

Science Popularization

Popularize What?



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科 普

普什么？



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ALL ABOUT SCIENCE

PHILOSOPHY, HISTORY, SOCIOLOGY & COMMUNICATION



MARIA BURGUETE AND LUI LAM
EDITORS

There is a lot of confusion and misconception concerning Science.

The nature and contents of science is an unsettled problem.

For example, Thales of 2,600 years ago was recognized as the father of science but the word science was introduced only in the 14th century; the definition of science is universally avoided in books about philosophy of science.

This book aims to clear up all these confusions and present new developments on the philosophy, history, sociology and communication of science.

It also aims to showcase the achievement of China's top scholars in these areas.

The 18 chapters, divided into five parts, are written by prominent scholars including the Nobel laureate Robin Warren, sociologist Harry Collins, and physicist-turned-historian Dietrich Stauffer.

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Science Communication (SciComm)

Jiang Zemin (2000):

- promote the scientific spirit
- popularize scientific knowledge
- communicate scientific thought and scientific method

Lam (2013):

- awaken citizens' inert curiosity about the world/universe

What for?

- promote citizens' ability to deal with practical problems
- promote citizens' ability to participate in public-affair management
- stimulate children's interest to be future humanists/scientists

Science Communication

(or Science Popularization, PopSci)

A brief history (from Peter Broks)

Early 19th century: **Republic of Science**—no separation of science from public; all could join.

Late 19th century: **Rise of the expert**; separation of scientific experts and lay public; SciComm is to bridge the gap. (1833, William Whewell coined the term “scientist”.)

20th century:

- 1950s: Sputnik triggers fear about **scientific literacy**.
- 1980s: **PUS** (**Public Understanding of Science**); SciComm as new duty for scientists.
- 2000: **PEST** (**Public Engagement with Science and Technology**); a whole new set of questions:
 - What counts as being a scientist?
 - Where do we draw the boundaries between science and non-science, between scientists and non scientists?
 - What counts as expertise? Who are the experts? What about lay experts?
 - Why listen?
 - **Engagement** presupposes particular social and political relationships which **in turn raises questions about authority and democracy**.

Knowledge

Human knowledge has two parts:

1. A **human-independent** part (e.g., law of gravity; could be discovered by aliens, too).
2. A **human-dependent** part (e.g., human related—humanities and social science, including application of “science”).

N.B.: The existence of human-independent part of knowledge is denied by the **Relativists**.

Why the Humanities are Important

Importance of humanities could be seen:

1. If all present “science” research is stopped or eliminated, the world is still the same—chaos and tragedies will continue—because it is the humanities (underdeveloped in the last 2600 years since Plato) that matters in human affairs.
2. Another way of seeing this is through the lesson of Apple company.



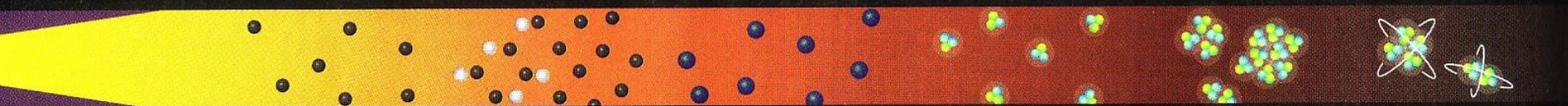
Putting a good **humanist** among the “**scientists**”/engineers could create great companies—good for the economy.

Human

In the Beginning

The cosmic timeline continues with fairly well-established events leading to the present day.

Earliest Moments of the Big Bang → Formation of Atoms →



10^{-35} second
Cosmic inflation creates a large, smooth patch of space filled with lumpy quark soup

10^{-30} s
One potential type of dark matter (axions) is synthesized

10^{-11} s
Matter gains the upper hand over antimatter

10^{-10} s
A second potential type of dark matter (neutralinos) is synthesized

10^{-5} s
Protons and neutrons form from quarks

0.01–300 s
Helium, lithium, and heavy hydrogen nuclei form from protons and neutrons

380,000 years
Atoms form from nuclei and electrons, releasing the cosmic microwave background radiation

Dark Ages → Modern Era →



380,000–300 million yr
Gravity continues to amplify density differences in the gas that fills space

300 million yr
First stars and galaxies form

1 billion yr
Limit of current observations (highest-redshift objects)

3 billion yr
Clusters of galaxies form; star formation peaks

9 billion yr
Solar system forms

10 billion yr
Dark energy takes hold and expansion begins to accelerate

13.7 billion yr
Today

Atoms formed in stars

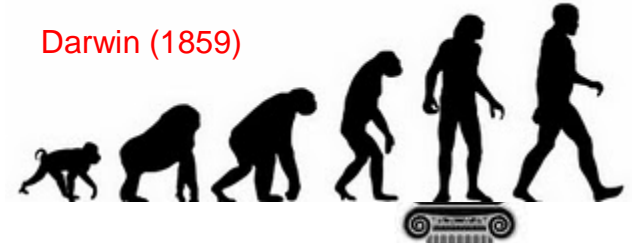
Earth formed

Life began

Life Emerged and Evolves

Years ago	Evolution	Migration	Life style	Art related
6 million	Chimp and human lineages split.			
2 million	<i>Homo erectus</i> appears.			
1.8 million	First wave of migration out of Africa begins.			
1.6 million			First use of fire; more complex stone tools created; arts could begin	
400,000			Earliest evidence of cooking.	
195,000	<i>Homo sapiens</i> (early modern humans) appears.			
60,000	Second wave of migration out of Africa			
35,000			Oldest known cave art (in France, Spain,...)	
10,000			Agriculture begins; first villages appear.	
5,500			Bronze Age begins.	
5,000			Earliest known writing	

Darwin (1859)

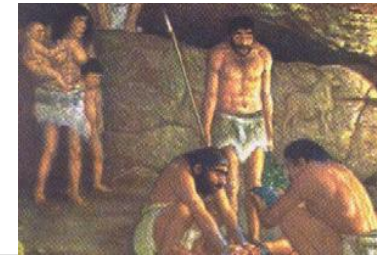


Don't eat me when I am sleeping.



Thou shalt not covet thy neighbor's wife

Ethics

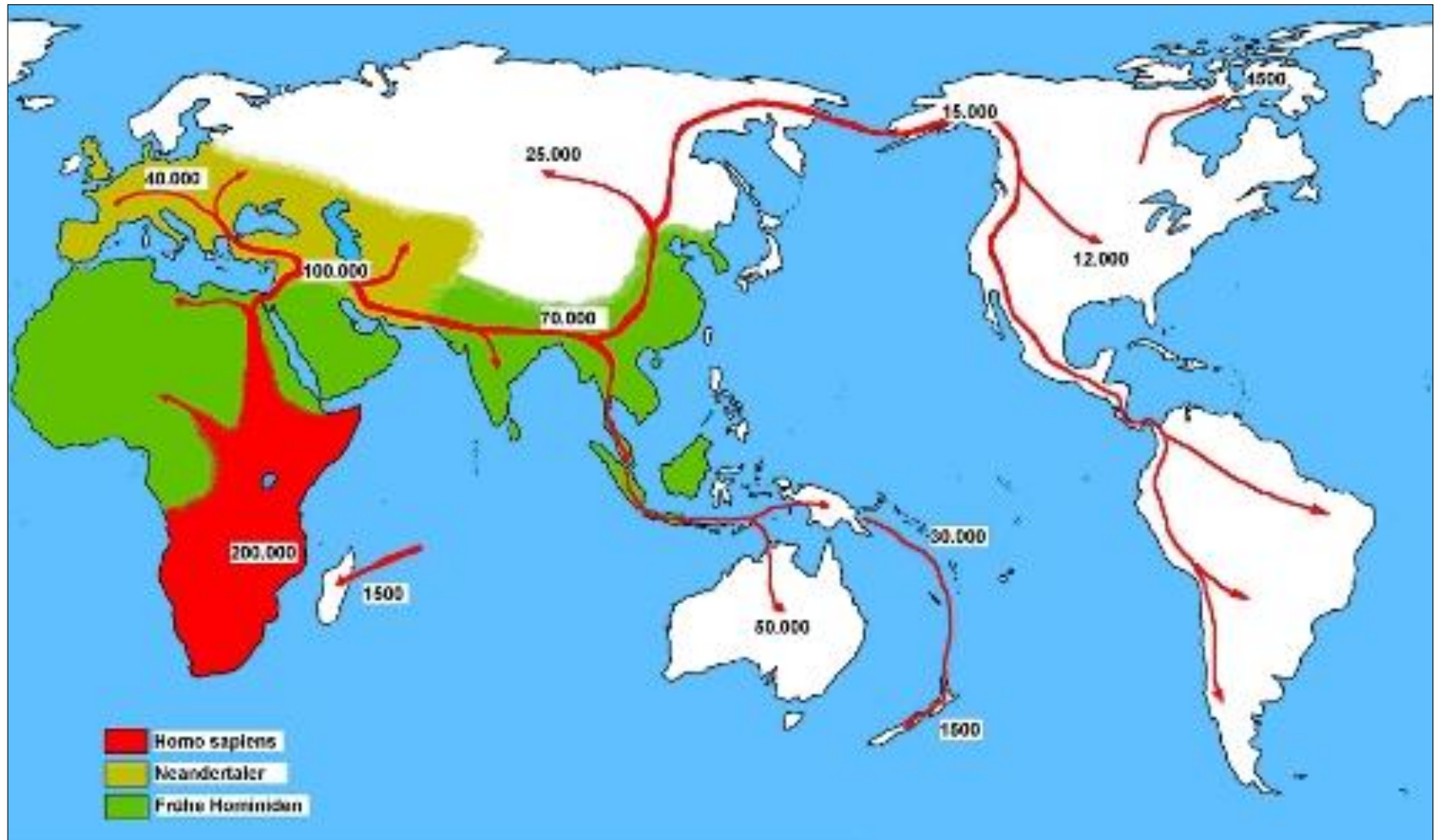


community

Arts

Ethics

Out of Africa

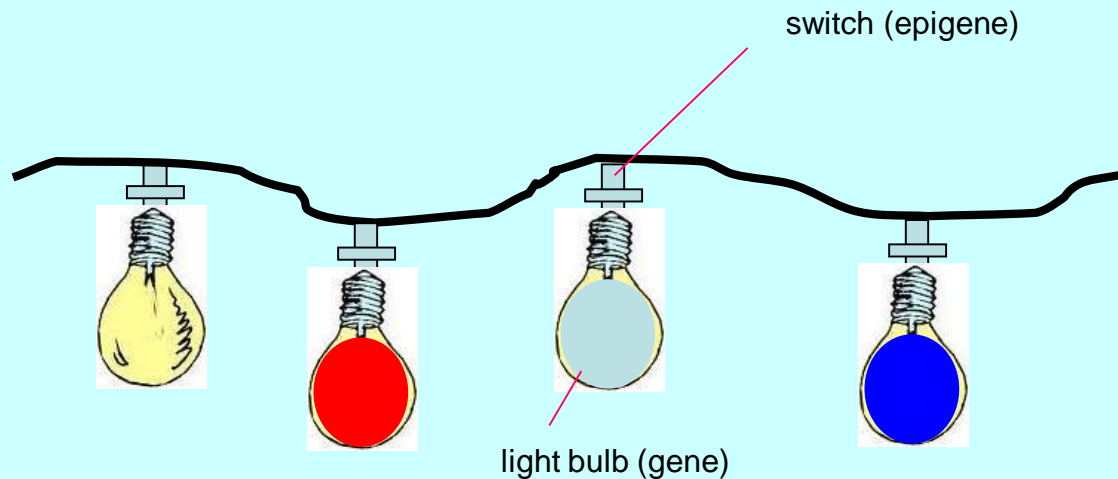


- All human beings have same origin and share the same genes, with similar intelligence.
- Science developed differently in different regions (e.g., ancient Greek and China) due to different choice of research topics.

Nature and Nurture are both Important

New Understanding of Evolution (last 10 years):

A combination of Darwin and Lamarck



Learned behavior could be passed on to next generation, too, by epigenes

Science

Science

- Science is the study of Nature
- Nature includes all material system (which are all made up of atoms).
- Humans is a material system (made up of atoms, evolved from simple living systems).



Everything in Nature is part of science!

- But this understanding could be reached only in the last 100 years or so, after Darwin's theory of evolution (1859) and Einstein's Brownian motion paper (1905) proving the existence of atoms.
- Early stage of science (starting with Thales) involves observations and speculations; systematic approach appears only in the later, mature stages (in the modern science period of the last 400 years since Galileo).



Civilization



Science Matters

Science Matters (SciMat, 人科), invented by Lui Lam in 2008, is a new discipline that treats all human-dependent matters as part of science.

Science = Natural science

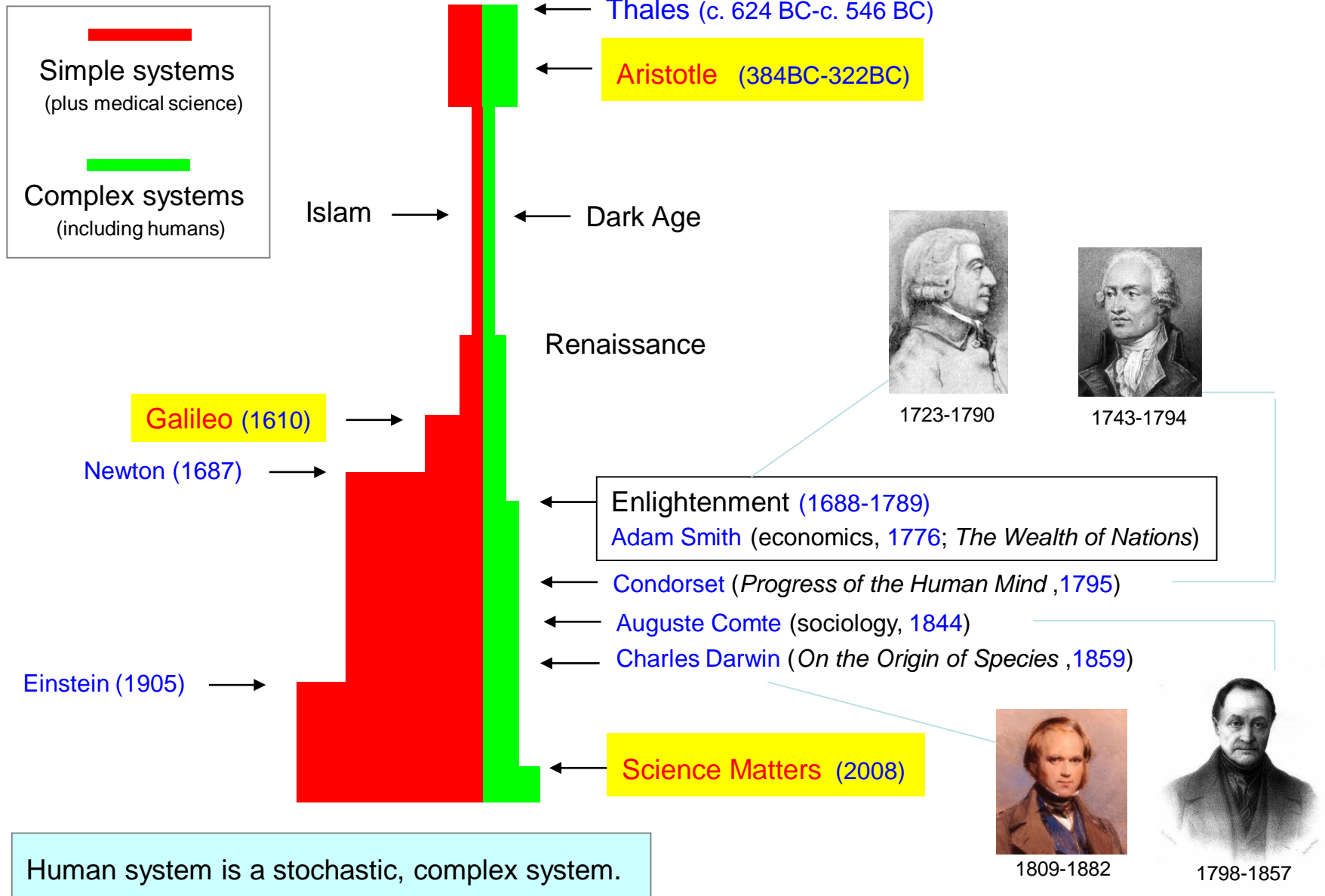
= human-independent science + human-dependent science

Science Matters

Humanities + social science

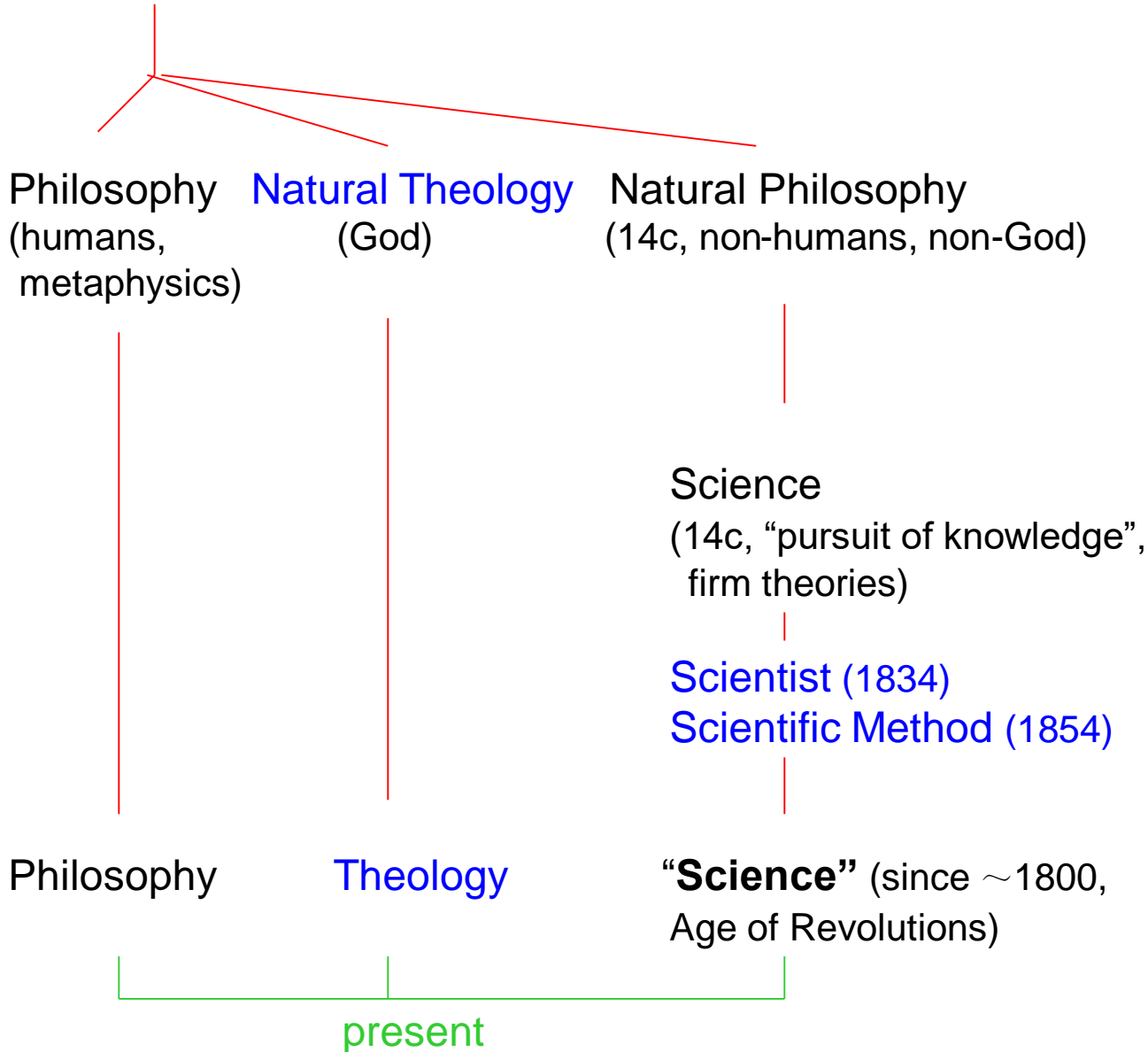
SciMat Website: www.sjsu.edu/people/lui.lam/scimat

Looking Back: A Brief History of Science



History of Words

Philosophy (600 BC, “love of wisdom”, Pythagoras; 13c, English)



William Whewell

Cambridge Don
who invented the
word “scientist” (1834)

Some Misconceptions about Science

Wrong: Science is about the systematic study of repeatable and controlled experiments.

Correct: The backbone of science is the collection of (interrelated) theories and controlled experiments; historical sciences (like astronomy and paleontology) advance by comparing their findings with results from controlled experiments.

Wrong: There is a set of well defined procedures making up the Science Method.

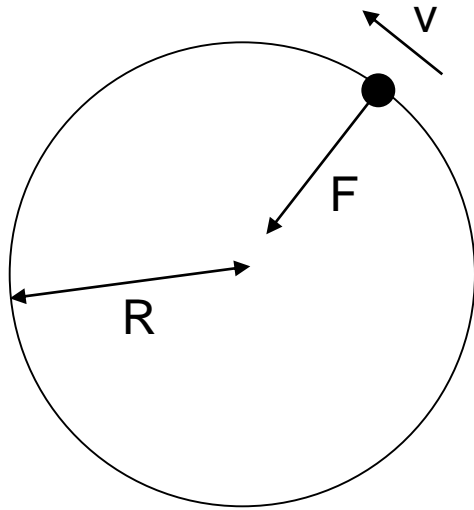
Correct: Science is about open-mindedness, honesty, earnest, admitting errors, and peer reviewing/checking. There is “scientific tradition” or “scientific experience” but no “scientific method”.

Wrong: Science is a social phenomenon (Hitler).

Correct: The science process is human dependent (and a social phenomenon) but the end result of nonhuman systems (like law of gravity) is human-independent.

Surprise 1

- Science never proves anything, *rigorously speaking (in the mathematical sense)*, because confirming experiments are always done with finite resolutions.



Example

Uniform circular motion

$$F = mv^2/R$$

To check this equation we measure each quantity and show that the left-hand side equals to the right-hand side. Finite resolution of all the measurements means that we can only conclude the equation is valid within the uncertainty of the measurements.

Surprise 2

- Science advances and lives with approximations.
(It works because, like when lost in a forest, a rough map is all one needs to get out of the forest.)

Science is thus not the route to reach “truth” (if there is such a thing).

Surprise 3

- Important scientific laws or theories are not always expressed in mathematical equations.

Two examples:

- The Third Law of Thermodynamics:

It is impossible to reach to reach the absolute zero in a finite number of steps.

- Darwin's Evolutionary Theory:

The fittest survives.

Reality Check: Uniqueness of Scientific Knowledge

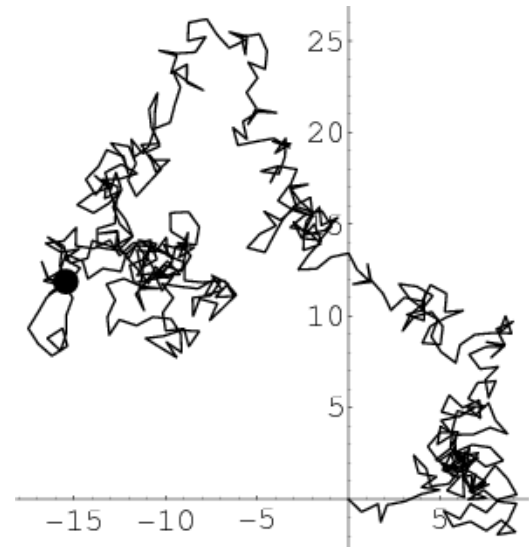
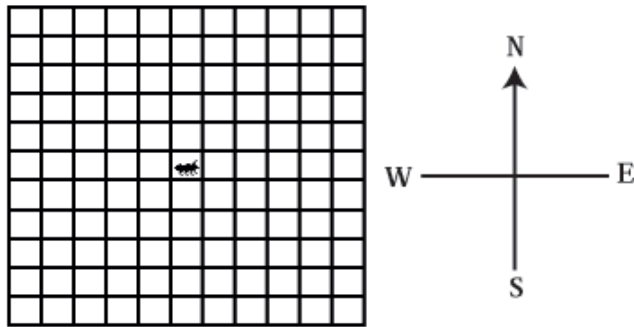
- And there is always the **reality check**.
- The “**cell phone test**”—any new theory, if it conflicts with that behind the building and working of a cell phone, has to explain why and why it is better. (The working of a cell phone depends on Maxwell Equations, quantum mechanics, semiconductors, general relativity,...)
- Science is valued because **it works**.

What to Communicate

1: The Human World is Stochastic

The human world is stochastic, i.e., probability is involved.
Two simple examples: Random Walk and Active Walk

Random Walk



Louis Bachelier

Ph.D. thesis in
economics (1900)

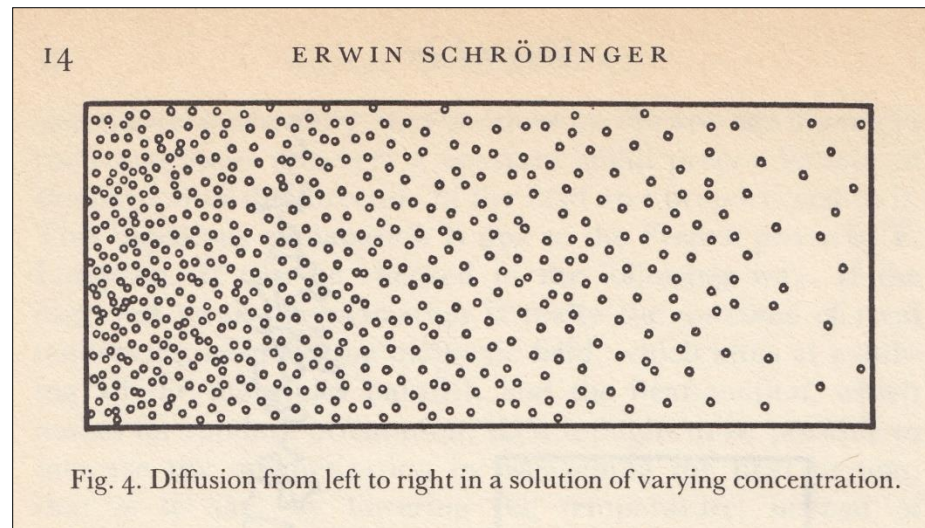
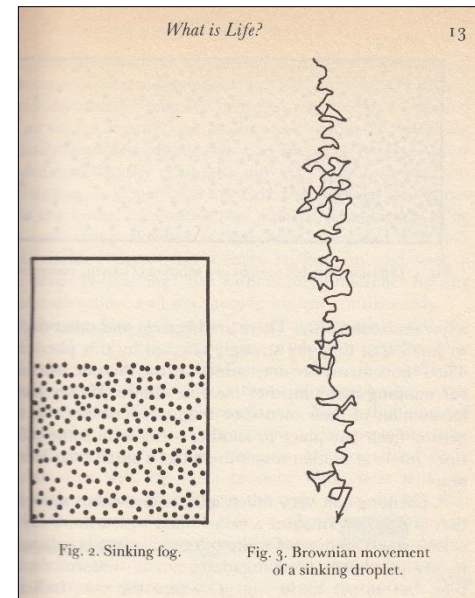
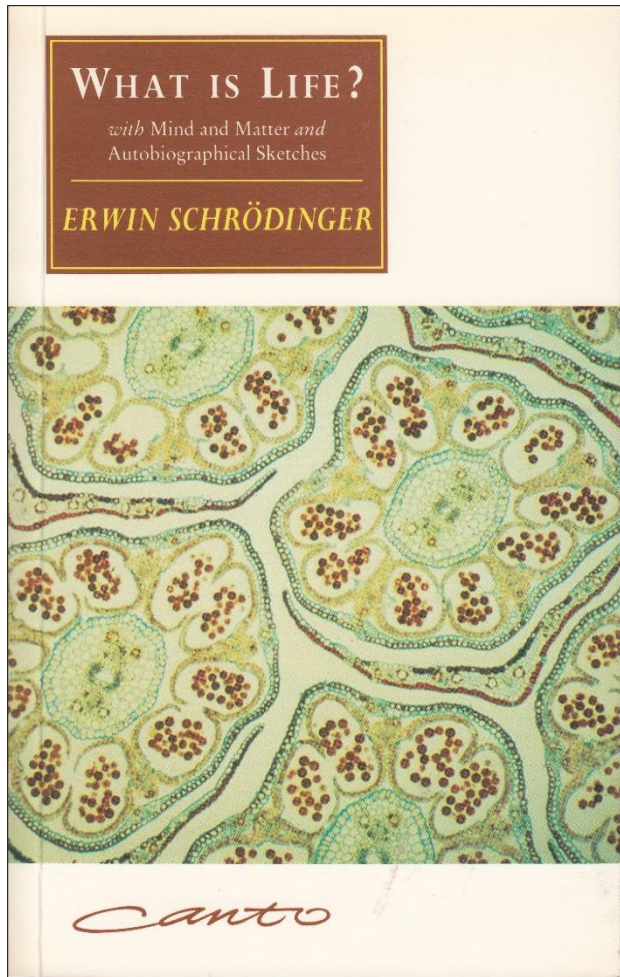


Einstein

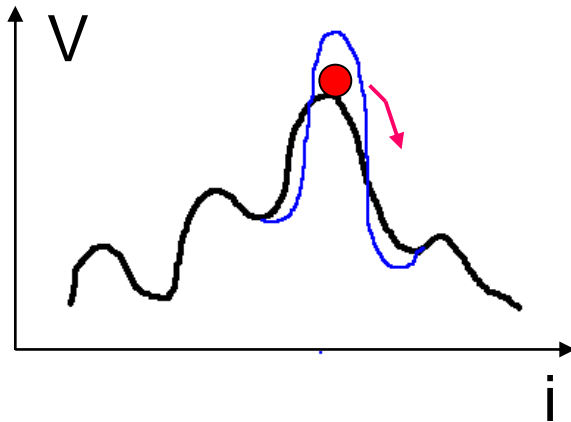
Brownian motion paper (1905)

Erwin Schrödinger

(1887-1961)



● **Active Walk** (invented by Lui Lam in 1992)



1. **Landscaping rule**: how the walker modifies the landscape as it walks.

2. **Stepping rule**: how the walker chooses its next step.

3. **Landscape's self-evolving rule**: change of landscape not due to walker (e.g. external factors).

Examples of stepping rule:

● **Deterministic** (DAW): Walker goes to next-nearest site with lowest height.

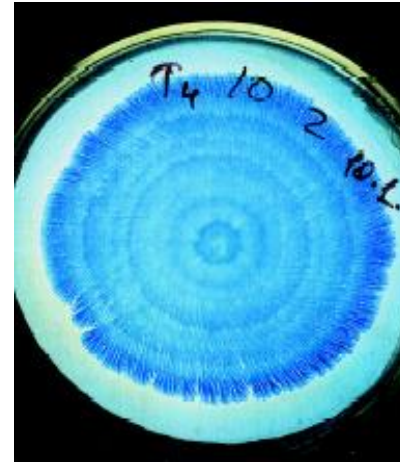
● **Probabilistic** (PAW): $P_{ij} \propto \begin{cases} (V_i - V_j)^\eta, & V_i > V_j \\ 0, & \text{otherwise} \end{cases}$

● **Boltzmann** (BAW): $P_{ij} \propto [\exp(V_i - V_j)/T]$

- **Active Walk** has been applied successfully to many living and nonliving systems from humanities, social sciences and natural sciences. See reviews by Lam in *International Journal of Bifurcation and Chaos* (2005, 2006).

Example

Bacteria patterns formed under hostile conditions




- **Active Walk** as a metaphor in the advancement of human efforts.

2: Popularize Complex Systems

Steven Hawking:

“Complex systems is the most important science in the 21th century.”

All world/human problems are complex.



Only 15 years ago, **complex systems** science had to justify its existence. **Today it is taking the world by storm.** Networks, big data, cascading crises, extreme events, the word "systems," and many other ideas are widely accepted and the basis for new advances and increasing the scope of science.

Bilinear effect in complex systems

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⁶ School of Visual Arts and Design, University of Central Florida - Orlando, FL 32826, USA

3: Modernize Science Communication

- In **science communication**,
the essence of the so-called “scientific method” (such as the scientific spirit and scientific tradition) and **the knowledge of human-dependent parts of science (concept of probability, the humanities and social sciences)** could be more important than those about non-living systems in the **public understanding of science**.
- Popularizing **complex systems** will help the public to understand complex issues (e.g., global climate change) better as citizens, and **will make CRISP the leader** in the field of science communications.



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The A
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(ISMC, established May 30, 2007)

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Author of *Cognitive Science, Literature and the Arts*



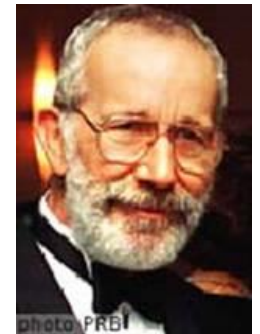
Father of Neuroarthistory

President of British Society for Philosophy of Science (1993-1995)

Columnist, *Scientific American*; editor, *Skeptical* magazine



Nobel Laureate
(2005)



Aim

To promote the SciMat idea and push the International SciMat Program.

WORLD SCIENTIFIC PUBLISHING COMPANY PROUDLY
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SCIENCE MATTERS SERIES

Science Matters is the new discipline that treats all human-dependent matters as part of science, wherein, humans (the material system of *Homo sapiens*) are/ studied scientifically from the perspective of complex systems. That “everything in Nature is part of science” was well recognized by Aristotle and da Vinci and many others. Yet, it is only recently, with the advent of modern science and experiences gathered in the study of evolutionary and cognitive sciences, neuroscience, statistical physics, complex systems and other disciplines, that we know how the human-related disciplines can be studied scientifically.

Science Matters (SciMat) covers all the topics in humanities and social sciences, with emphasis on the humanities.

SCIENCE MATTERS

Humanities as Complex Systems

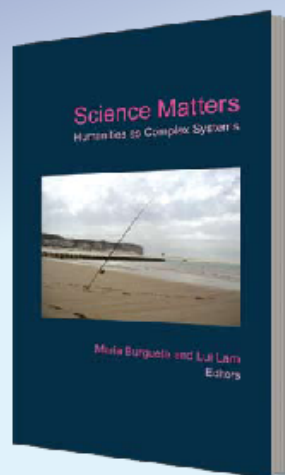
edited by Maria Burguete (*Scientific Research Institute Bento da Rocha Cabral, Portugal*) & Lui Lam (*San Jose State University, USA*)

All earnest and honest human quests for knowledge are efforts to understand Nature, which includes both human and nonhuman systems, the objects of study in science. Thus, broadly speaking, all these quests are in the science domain. The methods and tools used may be different; for example, the literary people use mainly their bodily sensors and their brain as the information processor, while natural scientists may use, in addition, measuring instruments and computers. Yet, all these activities could be viewed in a unified perspective — they are scientific developments at varying stages of maturity and have a lot to learn from each other.

That “everything in Nature is part of science” was well recognized by Aristotle, da Vinci and many others. Yet, it is only recently, with the advent of modern science and experiences gathered in the study of statistical physics, complex systems and other disciplines, that we know how the human-related disciplines can be studied scientifically.

Science Matters is about all human-dependent knowledge, wherein humans (the material system of *Homo sapiens*) are studied scientifically from the perspective of complex systems. It includes all the topics covered in the humanities and social sciences. Containing contributions from knowledgeable humanists, social scientists and physicists, the book is intended for those — from artists to scientists — who are curious about the world and are interested in understanding it with a unified perspective.

Contents: *Science Matters: A Unified Perspective* (L Lam); *Art and Culture: Culture THROUGH Science: A New World of Images and Stories* (P Caro); *Physiognomy in Science and Art: Properties of a Natural Body Inferred from Its Appearance* (B Hoppe); *Has Neuroscience Any Theological Consequence?* (A Dinis); *SciComm, PopSci and The Real World* (L Lam); *Philosophy and History of Science: The Tripod of Science: Communication, Philosophy and Education* (N Sanitt); *History and Philosophy of Science: Towards a New Epistemology* (M Burguete);



Philosophy of Science and Chinese Sciences: The Multicultural View of Science and a Unified Ontological Perspective (B Liu); *Evolution of the Concept of Science Communication in China* (D-G Li); *History of Science in Globalizing Time* (D Liu); *Raising Scientific Level: Why Markets are Moral* (M Shermer); *Towards the Understanding of Human Dynamics* (T Zhou et al.); *Human History: A Science Matter* (L Lam).

Readership: Physicists and other scientists, social scientists, humanists and laypeople.

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Science Popularization: Popularize What?

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Science Communication (SciComm) is to communicate science to the public. There are two components: what to communicate, and how to communicate. This talk is mostly about the former, with brief comments on the latter. To understand what to communicate the utmost important thing is to understand what science is. It turns out that there is no easy answer. The reason is that Science evolves with time, from the early Greek time on; it is a moving target. We will trace the historical evolution of the concept of Science, and clarify some common or uncommon misunderstandings. We will argue that the contents of science could be classified into two parts: simple systems and complex systems. The latter is completely ignored in SciComm, with dire consequences as the public's interest is concerned.

Lui Lam, physicist and humanist, obtained his BS from the University of Hong Kong; MS, University of British Columbia; PhD, Columbia University. Lam invented Bowlic liquid crystals (1982), Active Walks (1992), and two new disciplines: Histophysics (2002) and Science Matters (2008). He has published 14 books and over 170 scientific papers; the books include *Arts: A Science Matter* (2011) and *All About Science* (2014). He is the founder of the International Liquid Crystal Society (1990); cofounder of the Chinese Liquid Crystal Society (1980); founder and editor of two book series, "Science Matters" (World Scientific) and "Partially Ordered Systems" (Springer). Lam is an editor of *Wuli* and *Science Popularization*. His current research is in Scimat (Science Matters), Histophysics, and Complex Systems; Scimat website: www.sjsu.edu/people/lui.lam/scimat. Email: lui2002lam@yahoo.com.