PHYSICS FROM PLANCK SCALE TO BILLION PLUS LIGHTYEARS

Christopher C. Bernido, Ph.D.
Research Center for Theoretical Physics
Central Visayan Institute Foundation
Jagna, Bohol, Philippines

NAST Lecture Series, Tagbilaran City
November 21, 2017

The laws and principles of SCIENCE are essentially unchanged.

***Newton's Laws* (1680's)**
***Electromagnetism* (1800's)**
Quantum Mechanics (1930's)
Thermodynamics (1900's)
Etc.

TECHNOLOGY, HOWEVER, RAPIDLY CHANGES.

Slide Rules to Calculators

Landlines to wireless Cell phones

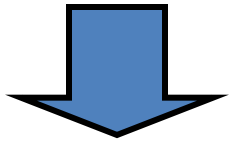
Scalpels to Laser Surgery

Bulky Monitors to flat Screens

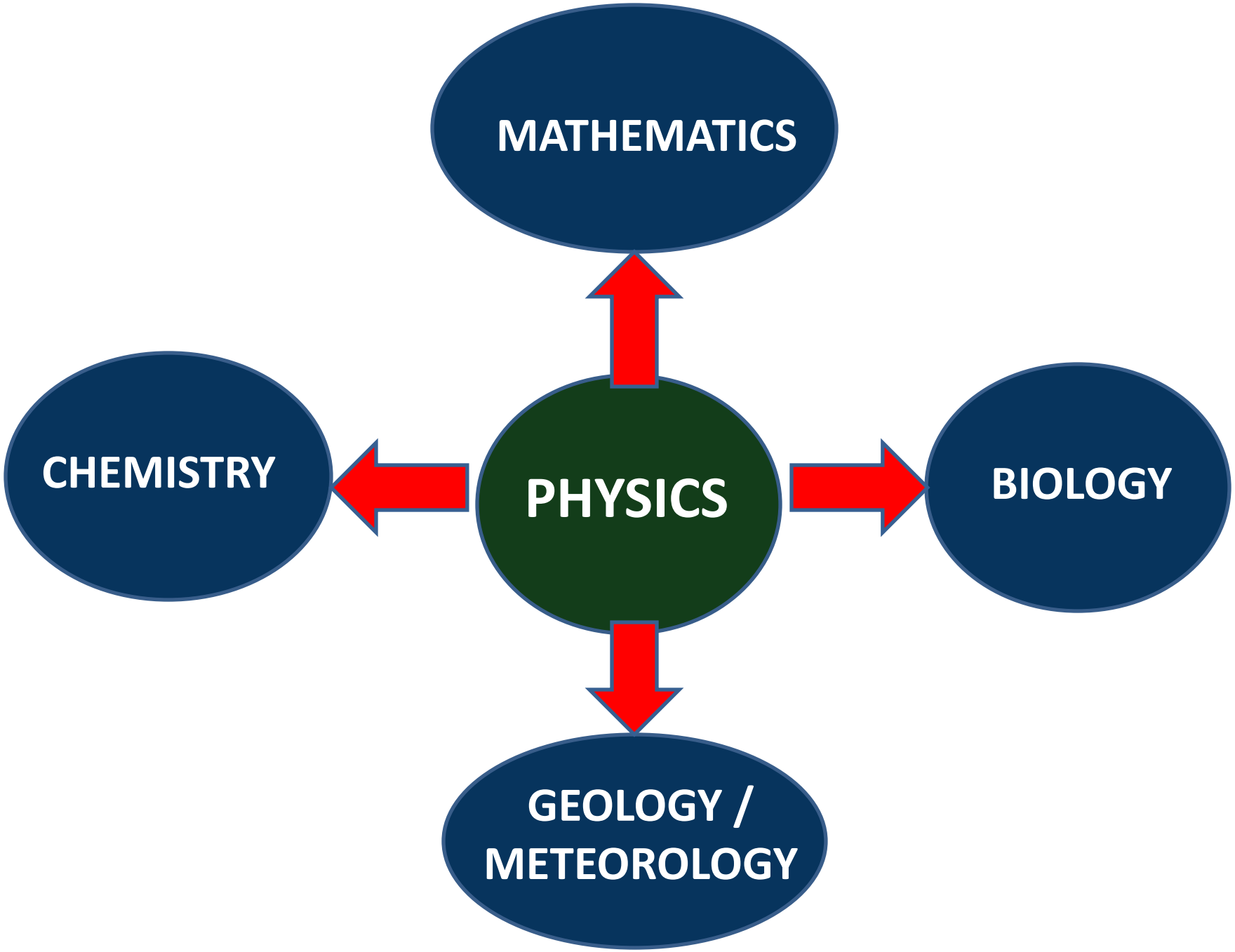
Big Computers to Laptops

Overhead Projectors to LCD's

Fossil fuel to Solar and Nuclear energy, etc.



The basis for powerful technological innovations is Science.


MATHEMATICS
CHEMISTRY
PHYSICS
BIOLOGY
GEOLOGY /
METEOROLOGY

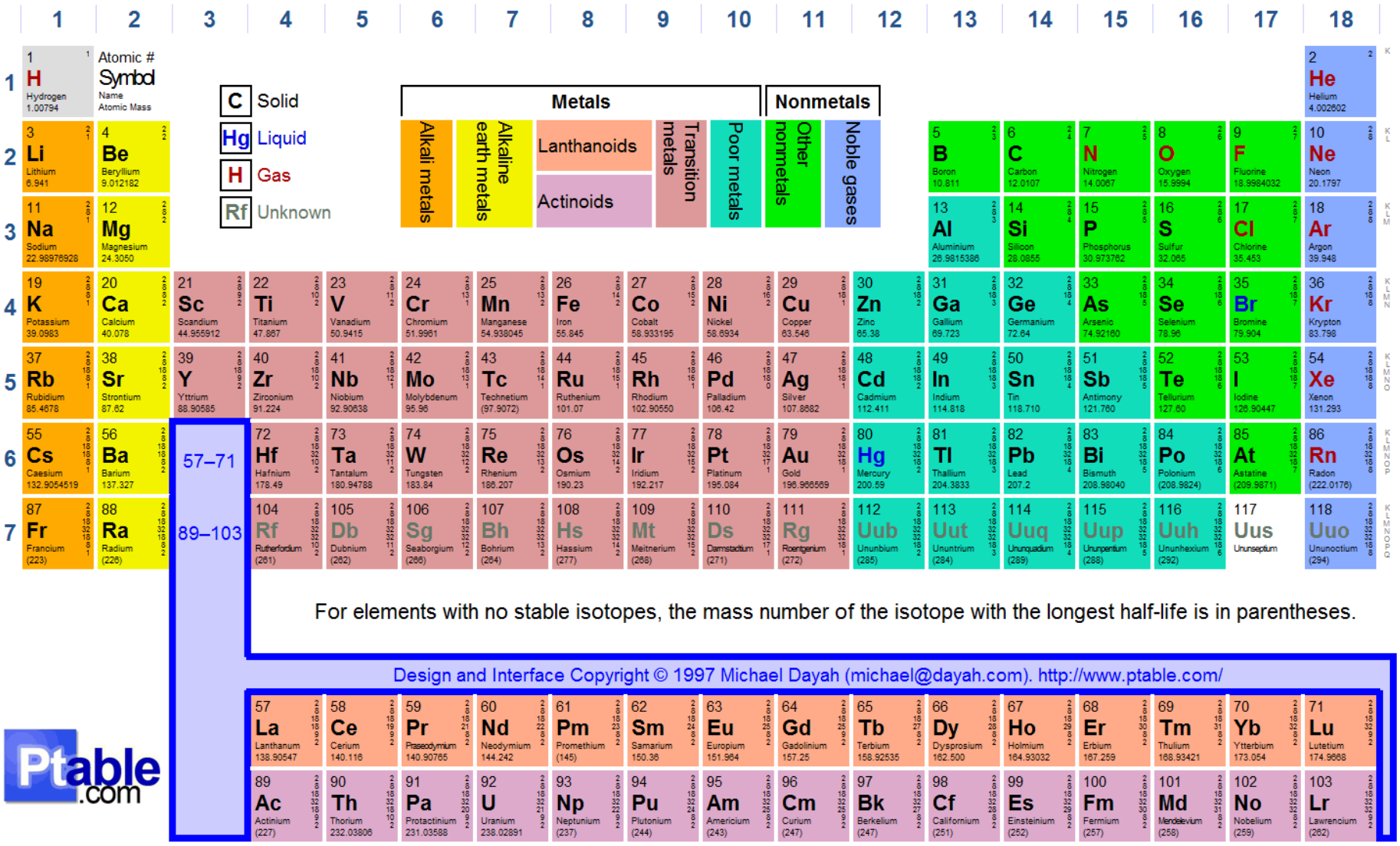
EXAMPLE: *Contribution to Chemistry*

Pauli's Exclusion Principle obeyed by all electrons in all the atoms.

Wolfgang Pauli
(Nobel Prize in Physics, 1945)

http://scarc.library.oregonstate.edu/coll/pauling/bond/people/pauli.html

Periodic Table of Elements



For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.

Ptable.com

http://www.ptable.com/

EXAMPLE: *Contribution to Biology*

Discovery of the DNA structure as a double helix by Crick and Watson.

https://www.geneticliteracyproject.org/2013/12/13/scientists-discover-second-code-hiding-within-dna/

Francis Crick (Physicist) and **James Watson** (Biologist)

http://www.irishtimes.com/life-and-style/people/sixty-years-of-dna-it-changed-our-understanding-of-life-1.1365885

EXAMPLE: *Contribution to Mathematics*

Isaac Newton invented Calculus

http://www.crystalinks.com/newton.html

EXAMPLE: *Contribution to Mathematics*

Paul Dirac invented the Dirac Delta Function.

… mathematical beauty
"is almost a religion to me."

- P. A. M. Dirac

(Nobel Prize in Physics)

EXAMPLE: *Contribution to Mathematics*

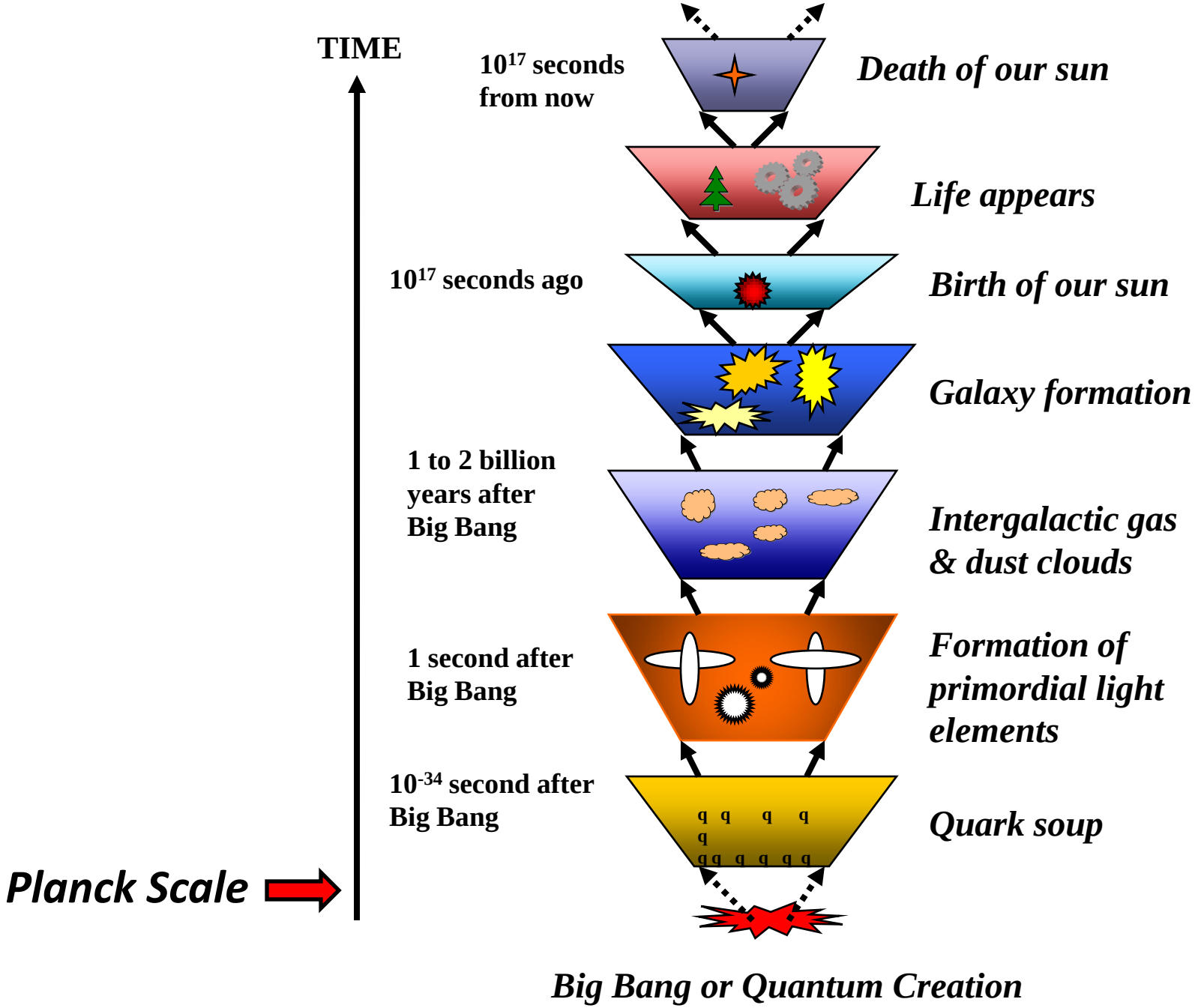
https://www.youtube.com/watch?v=AmUI2qf9uyo

EDWARD WITTEN

Fields Medal (1990): regarded as the highest award in Mathematics

Although he is definitely a physicist, his command of mathematics is rivaled by few mathematicians, and his ability to interpret physical ideas in mathematical form is quite unique. Time and again he has surprised the mathematical community by a brilliant application of physical insight leading to new and deep mathematical theorems... [H]e has made a profound impact on contemporary mathematics. In his hands physics is once again providing a rich source of inspiration and insight in mathematics.

- *M. Atiyah*


TIME
10^{17} seconds from now
Death of our sun
Life appears
10^{17} seconds ago
Birth of our sun
Galaxy formation
1 to 2 billion years after Big Bang
Intergalactic gas & dust clouds
1 second after Big Bang
Formation of primordial light elements
10^{-34} second after Big Bang
Quark soup
Planck Scale
Big Bang or Quantum Creation

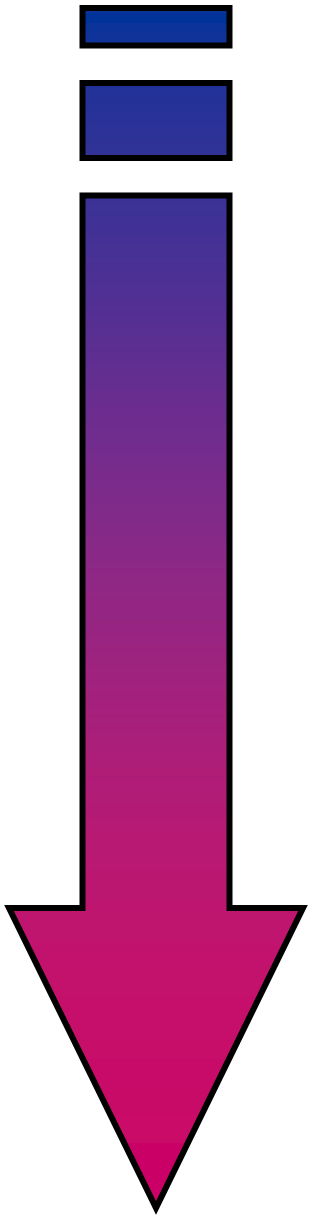
Typical Scales and Sizes of Objects

ITEMS TO BE MEASURED	Approximate size in centimeter
Thickness of a piece of chalk	10^{0} = 1 cm
Thickness of human hair	10^{-2} cm = 1 cm / 100
Size of an atom	10^{-8} cm

Typical Scales and Sizes of Objects

ITEMS TO BE MEASURED	Approximate size in centimeter
Size of proton	10^{-13} cm
Size of electron	Less than 10^{-17} cm
Size of universe at time 10^{-34} second	10^{-29} cm
Planck scale	10^{-33} cm

THE MATERIAL UNIVERSE



Galaxies: *stars, planets, etc.*

Terrestrial Objects: *chairs, plants, humans, piece of chalk, etc.*

Molecules

Atoms

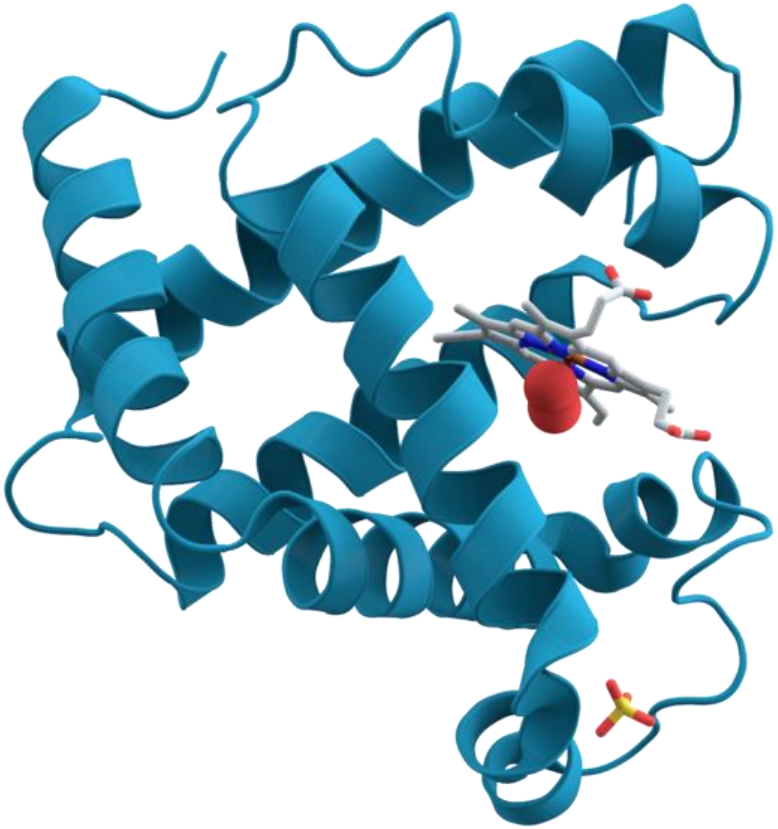
Baryons: *Protons & Neutrons*

Quarks & Leptons (electrons, neutrinos, etc.)

Areas in Physics:

- *Condensed Matter Physics*
- *High Energy Physics*
- *Astrophysics*
- *Particle Physics*
- *Laser Physics*
- *Instrumentation Physics*
- *Theoretical Physics*
- *Biophysics*
- *Geophysics*
- *Econophysics*
- *Medical Physics*
- *Cosmology , etc …*

BIOPHYSICS :



MYOGLOBIN

http://en.wikipedia.org/wiki/File:Myoglobin.png

Example:
Protein Folding Problem

NEUROPHYSICS :

How do neurons in our brain encode information?

6th Jagna International Workshop
International Journal of Modern Physics: Conference Series
Vol. 17 (2012) 23–33

DOI: 10.1142/S2010194512007908

World Scientific
www.worldscientific.com

ON A FRACTIONAL STOCHASTIC PATH INTEGRAL APPROACH IN MODELLING INTERNEURONAL CONNECTIVITY

CHRISTOPHER C. BERNIDO AND M. VICTORIA CARPIO-BERNIDO

Research Center for Theoretical Physics, Central Visayan Institute Foundation, Jagna, Bohol 6308, Philippines
E-mail: cbernido@mozcom.com

A fractional stochastic path integral approach is presented as a natural framework for treating the random distribution of possible communication chains in the synaptic transmission of signals between initiator and distant target receptor neurons. Fractional Brownian motion parametrization is invoked to account for strong correlations between segments of a neuronal communication chain. We then obtain the probability density function (pdf) for the location of the target receptor neuron in terms of the Hurst index that classifies the dynamics into short-memory or long-memory domains. This pdf obtained by the path integral approach is a fundamental solution of the corresponding Fokker-Planck equation.

6th Jagna International Workshop
International Journal of Modern Physics: Conference Series
Vol. 17 (2012) 19–22

DOI: 10.1142/S2010194512007891

ON NEURON MEMBRANE POTENTIAL DISTRIBUTIONS FOR VOLTAGE AND TIME DEPENDENT CURRENT MODULATION

J. B. SALIG, JR.

Physics Department, Mindanao University
7200 Ozamiz City, Philippines

M. V. CARPIO-BERNIDO and C. C. BERNIDO

Research Center for Theoretical Physics, Central Visayan Institute Foundation
Jagna, 6308 Bohol, Philippines
cbernido@mozcom.com

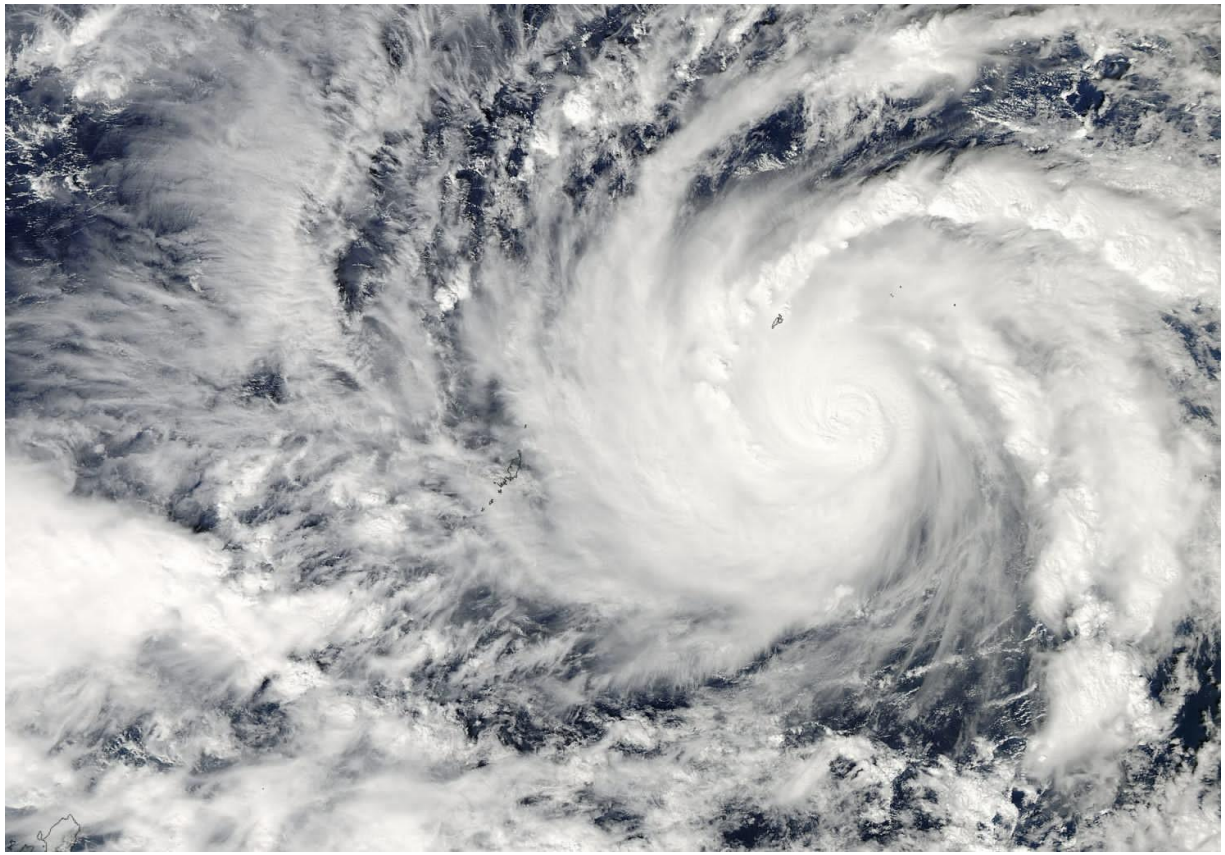
J. B. BORNALES

Physics Department, Mindanao State University-Iligan Institute of Technology
9200 Iligan City, Philippines
jinky.bornales@g.msuiit.edu.ph

Tracking variations of neuronal membrane potential in response to multiple synaptic inputs remains an important open field of investigation since information about neural network behavior and higher brain functions can be inferred from such studies. Much experimental work has been done, with recent advances in multi-electrode recordings and imaging technology giving exciting results. However, experiments have also raised questions of compatibility with available theoretical models. Here we show how methods of modern infinite dimensional analysis allow closed form expressions for important quantities rich in information such as the conditional probability density (cpd). In particular, we use a Feynman integral approach where fluctuations in

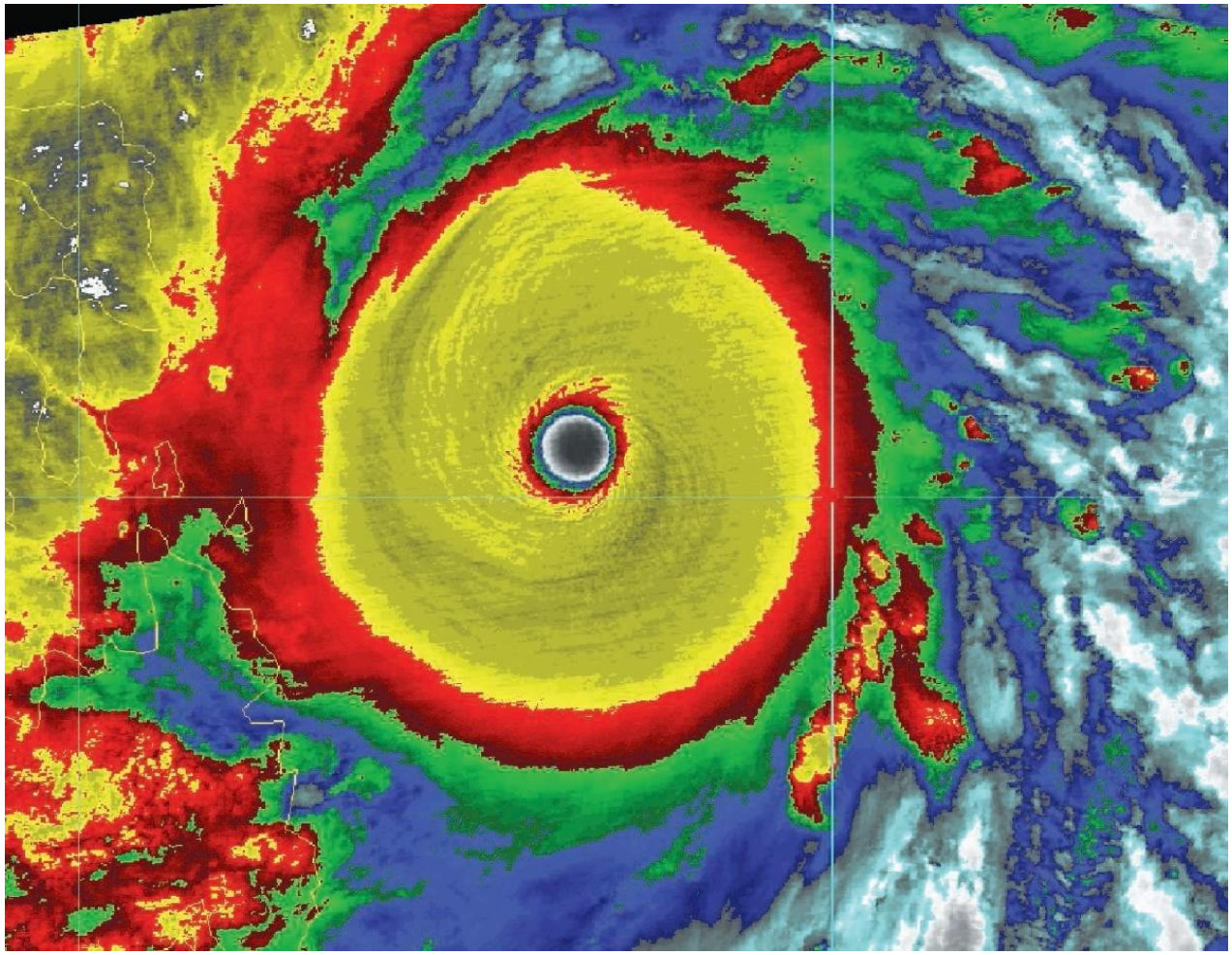
PHYSICS OF COMPLEX SYSTEMS :

Landfall or not? Forecasts disagree on path of dangerous Typhoon Hagupit as it nears the Philippines



http://www.washingtonpost.com/blogs/capital-weather-gang/wp/2014/12/03/landfall-or-not-forecasts-disagree-on-path-of-dangerous-typhoon-hagupit-as-it-nears-the-philippines/

Typhoons are large-scale single vortices.



Typhoon Haiyan
www.sciencemag.org SCIENCE Vol. 342 29 November 2013, p. 1027.

Hurricane Isabel (2003) as seen from orbit during Expedition 7 of the International Space Station. The eye, eyewall, and surrounding rainbands, characteristics of tropical cyclones, are clearly visible in this view from space.

https://en.wikipedia.org/wiki/Tropical_cyclone

Physics Letters A 378 (2014) 2016–2019

Contents lists available at ScienceDirect

Physics Letters A

www.elsevier.com/locate/pla

Modified diffusion with memory for cyclone track fluctuations

Christopher C. Bernido [a,*], M. Victoria Carpio-Bernido [a], Matthew G.O. Escobido [b]

[a] Research Center for Theoretical Physics, Central Visayan Institute Foundation, Jagna, Bohol 6308, Philippines
[b] W. Sycip Graduate School of Business, Asian Institute of Management, 123 Paseo de Roxas Ave., Makati City 1260, Philippines

ARTICLE INFO

Article history:
Received 28 March 2014
Received in revised form 1 June 2014
Accepted 2 June 2014
Available online 5 June 2014
Communicated by C.R. Doering

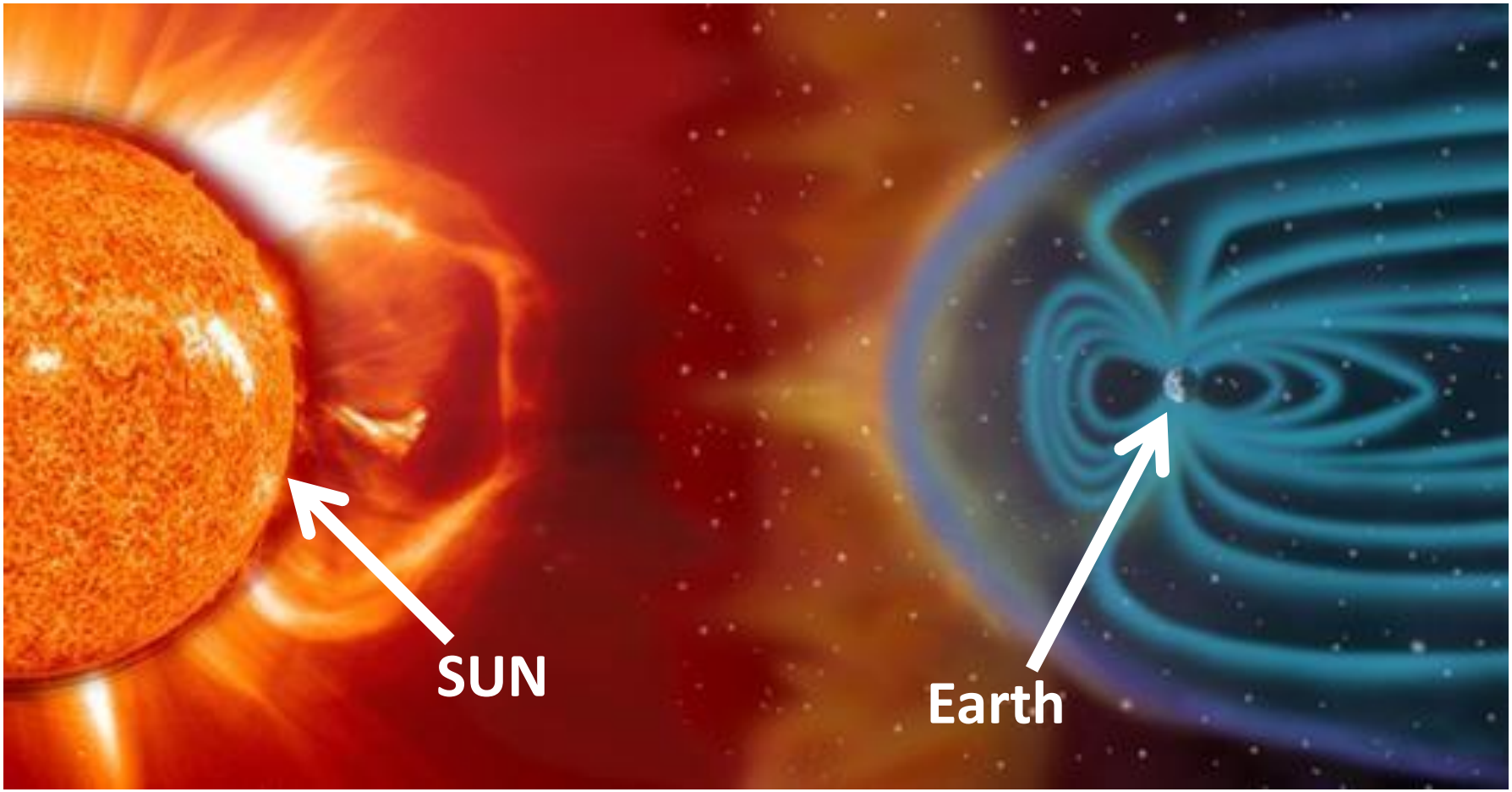
Keywords:
Exponentially modified Brownian motion
Cyclone track fluctuations
Fluctuations with memory

ABSTRACT

Fluctuations in a time series for tropical cyclone tracks are investigated based on an exponentially modified Brownian motion. The mean square displacement (MSD) is evaluated and compared to a recent work on cyclone tracks based on

SOLAR PHYSICS :

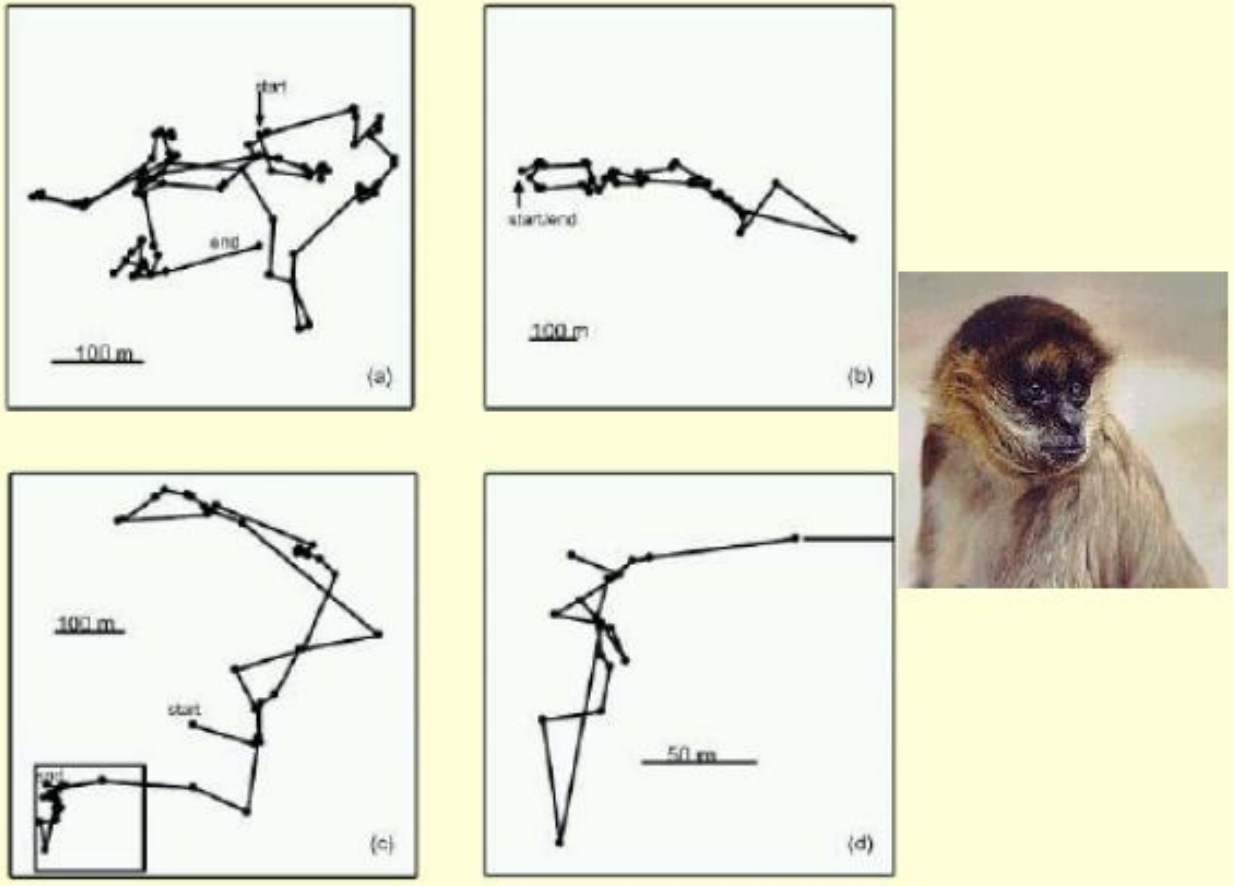
Understanding Space Weather & Geomagnetic Fluctuations



http://www.seeker.com/5-ways-the-solar-wind-will-blow-you-away-slide-show-1766283848.html?slide=xEbuKn

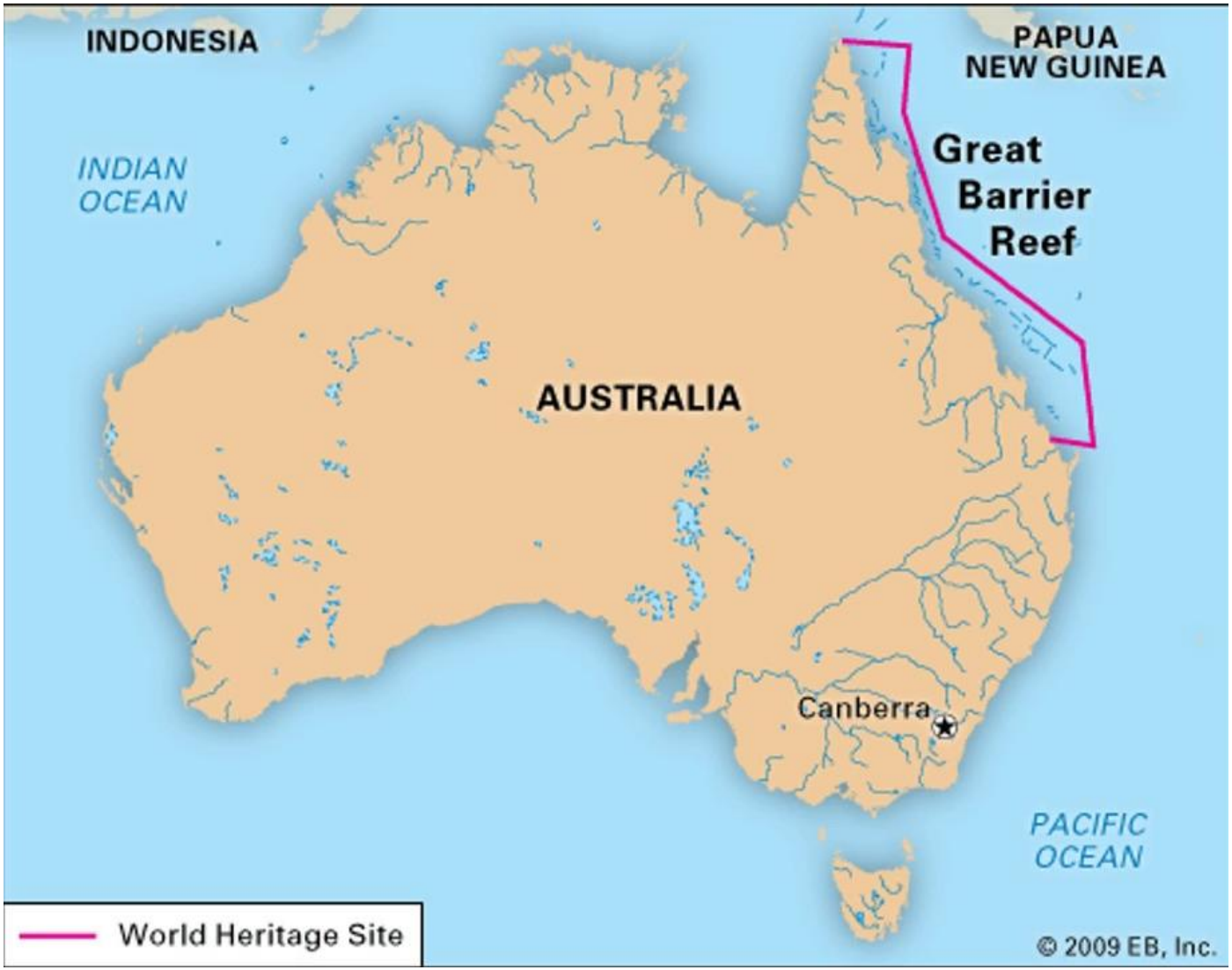
PHYSICS OF COMPLEX SYSTEMS :

Searching for Food



http://www.uni-leipzig.de/~diff/powerpoint_presentations/pdf/klafter.pdf

EARTH AND MARINE PHYSICS :



https://i.ytimg.com/vi/iZo7d8H8WzA/maxresdefault.jpg

EARTH AND MARINE PHYSICS :

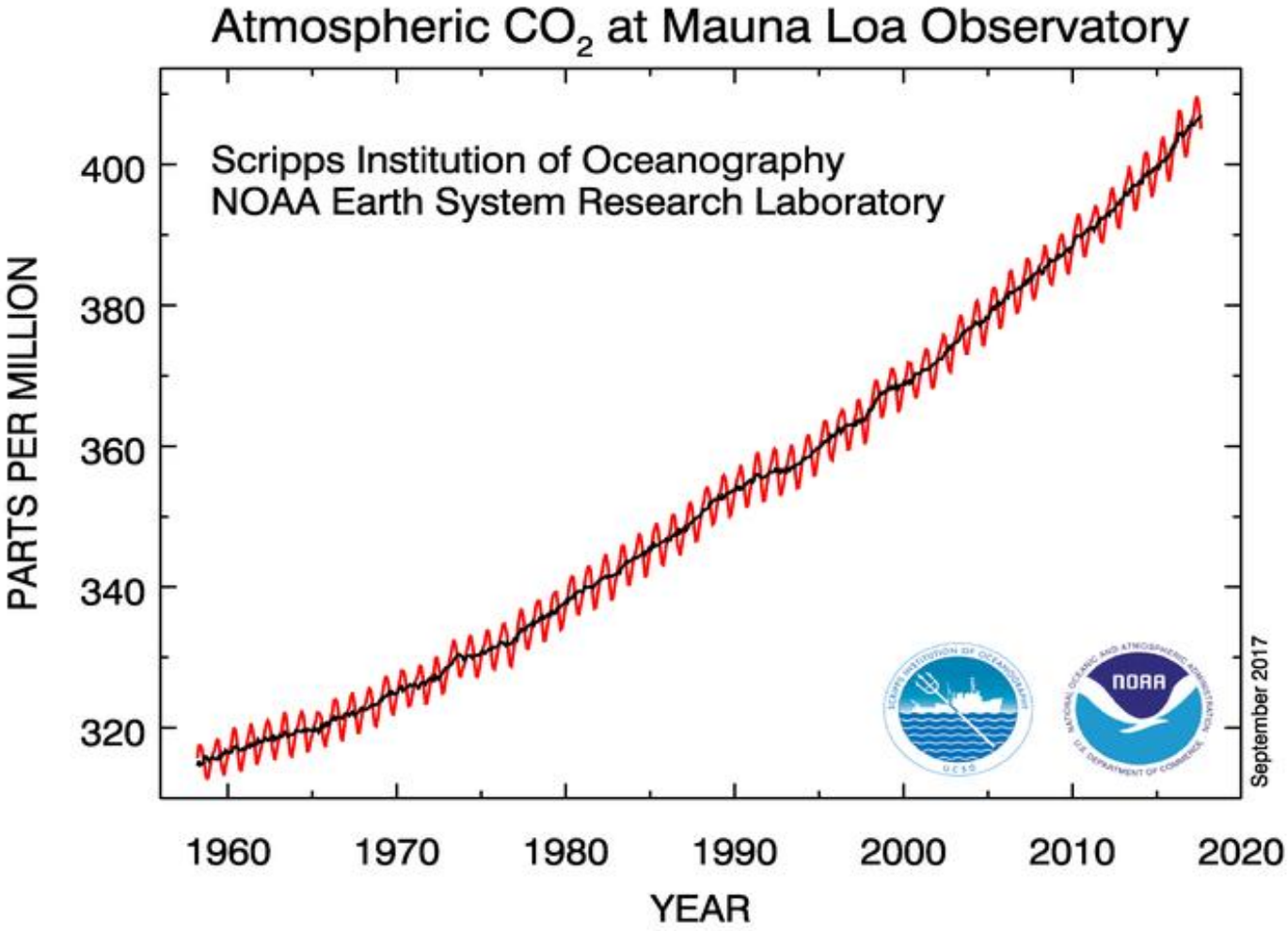
The past 30 years witnessed the loss of *half the coral cover* of the Great Barrier Reef due to elevated sea surface temperature, ocean acidification, and typhoons, among others.

http://www.aims.gov.au/documents/30301/2107350/Acidification.pdf/4224fe9f-efd2-4f91-a7b2-604137a87f2d

https://thumbnails.trvl-media.com/zcvYGoswHQ7jvcxujhBOVsW2jTI=/768x432/images.trvl-media.com/media/content/shared/images/travelguides/destination/889/Great-Barrier-Reef-29303.jpg

https://www.vox.com/science-and-health/2016/11/29/13781434/great-barrier-reef-coral-dead

ATMOSPHERIC PHYSICS :



Data (red) of the rising atmospheric CO_2

Comparing Fluctuations in CO_2 Levels and Percent of Great Barrier Reef (GBR) Coral Cover

GBR Coral Cover

$$x = x_0 + \int_0^T (T-t)^{\frac{\mu-1}{2}} t^{\frac{\mu-1}{2}} \sqrt{\cos(at)}\, dB(t)$$

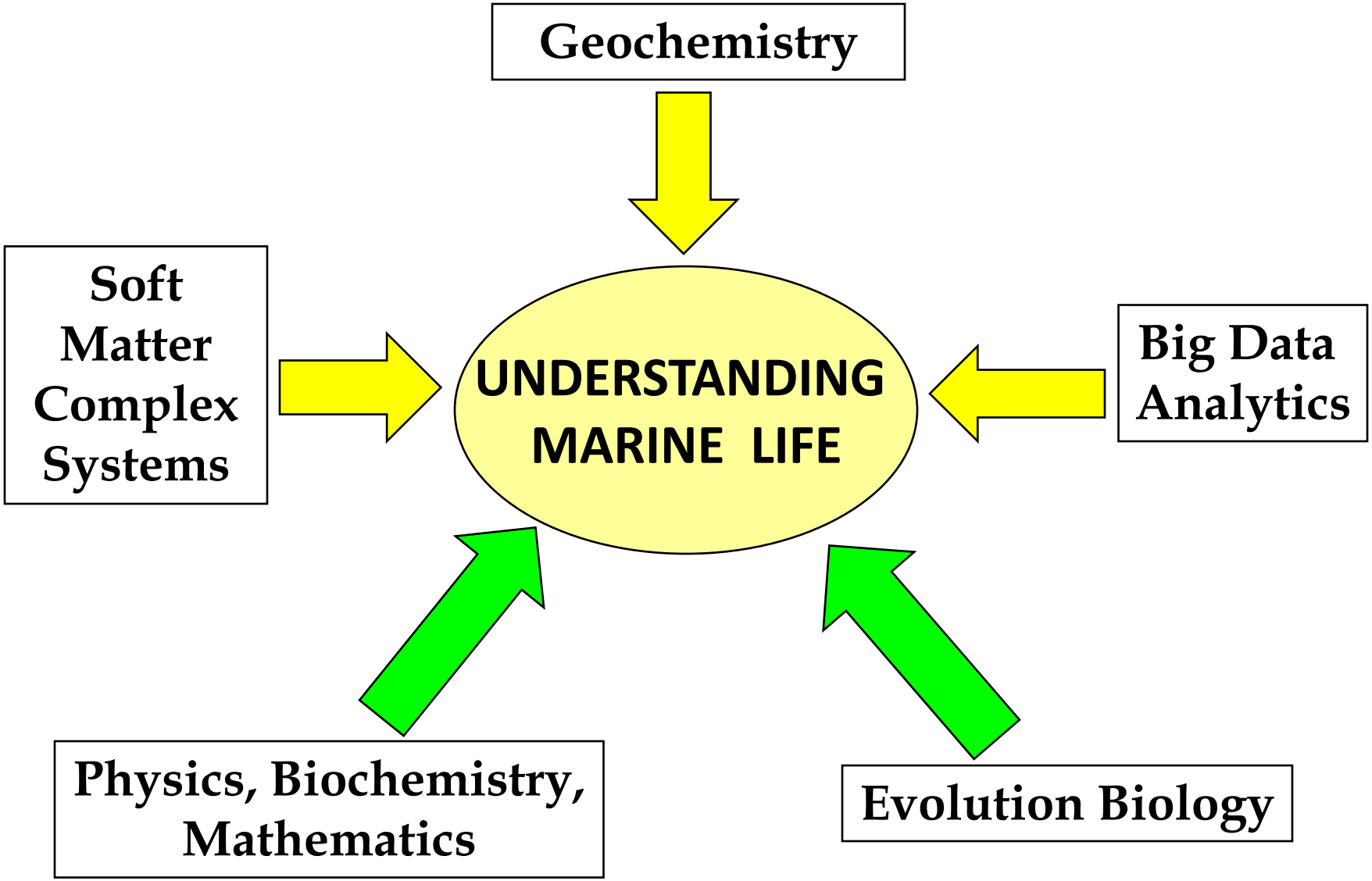
Difference

CO_2 Levels

$$x = x_0 + \int_0^T (T-t)^{\frac{\mu-1}{2}} t^{\frac{\mu-1}{2}} e^{at/2}\, dB(t)$$

THE SAME MEMORY FUNCTION

$$(T-t)^{\frac{(\mu-1)}{2}}$$


Geochemistry
Soft Matter Complex Systems
UNDERSTANDING MARINE LIFE
Big Data Analytics
Physics, Biochemistry, Mathematics
Evolution Biology

The Coral Triangle

Contains 30 percent of the world's reefs and more than 3,000 species of fish

— Coral Triangle Region Core Reefs

CHINA

TAIWAN

PHILIPPINES

PACIFIC OCEAN

MALAYSIA

INDONESIA

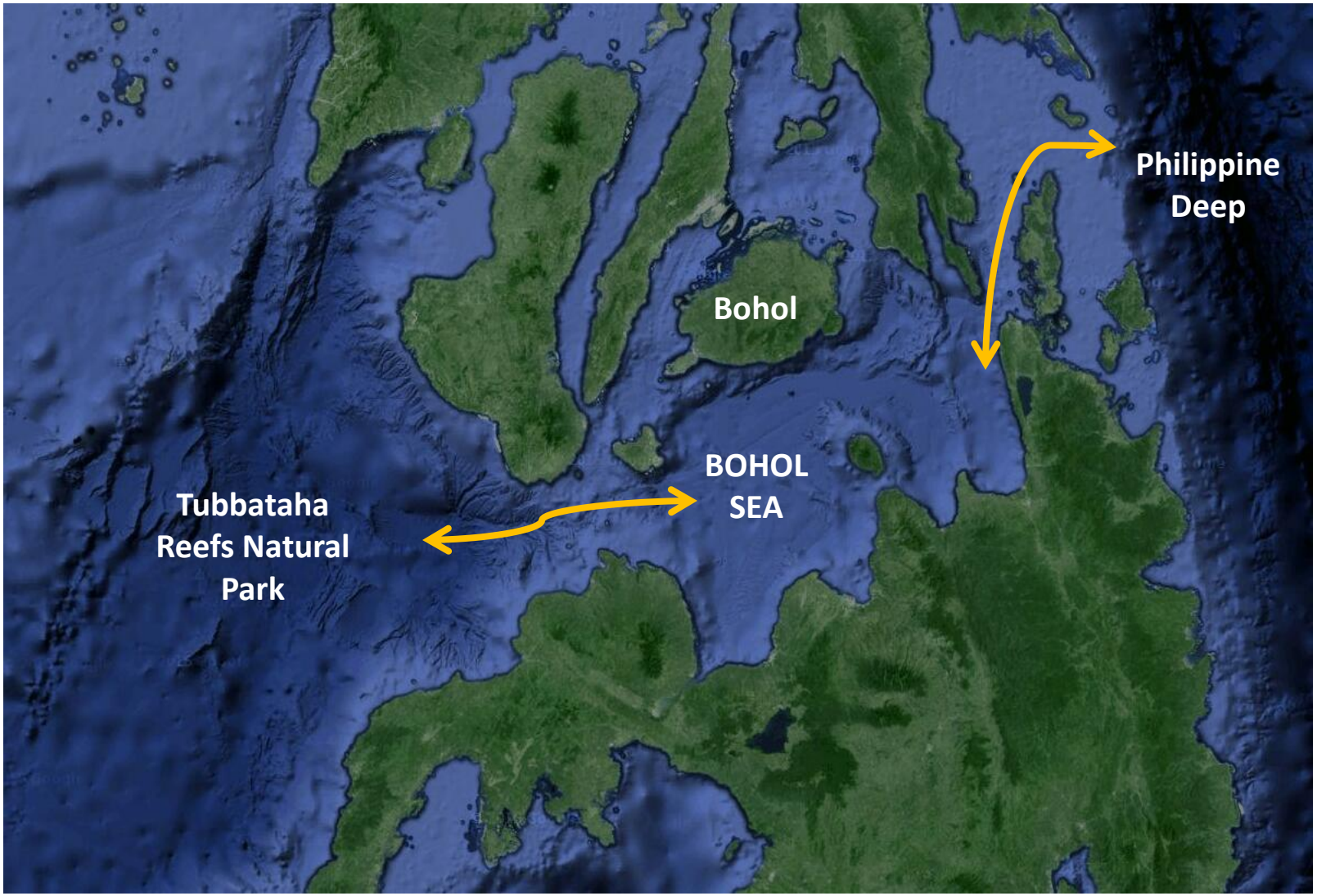
PAPUA NEW GUINEA

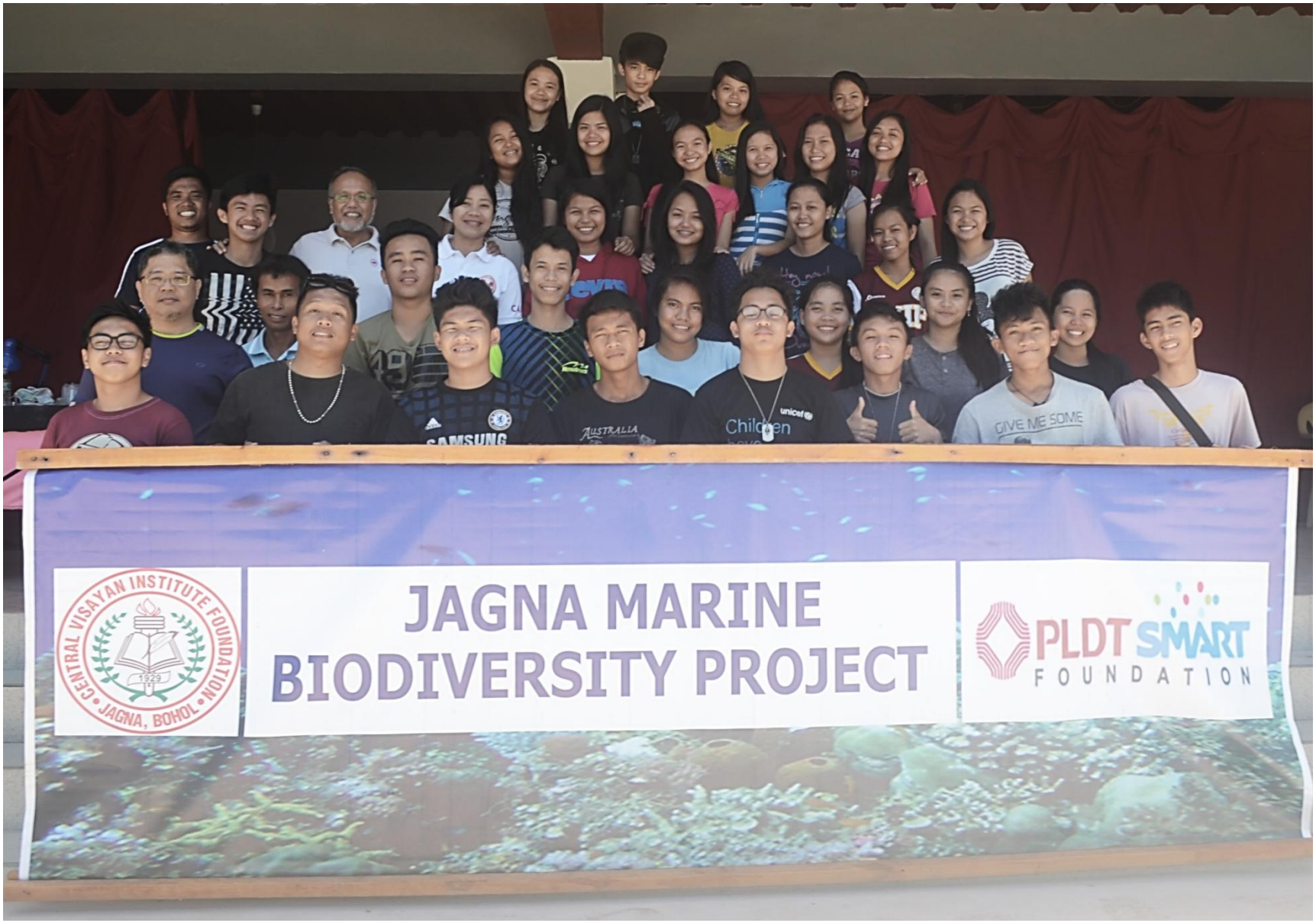
AUSTRALIA

750 km

Source: WWF/WRI

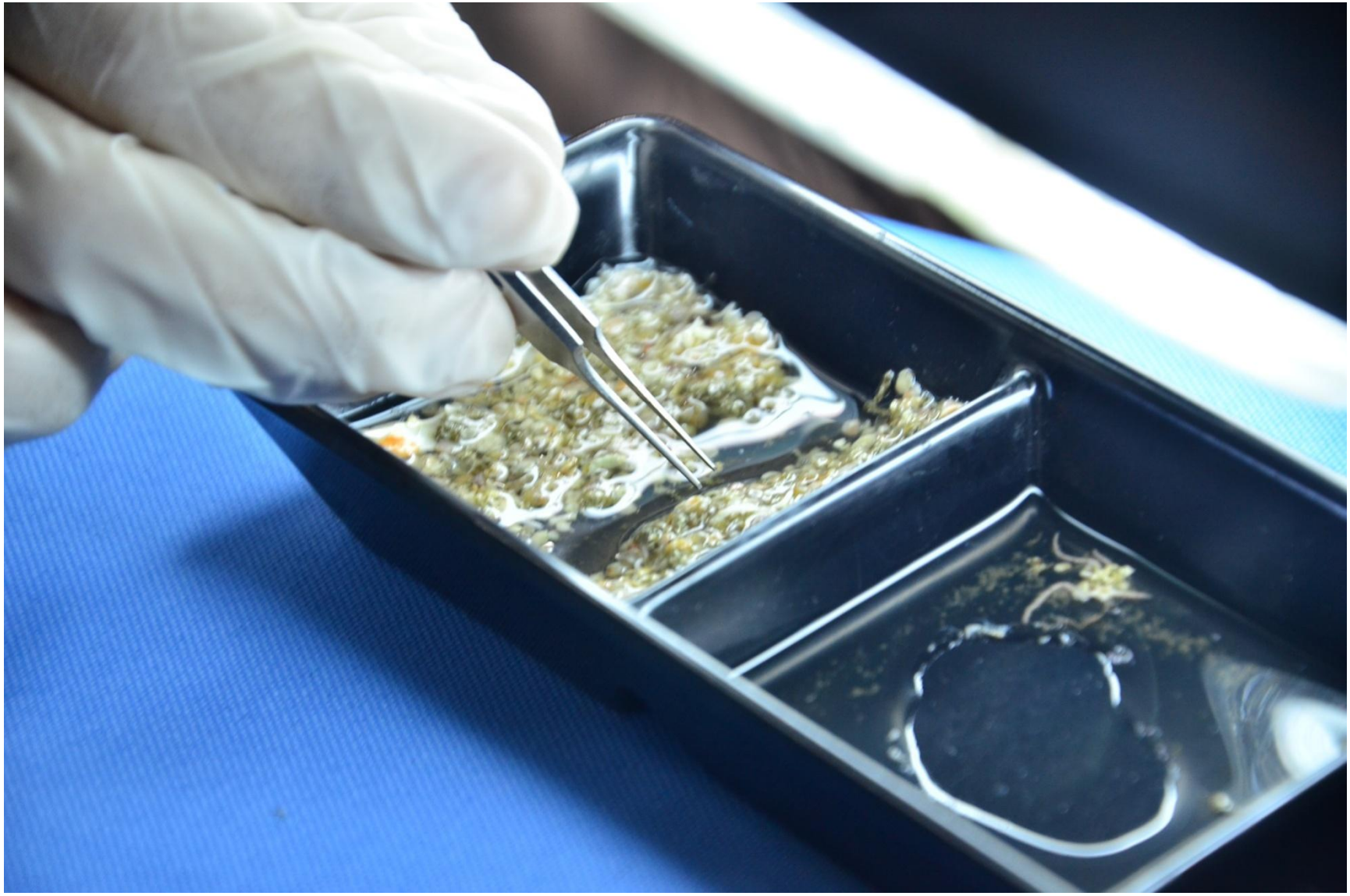
AFP


Philippine
Deep
Bohol
BOHOL
SEA
Tubbataha
Reefs Natural
Park

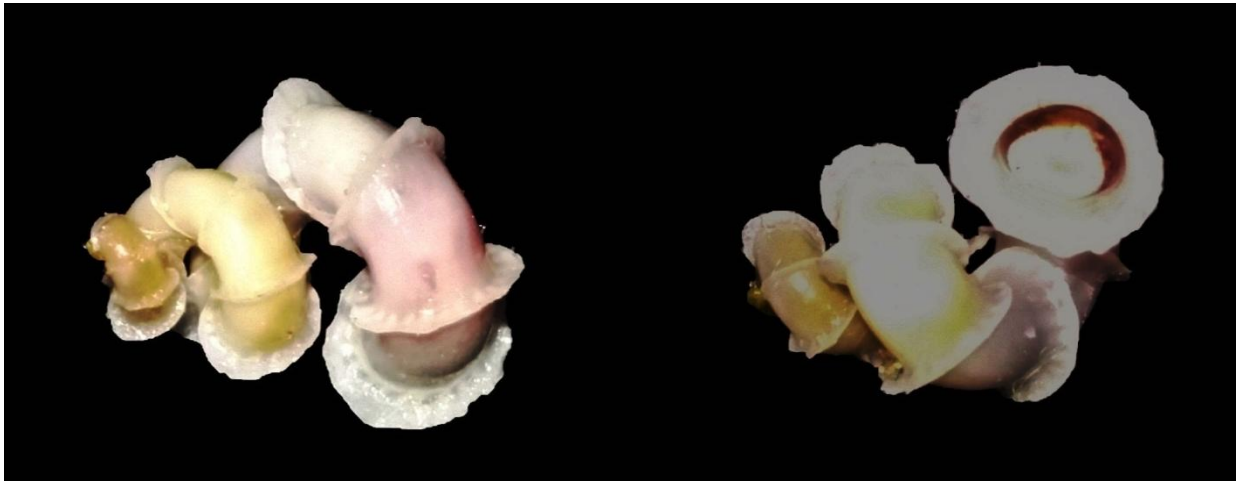

CENTRAL VISAYAN INSTITUTE FOUNDATION
1929
JAGNA, BOHOL
JAGNA MARINE
BIODIVERSITY PROJECT
PLDT SMART
FOUNDATION

INTERTIDAL COLLECTION

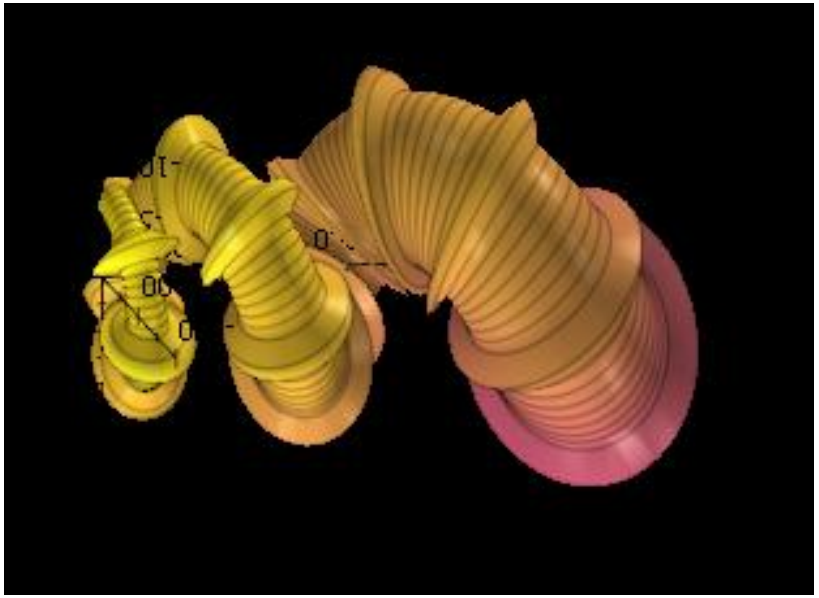
Students sorting and classifying microorganisms from the sea.

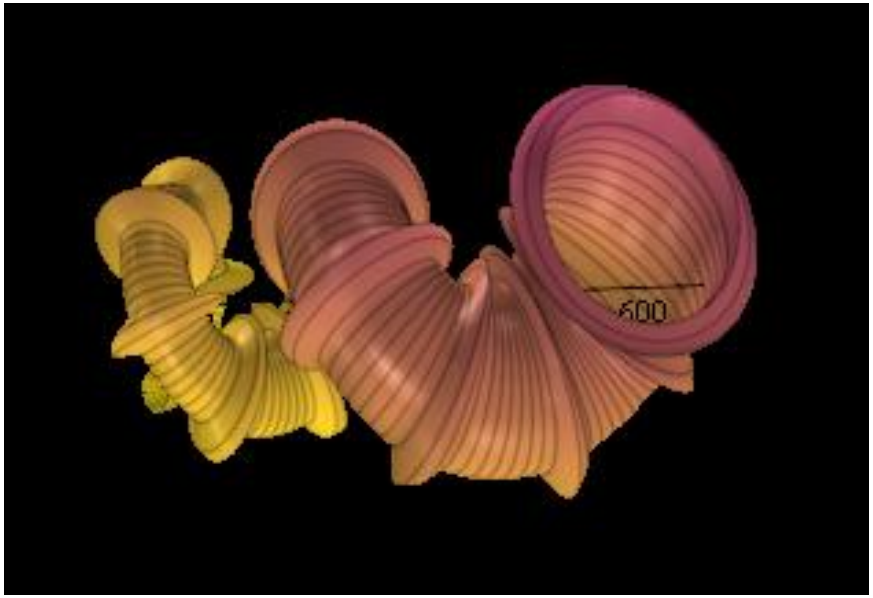


Sorting and classifying microorganisms from the sea.

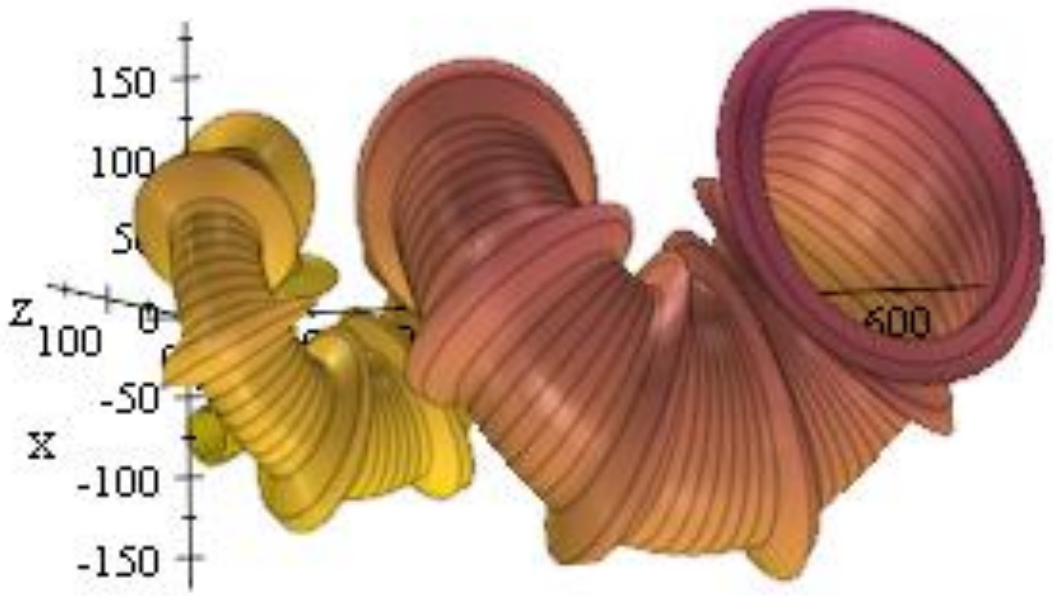


Cycloscala above is modelled mathematically below:





$$[x, y, z] = [75\cos(2.2t), 10t^2, -75\sin(2.2t)]$$



Growth as a function of time t :

$$[x, y, z] = [75\cos(2.2t), 10t^2, -75\sin(2.2t)]$$

Tube radius r as a function of time t (*with Ribs*):

$$10\exp\left(1.6(\sin(6.8t))^{22}\right) + (2+t)^2$$

Cycloscala hyalina

Turkey, Hatay, Iskenderun

NMR 32389. Common size 8 mm

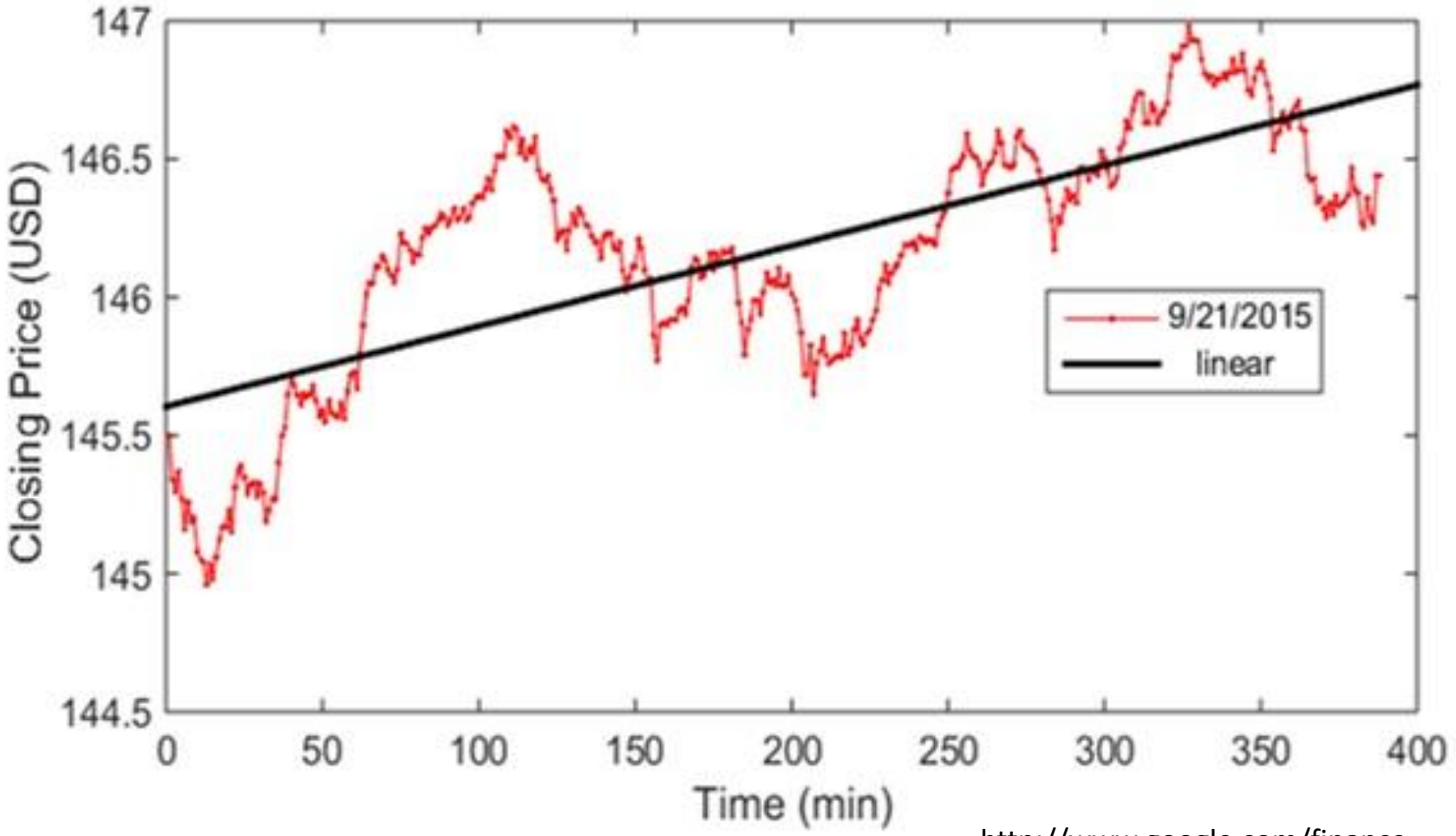
Taxonomic Classification of Mollusks

SPECIMEN	Primary Structural Curve Parameters			
	a	b	c	d
***Cycloscala* from Jagna Bay**	75	2.2	10	2
***Cycloscala* hyalina from Turkey**	$\sqrt{t}\exp\left(\frac{t}{1.7}\right)$	5.5	1	3.2

C. Bernido et al, AIP Conference Proceedings 1871, 060005 (2017).

ECONOPHYSICS :

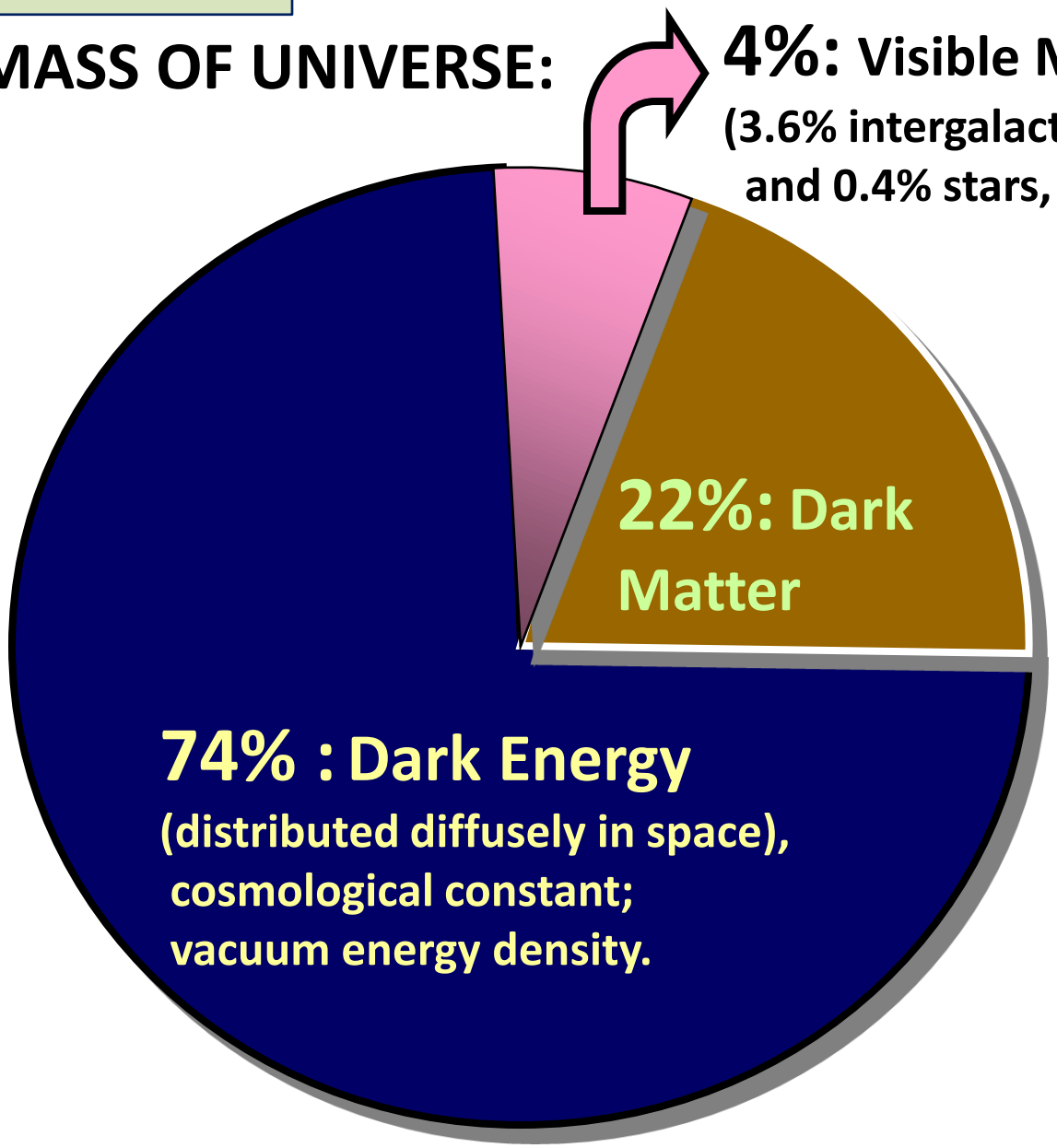
IBM Closing Price on 21 September 2015



http://www.google.com/finance

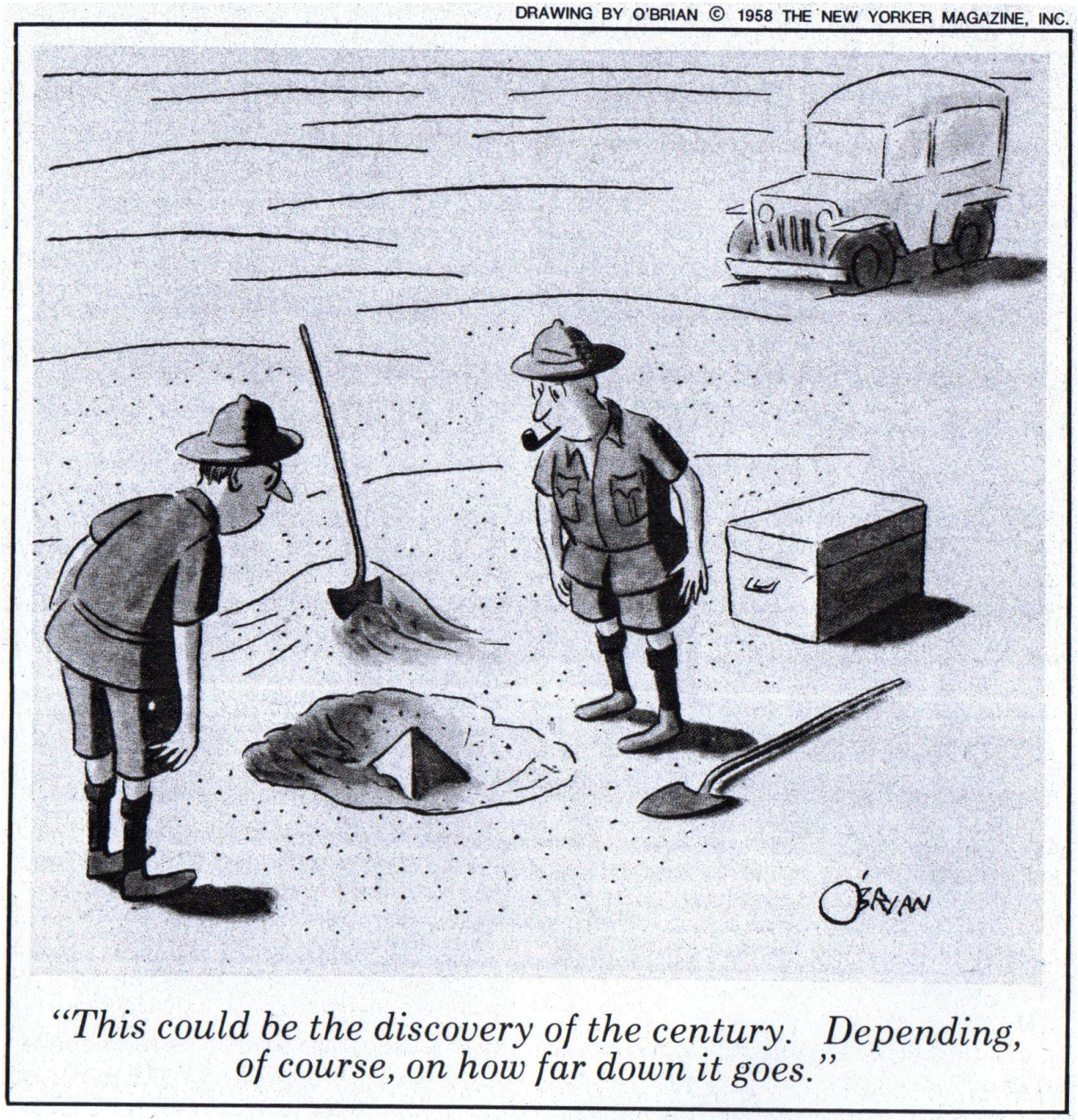
COSMOLOGY :

MASS OF UNIVERSE:



Dark Matter :

Is it composed of new types of Fundamental Particles?



Adopted from:
Physics Today
April 1979, p. 41

METHODS AND APPLICATIONS OF
WHITE NOISE ANALYSIS
IN INTERDISCIPLINARY SCIENCES

Analysis, modeling, and simulation for better understanding of diverse complex natural and social phenomena often require powerful tools and analytical methods. Tractable approaches, however, can be developed with mathematics beyond the common toolbox. This book presents the white noise stochastic calculus, originated by T Hida, as a novel and powerful tool in investigating physical and social systems. The calculus, when combined with Feynman's summation-over-all-histories, has opened new avenues for resolving cross-disciplinary problems. Applications to real-world complex phenomena are further enhanced by parametrizing non-Markovian evolution of a system with various types of memory functions. This book presents general methods and applications to problems encountered in complex systems, scaling in industry, neuroscience, polymer physics, biophysics, time series analysis, relativistic and nonrelativistic quantum systems.

World Scientific
www.worldscientific.com
8988 hc

ISBN 978-981-4583-11-8

METHODS AND APPLICATIONS OF WHITE NOISE ANALYSIS IN INTERDISCIPLINARY SCIENCES

Bernido
Carpio-Bernido

METHODS AND APPLICATIONS OF WHITE NOISE ANALYSIS IN INTERDISCIPLINARY SCIENCES

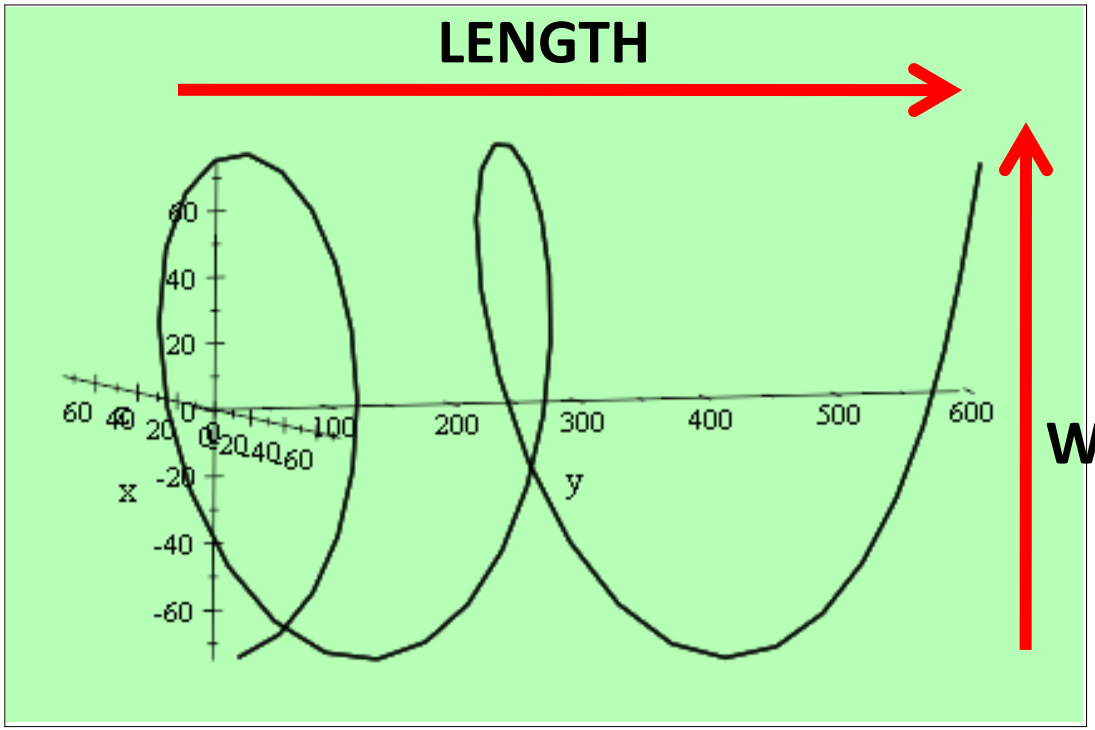
Christopher C Bernido
M Victoria Carpio-Bernido

World Scientific

THANK YOU !

The parameters a, b, c, d characterize the **primary structural curve** of the shell.

$$x = a\cos(b\,t)$$
$$y = c\,t^{d}$$
$$z = -a\sin(bt)$$



$a = 75\,,\quad b = 2.2,\quad c = 10,\quad d = 2$