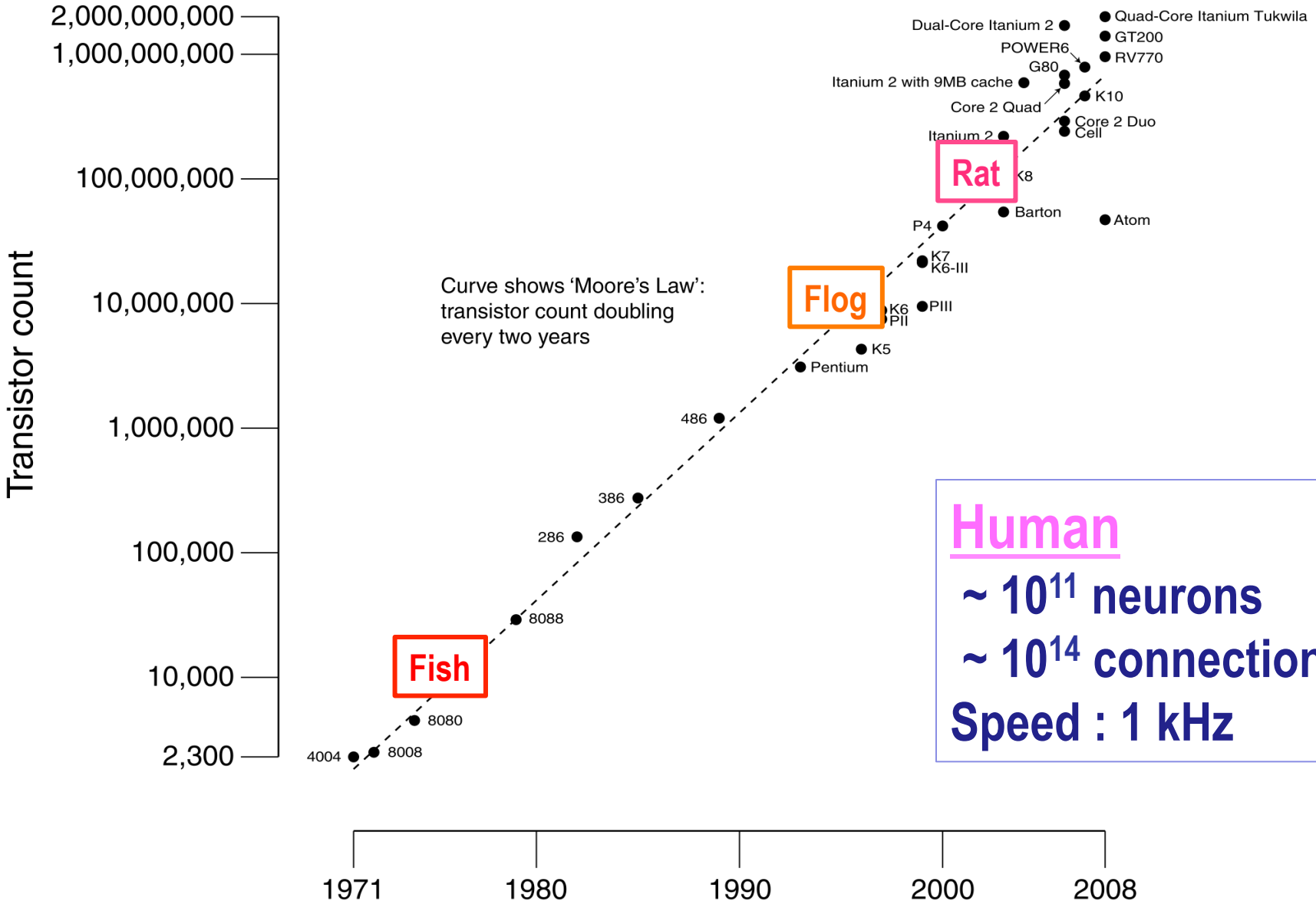
Bullfrog (~10^7 neurons)



Rat (~10^8 neurons)

Neurons in Brain

Human



Human

~ 10^{11} neurons

~ 10^{14} connections

Speed : 1 kHz

Computer vs. Brain

	Computer	Human Brain
Key Unit	Transistor	Neuron
No. of units	~ 10^9	~ 10^{11}
Connection	Copper Wire	Axon + Dendrite
No. of Connections	~ 10^{10}	~ 10^{14}
Signal Carrier	Electrons	Ions (Na+, Ca+, K+)
Clock Speed	~ 1 GHz	~ 1 kHz
Method	Sequential	Parallel Processing

Arisaka's high-speed Microscope

UCLA Newsroom on January 11, 2011

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New UCLA-designed microscope records firing of thousands of individual neurons in 3-D

Imaging system could help reveal 'miscommunications' in autism, schizophrenia

By Mark Wheeler | January 11, 2011

Some disorders of the brain are obvious — the massive death of brain cells after a stroke, the explosion in the growth of cells that marks a tumor. Other disorders, such as autism, schizophrenia and mental retardation show no physical signs of damage and are believed to be caused by problems in how brain cells communicate with one another.

To understand the root of the problem of these latter diseases, visualizing brain activity is key. But even the best imaging devices available — fMRIs and PET scans — can only give a "coarse" picture of brain activity.

UCLA neuroscientists have now collaborated with physicists to develop a non-invasive, ultra–high-speed microscope that can record in real time the firing of thousands of individual neurons in the brain as they communicate, or miscommunicate, with each other.

"In our view, this is the world's fastest two-photon excitation microscope for three-dimensional imaging *in vivo*," said UCLA physics professor Katsushi Arisaka, who designed the new optical imaging system with UCLA assistant professor of neurology and neurobiology Dr. Carlos Portera-Cailliau and colleagues.

Their research appears in the Jan. 9 edition of the journal Nature Methods.

Because neuropsychiatric diseases like autism and mental retardation often display no physical brain damage, it's thought they are caused by conductivity problems — neurons not firing properly. Normal cells have patterns of electrical activity, said Portera-Cailliau, but abnormal cell activity as a whole doesn't generate relevant information the brain can use.

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310-794-2265
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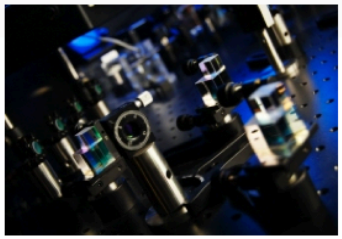
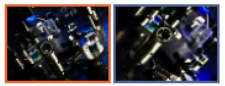
Related Images

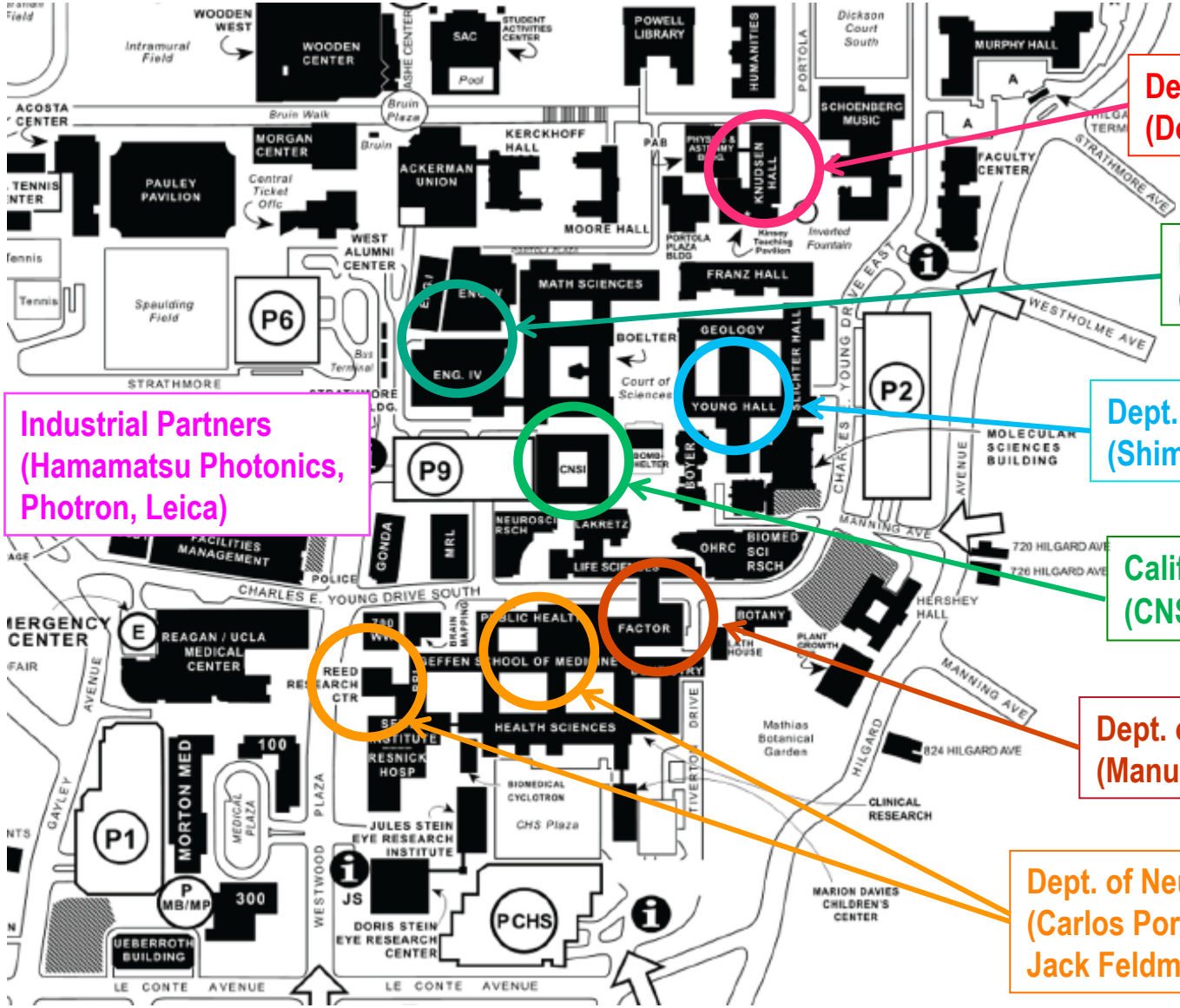


STEM microscope designed at UCLA



View All Images

Arisaka's Campus-wide Collaborations on High-Speed Bio-imaging



Dept. of Physics & Astronomy (Dolores Bozovic, Mayank Mehta)

Dept. of Electrical Engineering (Bahram Jalali)

Dept. of Chemistry & Biochemistry (Shimon Weiss)

California Nano Systems Institute (CNSI, Laurent Bentolila)

Dept. of Surgical Oncology (Manuel Penichet)

Dept. of Neurology & Neurobiology (Carlos Portera-Cailliau, Jack Feldman, Tom Otis)

Industrial Partners (Hamamatsu Photonics, Photron, Leica)

Some Technical Details

1. Easy-to-follow lecture style
2. Complete lecture notes & Webcasts
3. Massive e-mail distribution for intense personal communication (every day)
4. Special office hours for students below average.
5. Extensive sample exams and review sessions
6. Only conceptual questions in the exams

1. Lecture Organization

- Always quick review of the previous lecture in the first 5 minutes (to refresh their brains.)
- At least one eye-catching demonstration before introduction of a new concept of the day (to get the maximum attention from the students).
- Only one new important concept per lecture (that is the maximum students can absorb.)
- Absolutely minimum mathematical derivation on a black board (to emphasize physics.)
- Enormous examples from daily life and bio/medical examples in class, usually every 5 minutes

An example of announcement

Announcement on 3/11 (Fri)

- **Final Exam**
  - 3/15(Tue) 11:30 – 2:30 at Ackerman Union Grand Ballroom
  - Please read my e-mail this morning.
- **Extra reviews & office hours by TA:**
  - 3/11 (Fri) 5:00 – 6:50 pm Review by John (KNSY PV 1220B)
  - 3/14 (Mon) 1:00 – 4:00 pm Office hours by Daniel (PAB 2434)
- **Sample Exam for the Final**
  - You are ready to do all the problems.
  - Study all the sample exams for the midterms.
  - Most of solutions provided on Web. (no more will be provided.)
- **Tutorial 9**
  - Posted on Web, due on 3/13 (Sun) 2 am as usual.
  - There will be no Homework 9.

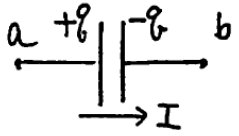
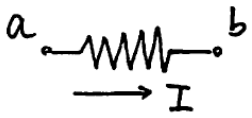
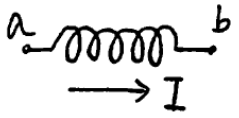
2. Lecture Note & Webcasts

- Students can purchase the complete lecture notes at the beginning of the 10 week course.
- Only ~60% of textbook covered.
- Summary of the materials
- Webcasting all the lectures

Covered chapters in Textbook

	Chapter	Contents	Important	Covered	Not covered
	14	Oscillations	1, 2, 3	4, 5, 6	6, 7, 8
	15	Wave Motion	1, 2, 3, 4, 6, 9	7, 8	10, 11
	16	Sound	1, 3, 4, 7	2, 8, 9	5, 6
First Midterm					
	21	Electric Charge and Electric Field	1, 2, 3, 5, 6, 8, 9	4, 10, 12	7, 11, 13
	22	Gauss's Law	1, 2, 3		4
	23	Electric Potential	1, 2, 3, 8		4, 5, 6, 7, 9
	24	Capacitance, Electric Energy	1, 2, 3, 4	5	6
	25	Electruc Currents, Resistance	2, 3, 5, 6, 7	1, 4, 9, 10	8
	26	DC Circuits	2, 3	1, 4	5, 6, 7
Second Midterm					
	27	Magnetism	1, 2, 3, 4	6, 9	5, 7, 8
	28	Sources of Magnetic Field	1, 2, 3, 4, 5	7	6, 8, 10
	29	EM Induction and Faraday's Law	1, 2, 3	4	5, 6, 7, 8
	30	Inductance, EM Oscillations	2, 3, 5	4	1, 6, 7, 8, 9, 10, 11
	31	Maxwell's Euqations and EM Waves		1, 2, 3, 4, 5, 6	7, 8, 9, 10
Final Exam					

Summary of CRL

	Capacitance	Resistance	Inductance
Symbol	C  Capacitor	R  Resistor	L  Inductor
Unit	Farad (F)	Ohm (Ω)	Henry (H)
Definition	$Q = CV$	$V = IR$	$\mathcal{E} = -L\frac{dI}{dt}$
Voltage drop $V_b - V_a$	$-\frac{Q}{C}$	$-IR$	$-L\frac{dI}{dt}$
Series	$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$	$R_{eq} = R_1 + R_2$	$L_{eq} = L_1 + L_2$
Parallel	$C_{eq} = C_1 + C_2$	$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$	$\frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2}$
Stored energy	$\frac{1}{2}CV^2$	none	$\frac{1}{2}LI^2$
Energy density	$\frac{1}{2}\epsilon_0 E^2$	none	$\frac{1}{2}\frac{B^2}{\mu_0}$
Thermal energy loss	none	I^2R	none

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ANTHROPOLOGY 7 - LEC 1
ANTHROPOLOGY M127 - LEC 1
ANTHROPOLOGY 135B - LEC 1
ASIAN AMERICAN STUDIES 187B - LEC 2
ASTRONOMY 3 - LEC 1
ASTRONOMY 127 - LEC 1
ATMOSPHERIC AND OCEANIC SCIENCES 1 - LEC 1
BIOMEDICAL RESEARCH

Physics 6B - Lec 3 - Physics for Life Sciences Majors: Waves, Electricity, and Magnetism

Lec 3 - Katsushi Arisaka

Winter Quarter 2011 • MWF 1:00 PM-1:50 PM • Physics & Astronomy 1425

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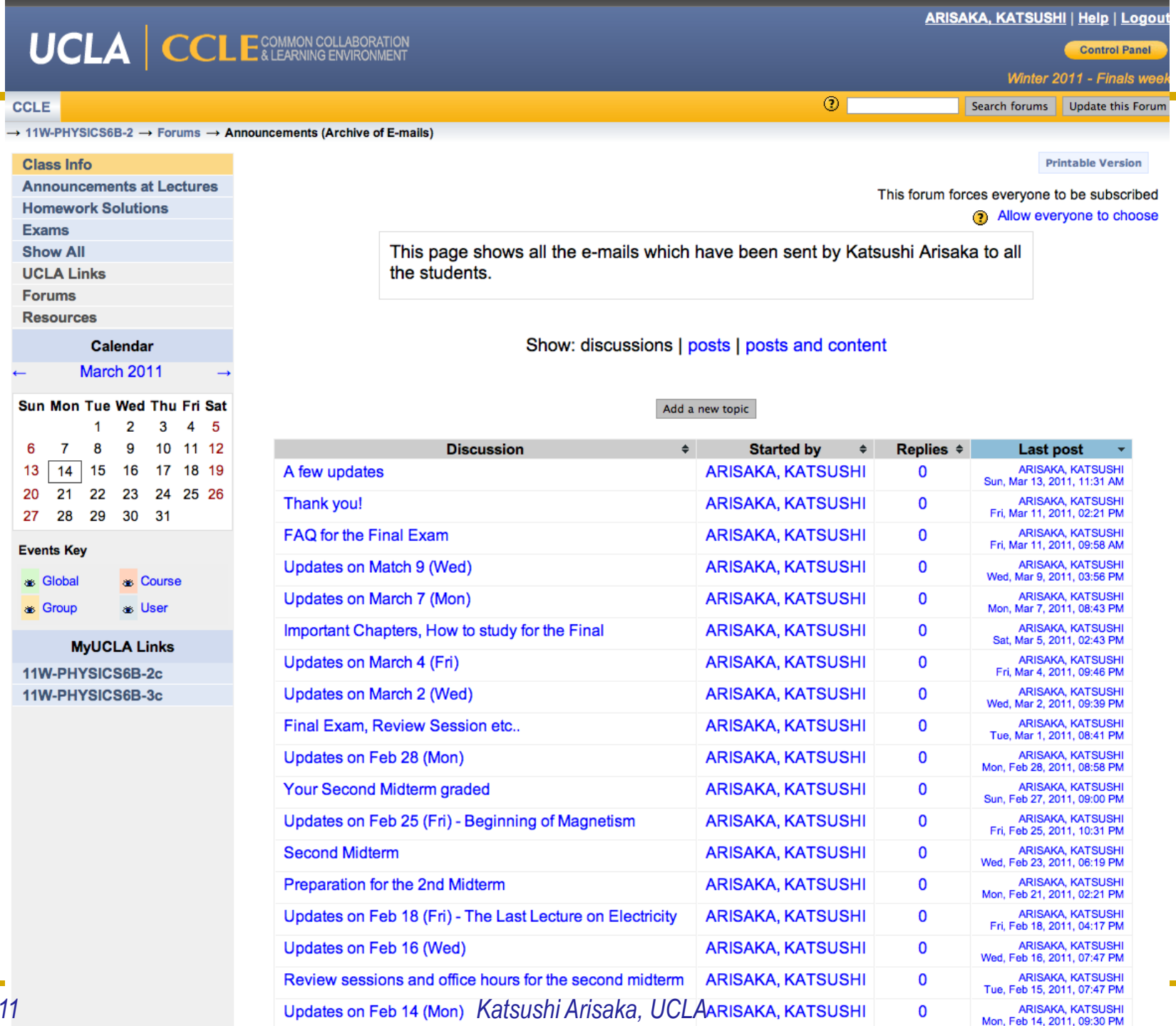
Non-iTunes Podcast Subscription Links: VIDEO AUDIO

Date	Title			
Mon 01/03/2011	**Lecture**	iPhone/iTouch/iPad	Audio	Video
Wed 01/05/2011	**Lecture**	iPhone/iTouch/iPad	Audio	Video
Fri 01/07/2011	**Lecture**	iPhone/iTouch/iPad	Audio	Video
Mon 01/10/2011	**Lecture**	iPhone/iTouch/iPad	Audio	Video
Wed 01/12/2011	**Lecture**	iPhone/iTouch/iPad	Audio	Video
Fri 01/14/2011	**Lecture**	iPhone/iTouch/iPad	Audio	Video

3. E-mails

- Administrative information
  - Home work assignment.
  - Information for the exams
- Summary of today's lecture
- Preview of the next lecture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This page shows all the e-mails which have been sent by Katsushi Arisaka to all the students.
Show: discussions | posts | posts and content
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A few updates ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Sun, Mar 13, 2011, 11:31 AM
Thank you! ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Fri, Mar 11, 2011, 02:21 PM
FAQ for the Final Exam ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Fri, Mar 11, 2011, 09:58 AM
Updates on Match 9 (Wed) ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Wed, Mar 9, 2011, 03:56 PM
Updates on March 7 (Mon) ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Mon, Mar 7, 2011, 08:43 PM
Important Chapters, How to study for the Final ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Sat, Mar 5, 2011, 02:43 PM
Updates on March 4 (Fri) ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Fri, Mar 4, 2011, 09:46 PM
Updates on March 2 (Wed) ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Wed, Mar 2, 2011, 09:39 PM
Final Exam, Review Session etc.. ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Tue, Mar 1, 2011, 08:41 PM
Updates on Feb 28 (Mon) ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Mon, Feb 28, 2011, 08:58 PM
Your Second Midterm graded ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Sun, Feb 27, 2011, 09:00 PM
Updates on Feb 25 (Fri) - Beginning of Magnetism ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Fri, Feb 25, 2011, 10:31 PM
Second Midterm ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Wed, Feb 23, 2011, 06:19 PM
Preparation for the 2nd Midterm ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Mon, Feb 21, 2011, 02:21 PM
Updates on Feb 18 (Fri) - The Last Lecture on Electricity ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Fri, Feb 18, 2011, 04:17 PM
Updates on Feb 16 (Wed) ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Wed, Feb 16, 2011, 07:47 PM
Review sessions and office hours for the second midterm ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Tue, Feb 15, 2011, 07:47 PM
Updates on Feb 14 (Mon) ARISAKA, KATSUSHI 0 ARISAKA, KATSUSHI Mon, Feb 14, 2011, 09:30 PM

Updates on Match 9 (Wed)
by ARISAKA, KATSUSHI - Monday, March 14, 2011, 02:26 PM

Dear all,

Hope you enjoyed today's lecture on Electromagnetic waves. As I said, this is the most fascinating phenomena in nature. Nowadays all kinds of fancy electronics (such as TV and Cell phone) utilize it. But more importantly, our eyes are based on it as well. Isn't it amazing how nature works and how animals utilize it? It is equally amazing that we, human, can understand how nature works (thanks to Maxell)!

Here are some updates. See you at one of the review sessions!

- Katsushi

Final Exam

The Final Exam for both Lecture 2 and 3 is scheduled as follows:
--- Tuesday, March 15, 2011, 11:30am-2:30pm
--- Ackerman Union Grand Ballroom

Review sessions

I have scheduled the following review sessions:
--- 3/9 (Wed) 6:00 – 7:50 pm (MS 4000A)
--- 3/10 (Thu) 2:00 – 3:50 pm (BUNCHE 2209A)
I will explain Sample Problem #8 - 15.
At least, please try Problem #8, 10 and 12 in advance. If you cannot solve them, take a look at the solution and study from the Textbook.

TA's review sessions and extra office hours

There will be special review sessions and office hours by TA:
--- 3/10 (Thu) 6:00 – 7:50 pm Review by Mark (WGYOUNG CS76)
--- 3/11 (Fri) 5:00 – 6:50 pm Review by John (KNSY PV 1220B)
--- 3/14 (Mon) 1:00 – 4:00 pm Office hours by Daniel (PAB 2434)

4. Special Office Hours

- Open special office hours only for the students below average in the midterm.
- Teach them "how to learn physics by themselves"
  - Critical thinking.
  - Become honest to his/her own understanding level

5. Sample Exams and Review Sessions

- **Sample Exams:**
  - Extremely long, challenging sample exams, based on the real exams in the past.
- **Extensive Review Sessions.**
  - Two hours (x 3 time slots) for the first midterm
  - Two sessions of two hours (x 3 time slots) for the second midterm and the final exam
  - Focusing on the sample exam problems

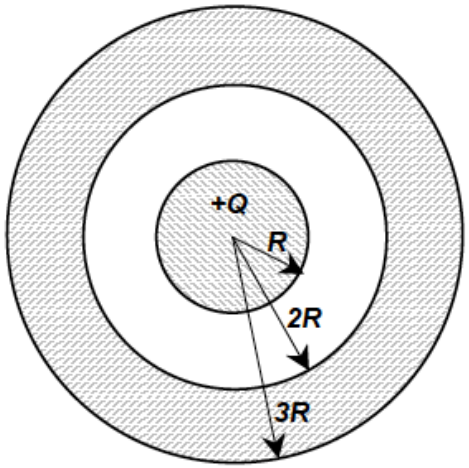
6. Exams

- Very similar to the sample exams.
- Only conceptual questions
- All the answers must be derived from the most fundamental laws of nature, such as Newton's law or Maxwell equations by themselves.
- No cheat sheet, no calculator, nothing allowed in the exam, except their own brains and pencil.
- Memorization is the essential part, because students cannot memorize the abstract concepts and equations unless they understand.
- Once they understand, they will never forget.

Sample Exam Problem

A solid conducting sphere of radius R has a total net charge $+Q$. A conducting spherical shell of inner radius $2R$ and outer radius $3R$ is concentric with the solid sphere and has no net charge. Let r be the distance from the center of the sphere.

a) Find the electric Field $\vec{E}$ inside the sphere ($r < R$).
b) Find the electric Field $\vec{E}$ in the region between the sphere and the shell (as a function of r, for $R < r < 2R$).
c) Find the electric Field $\vec{E}$ inside the shell ($2R < r < 3R$).
d) Find the electric Field $\vec{E}$ outside the shell (as a function of r, for $3R < r$).
e) Plot the graph of $\vec{E}$ as a function of r. (Assume that the outward field has positive sign, and the inward field has negative sign.)
f) Draw the field lines on the picture on this page.
g) Compute the surface charge density σ on the surface of the sphere. (Express σ by Q and R.)
h) Show that $\sigma = \varepsilon_0 E$ (as you expected).
i) Find the total charge on the inner surface of the shell.
j) Find the total charge on the outer surface of the shell.
k) Find the potential V outside of the shell, assuming $V = 0$ at $r \to \infty$. (Express V as a function of r, for $3R < r$.)
l) Find the potential V inside the shell ($2R < r < 3R$).
m) Find the potential V in the region between the sphere and the shell ($R < r < 2R$).
n) Find the potential V inside the sphere ($r < R$).
o) Plot the graph of the potential V as a function of r.



Real Exam Problem

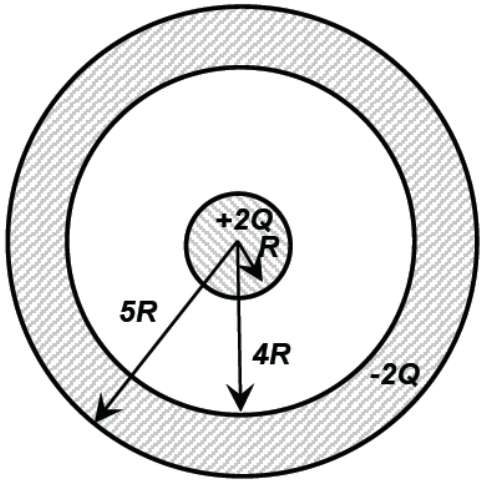
A solid conducting sphere of radius ***R*** has a total positive charge **+2*Q***. A conducting spherical shell of inner radius **4*R*** and outer radius **5*R*** is concentric with the solid sphere and has a total negative charge **-2*Q***. Let r be the distance from the center of the sphere. First, please calculate the electric fields from inside out by applying Gauss's law.

a) Find the electric Field $\vec{E}$ inside the sphere ($r < R$).

b) Find the electric Field $\vec{E}$ in the region between the sphere and the shell (as a function of r, for $R < r < 4R$).

c) Find the electric Field $\vec{E}$ inside the shell ($4R < r < 5R$).

d) Find the electric Field $\vec{E}$ outside the shell (as a function of r, for $5R < r$).



e) Plot the graph of $\vec{E}$ below as a function of r. (Assume that the outward field has positive sign, and the inward field has negative sign.)

Summary

- It is NOT a question of English, but a question of communication skills with students.
- There are several technical details which appear effective on communications.
  - E-mails, office hours, review sessions….
- The most important aspect:
  - Enjoy teaching
  - Propagate your excitement
  - Show that you care students.

Web Links of Winter 2011 Class

- Physics 6B
  - https://ccle.ucla.edu/course/view/11W-PHYSICS6B-2
- Physics 89 (Honors class)
  - https://ccle.ucla.edu/course/view/11W-PHYSICS89-1
- This presentation
  - http://home.physics.ucla.edu/~arisaka/Teaching/