

IS THERE INTELLIGENT LIFE ANYWHERE?

**IS THERE IS INTELLIGENT LIFE ON
EARTH?**

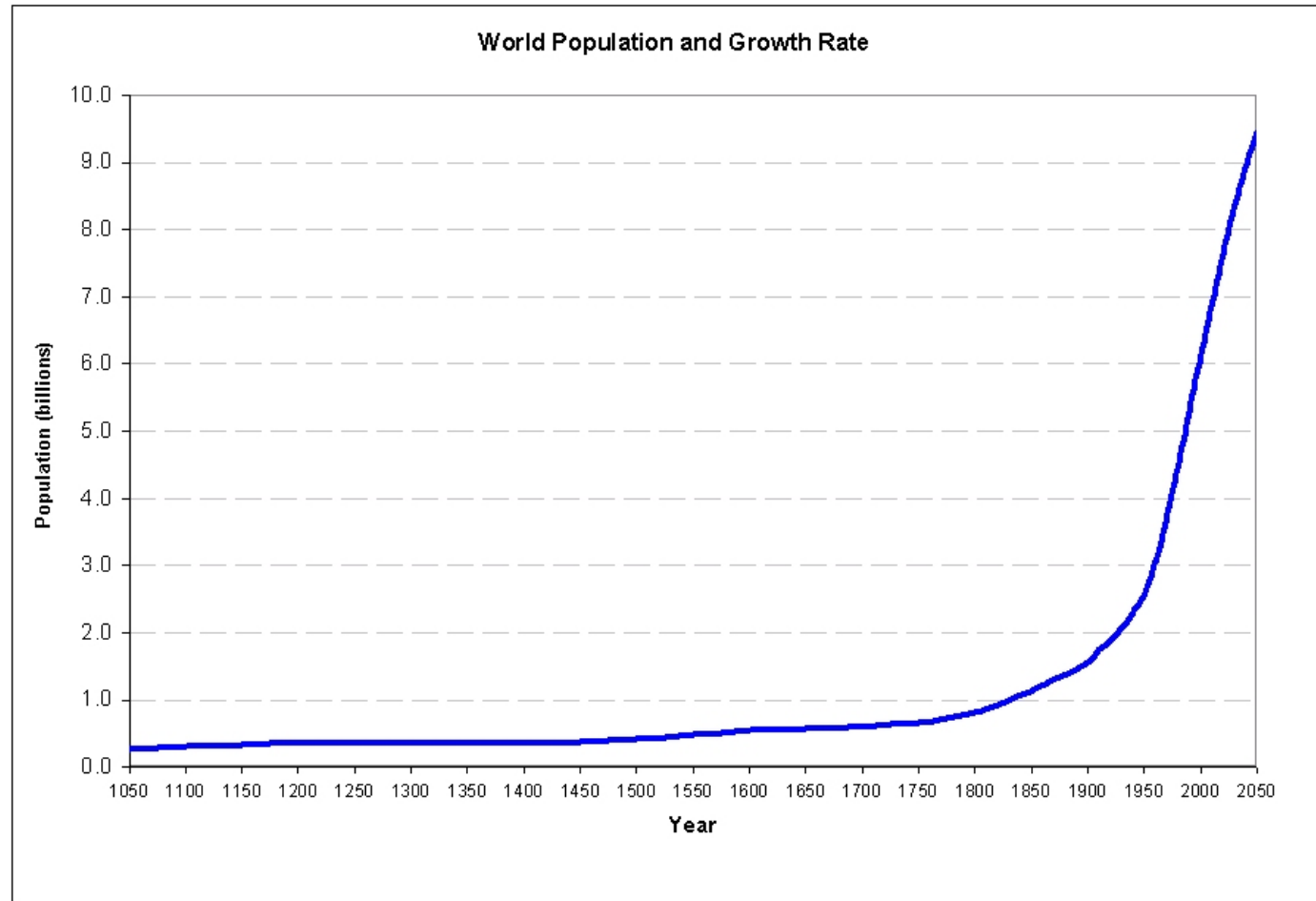
INTELLIGENCE - OED

**THE ABILITY TO ACQUIRE AND APPLY
KNOWLEDGE AND SKILLS.**

GENESIS 1:28

**“AND GOD BLESSED THEM, AND GOD SAID UNTO THEM, BE FRUITFUL, AND MULTIPLY, AND REPLENISH THE EARTH
....”**

WORLD POPULATION AND GROWTH

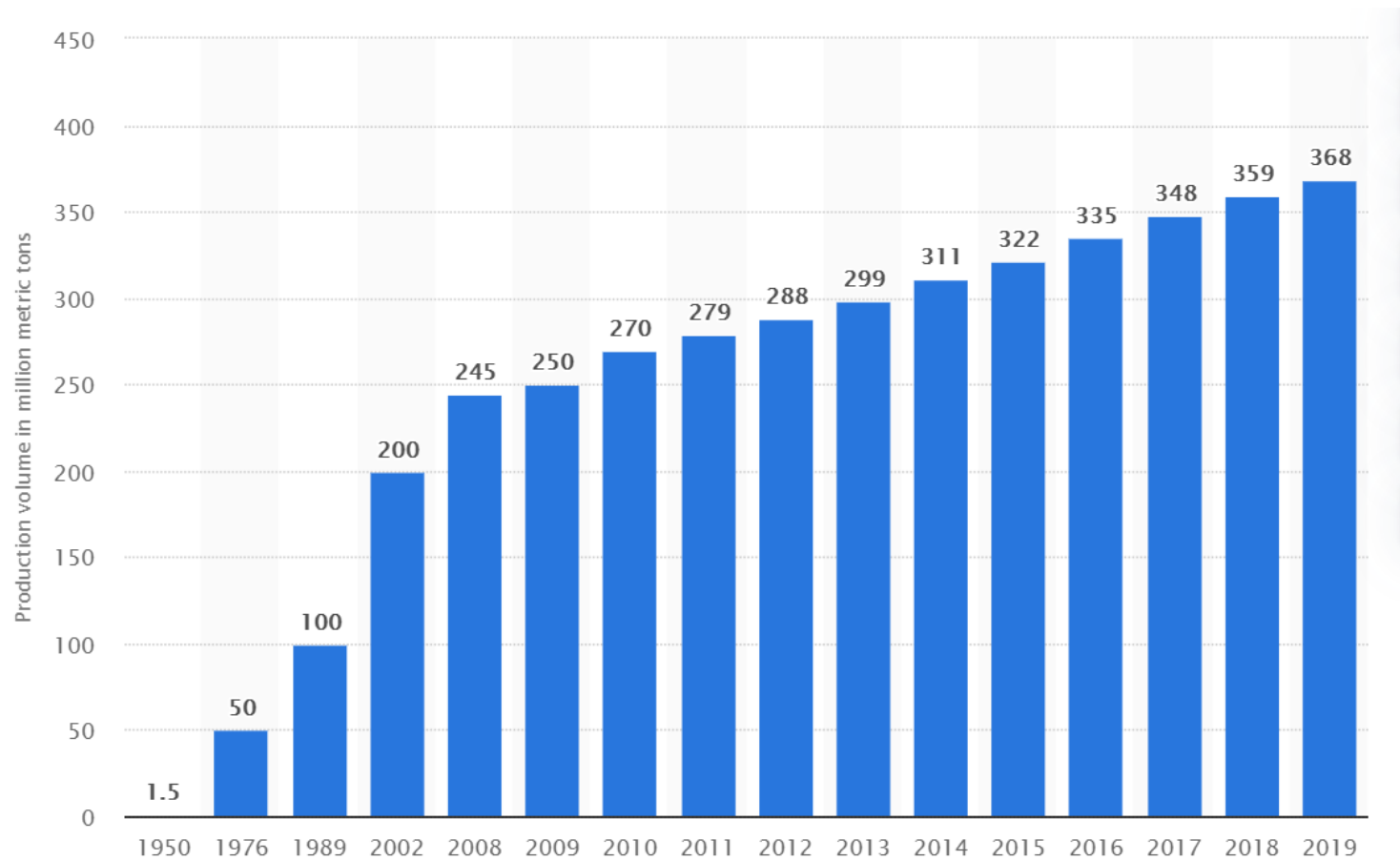


GENESIS 1:28.1

**“AFTER THE POPULATION GROWTH
CURVE TENDS TOWARDS THE VERTICAL,
YOU HAVE COMPLETED YOUR TASK.
NOW, YOU CAN REST.”**

**THE PLANET IS DROWNING IN THE
MOST USEFUL MATERIAL EVER
INVENTED.**

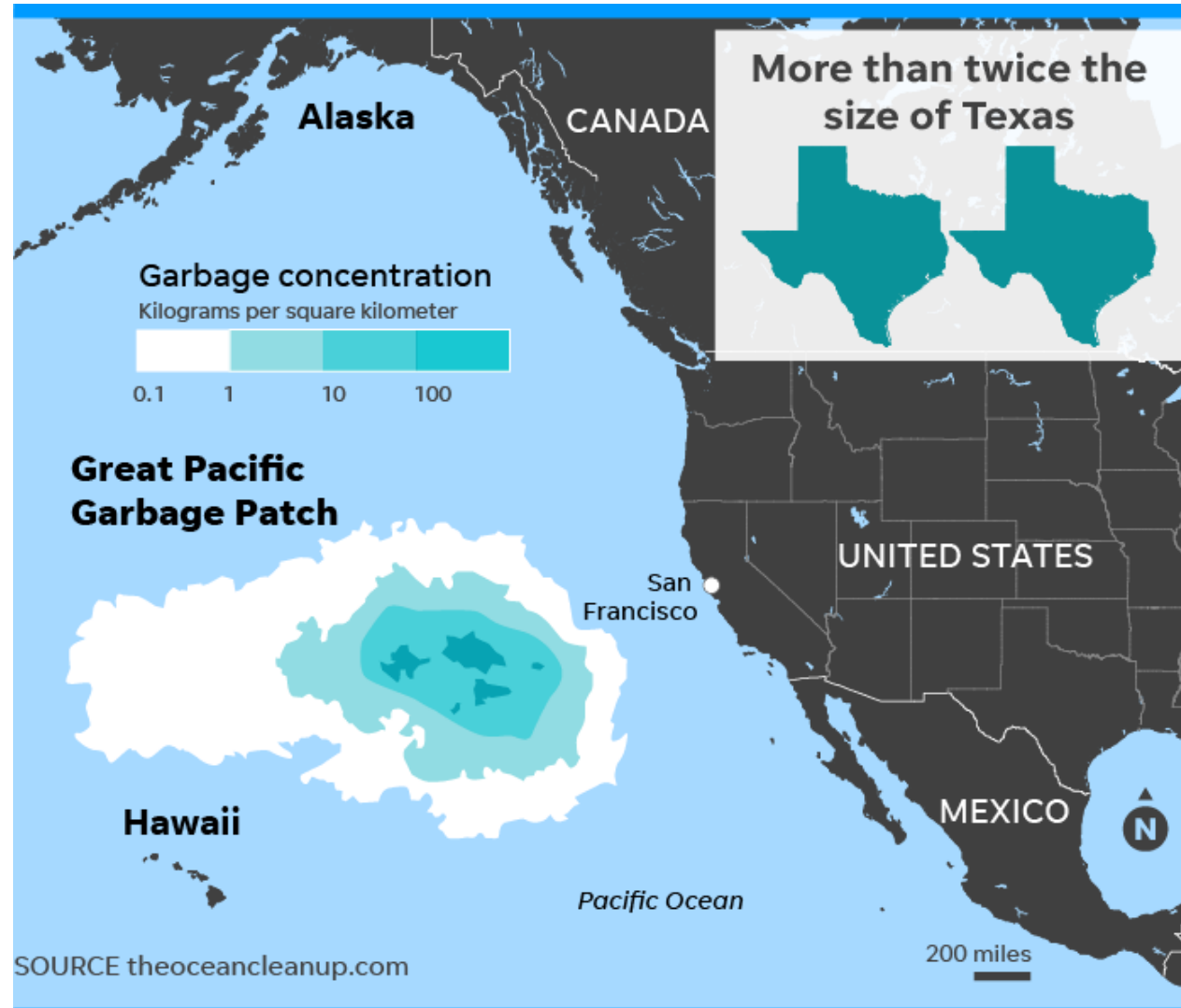
PRODUCTION OF PLASTICS WORLDWIDE



SARGASSO SEA



GREAT PACIFIC GARBAGE PATCH



GREAT PACIFIC GARBAGE PATCH



Like Comment



Ripley's Believe It or Not!

Album: Timeline Photos

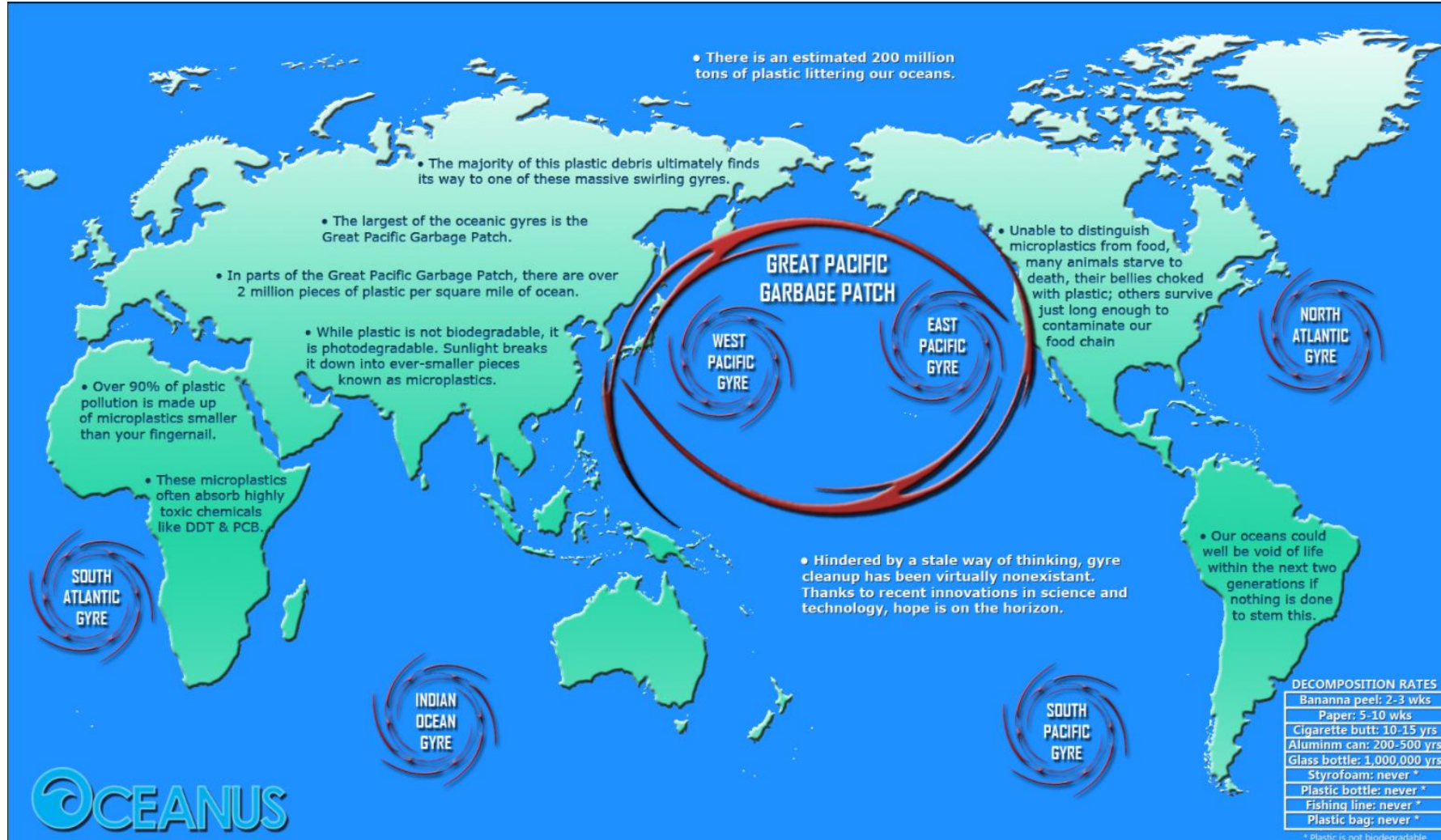
THE GREAT WAVE OF KANAGAWA



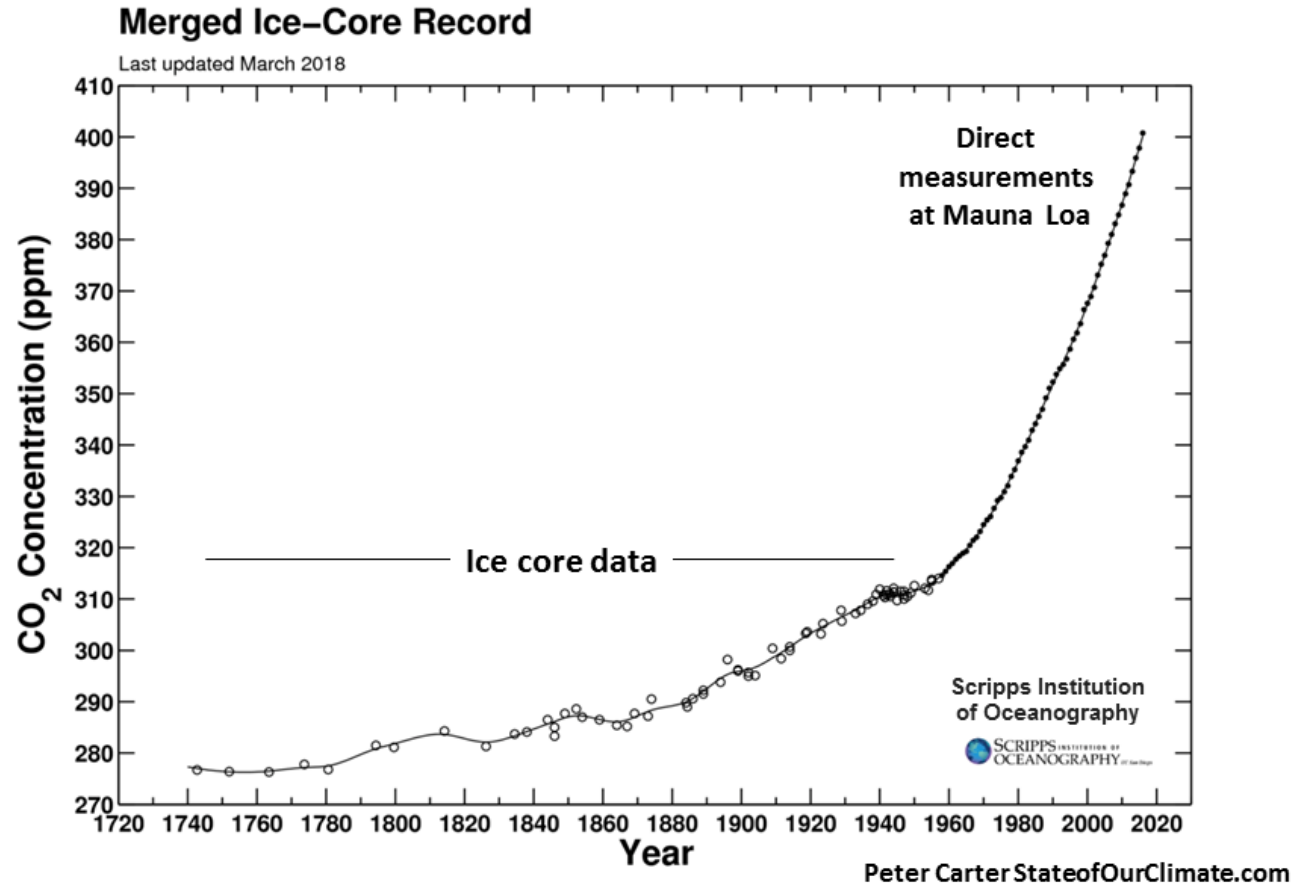
THE GREAT GARBAGE WAVE



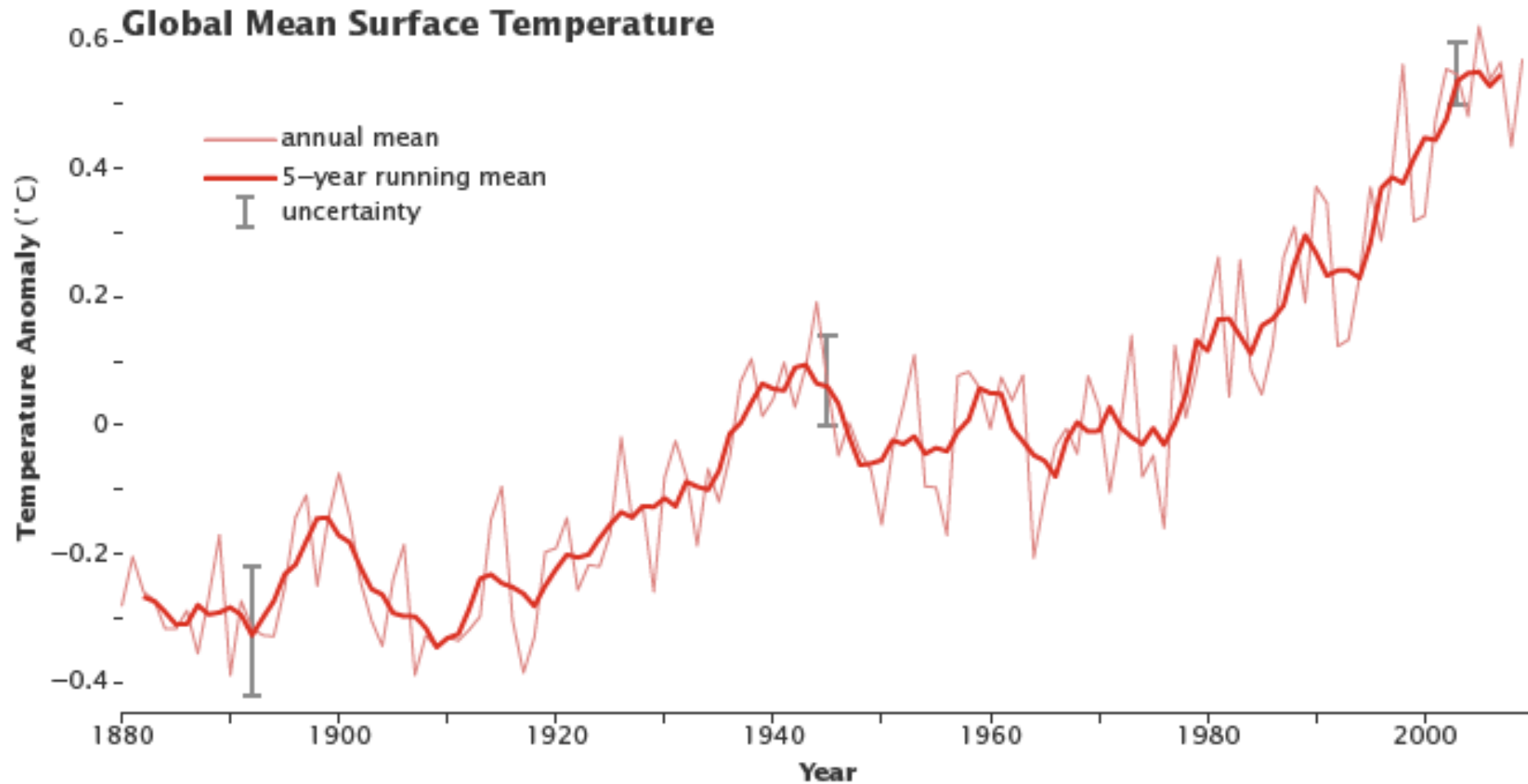
OCEAN GYRES



ACCELERATING ATMOSPHERIC CO₂ CONCENTRATION 1720 – MARCH 2018



GLOBAL MEAN SURFACE TEMPERATURE



MANHATTAN SIZE ICEBERG BREAKS OFF THE BRUNT GLACIER



**THE INTELLIGENT LIFE ON EARTH IS
HARMFUL TO THE PLANET AND ITS
INHABITANTS.**

BIOLOGICAL DEFINITION OF LIFE

**THE CAPACITY TO GROW, METABOLIZE, RESPOND TO STIMULI,
ADAPT, AND REPRODUCE.**

SVANTE ARRHENIUS (1859-1927)



PANSPERMIA

- IN 1903, ARRHENIUS PUBLISHED HIS PAPER THE DISTRIBUTION OF LIFE IN SPACE
- HYPOTHESIS THAT LIFE EXISTS THROUGHOUT THE UNIVERSE
- DISTRIBUTED BY SPACE DUST, METEORIDS, ASTEROIDS, COMETS, AND PLANETOIDS

THOMAS GOLD (1920-2004)



COSMIC GARBAGE THEORY

- POSSIBILITY THAT EXTRATERRESTRIAL SPACE TRAVELERS MAY HAVE VISITED EARTH A LONG TIME AGO
- UNINTENTIONALLY BROUGHT LIFE TO EARTH WITH THEIR LEFTOVER WASTE

ARRHENIS' AND GOLD'S IDEAS

DO NOT ANSWER THE QUESTION OF THE ORIGIN OF LIFE, BUT MERELY PLACES IT ON ANOTHER CELESTIAL BODY.

JAMES JEANS (1887-1946)



THOMAS HUXLEY (1825-1895)



SIX MONKEYS THEOREM

- STRUMMING UNINTELLIGENTLY ON SIX TYPEWRITERS
- FOR MILLIONS AND MILLIONS OF YEARS
- WOULD EVENTUALLY TYPE ALL THE BOOKS IN THE BRITISH MUSEUM

TO BE, OR NOT TO BE ...



THE POWER OF RANDOM PROCESSES AND UNIMAGINABLE LENGTHS OF TIME

MAKING A DECISION



ALEXANDER OPARIN (1894-1980)



SOVIET SOUP

ALEXANDER OPARIN POSTULATED HIS PRIMORDIAL SOUP THEORY IN RUSSIAN IN 1924 IN A SMALL PAMPHLET TITLED *PROISKHOZHDENIE ZHIZNY (THE ORIGIN OF LIFE)*.

JOHN HALDANE (1892-1964)



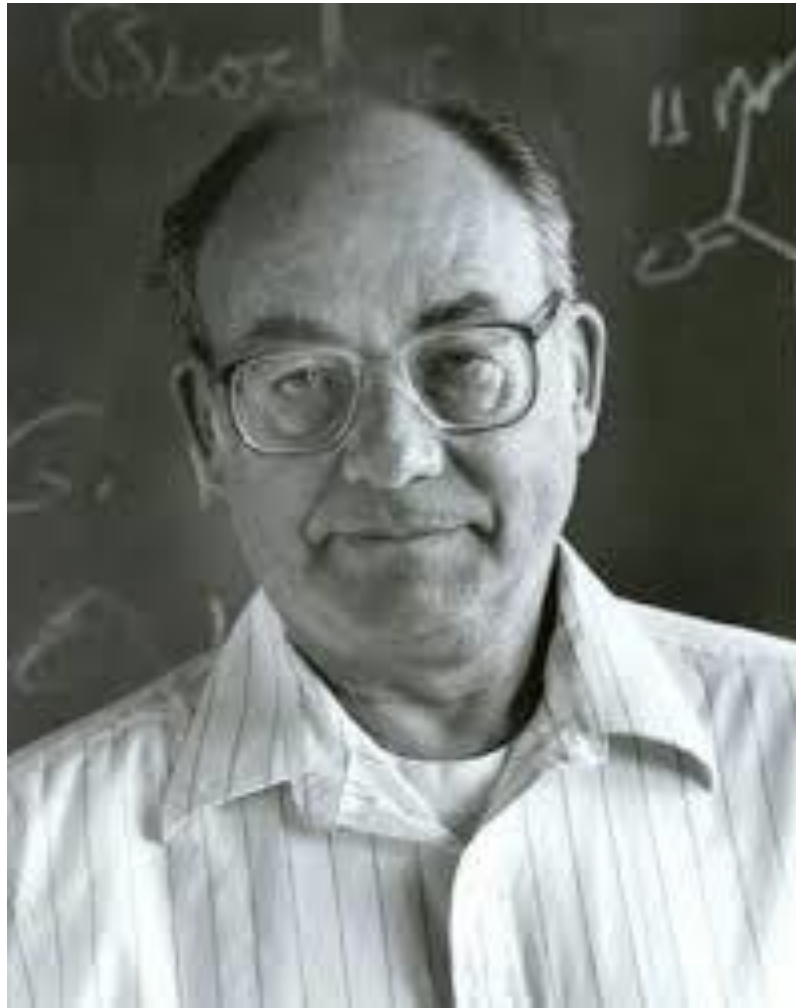
BRITISH SOUP

HALDANE INDEPENDENTLY POSTULATED HIS PRIMORDIAL SOUP THEORY IN 1929 IN AN EIGHT-PAGE ARTICLE "THE ORIGIN OF LIFE" IN *THE RATIONALIST ANNUAL*.

OPARIN AND HALDANE HYPOTHESIS

TESTED BY MILLER AND UREY

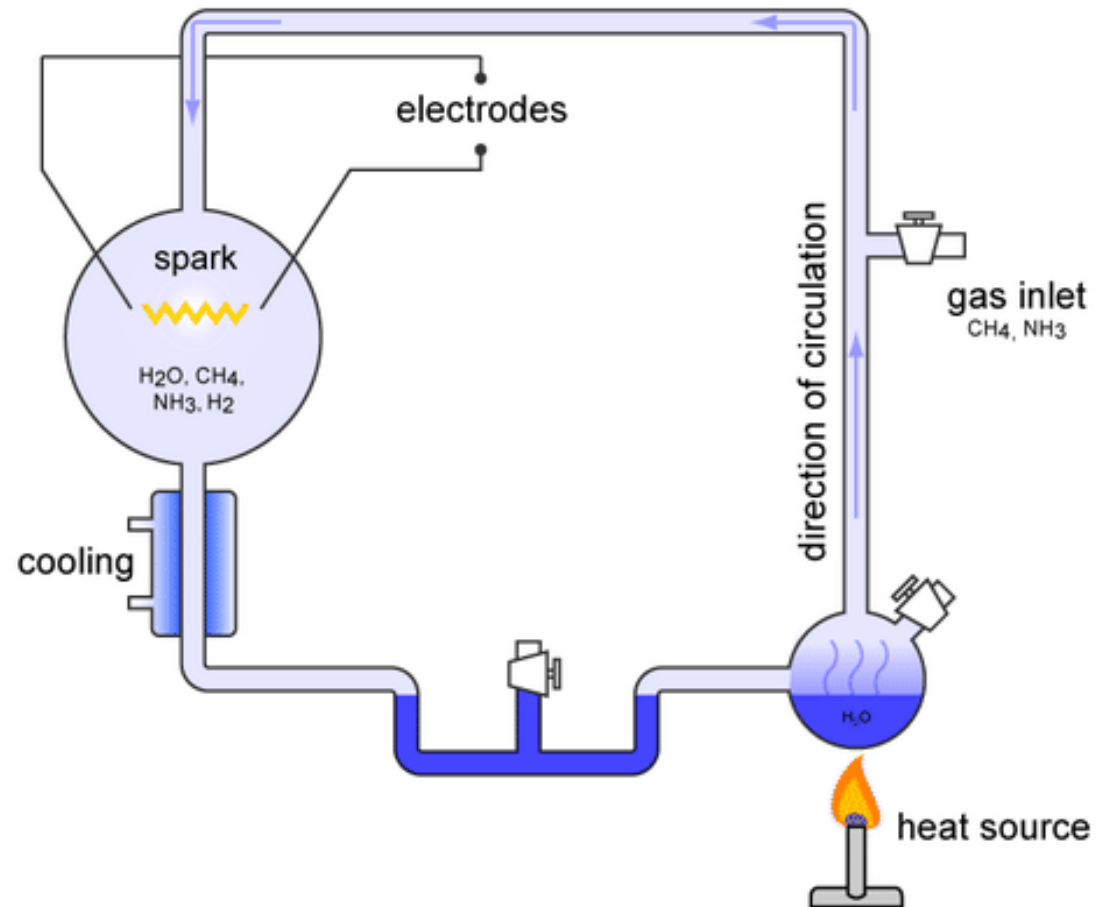
STANLEY MILLER (1930-2002)



HAROLD UREY (1893-1981)



MILLER – UREY APPARATUS



MILLER-UREY FINDING

- IT ESTABLISHED THAT EARTH'S PRIMITIVE ATMOSPHERE WAS CAPABLE OF PRODUCING THE BUILDING BLOCKS OF LIFE FROM INORGANIC MATERIALS.

**IS THERE INTELLIGENT LIFE
BEYOND EARTH?**

**SEARCHING FOR INTERSTELLAR
COMMUNICATIONS, 1959
GIUSEPPE COCCONI AND PHILIP MORRISON**



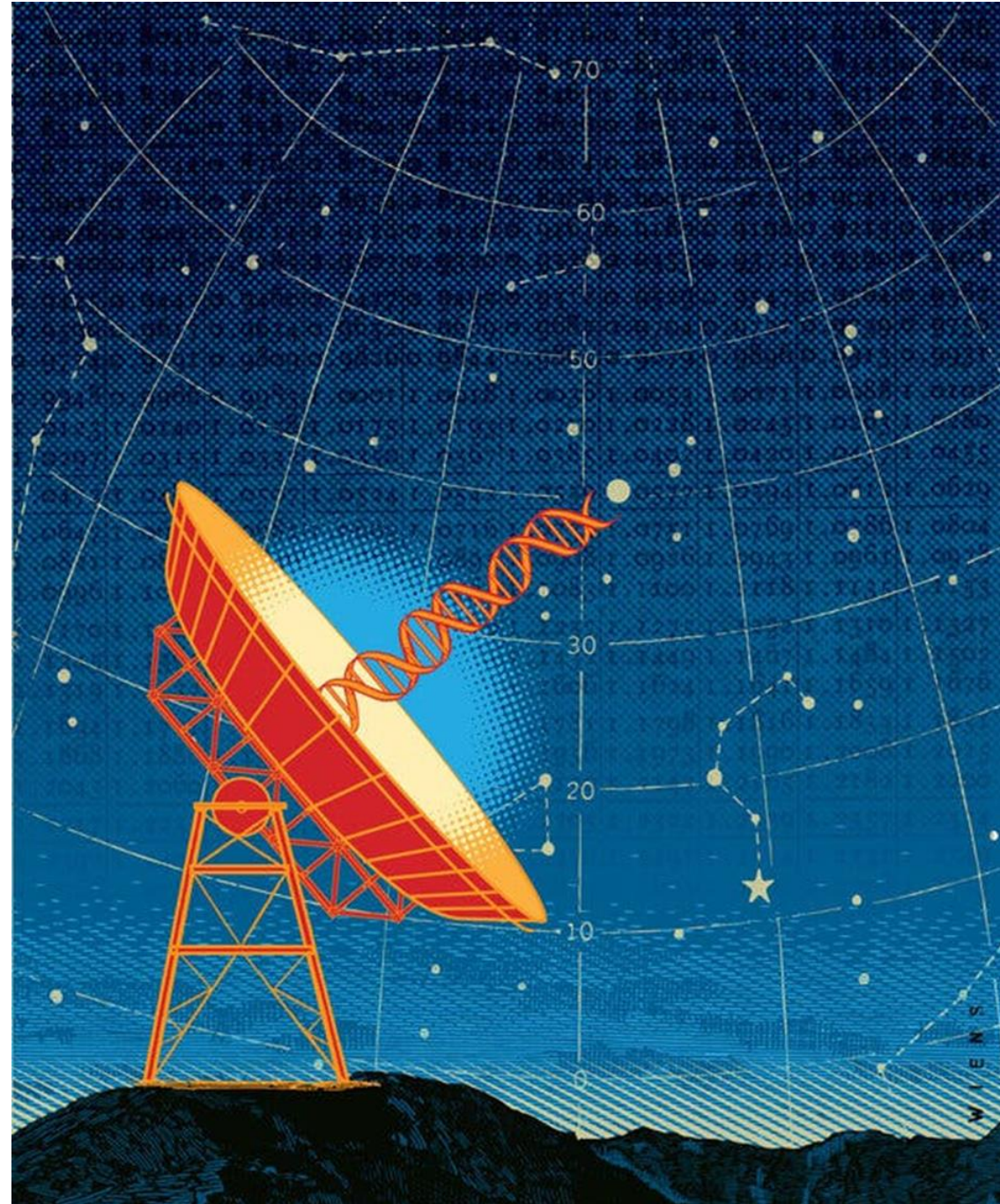
CONTACT

“...NEAR SOME STAR RATHER LIKE THE SUN THERE ARE CIVILIZATIONS WITH SCIENTIFIC INTERESTS...”

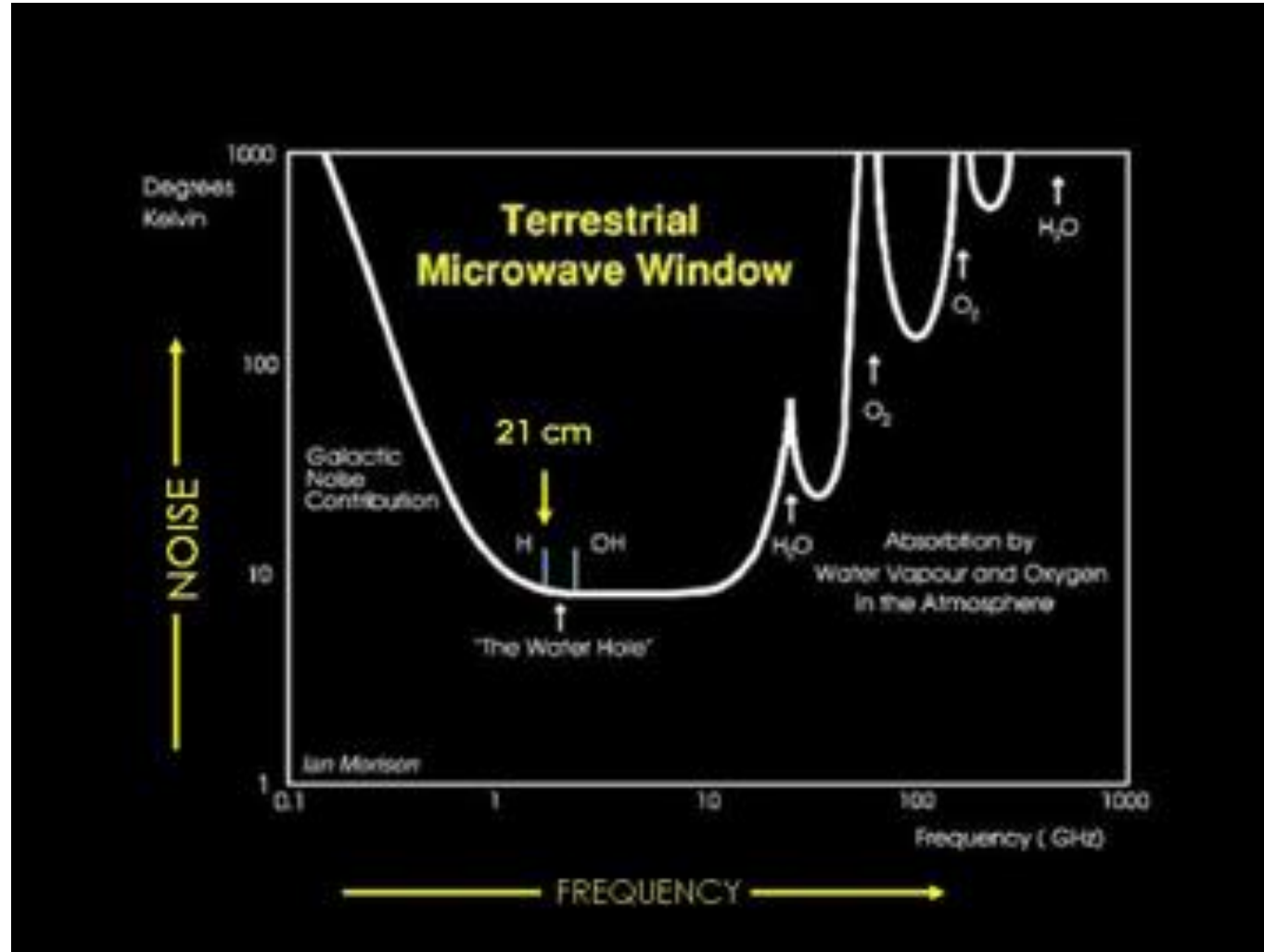
“TO THE BEINGS OF SUCH A CIVILIZATIONS, OUR SUN MUST APPEAR AS A LIKELY SITE FOR THE EVOLUTION OF A NEW SOCIETY. ”

WHERE TO LOOK

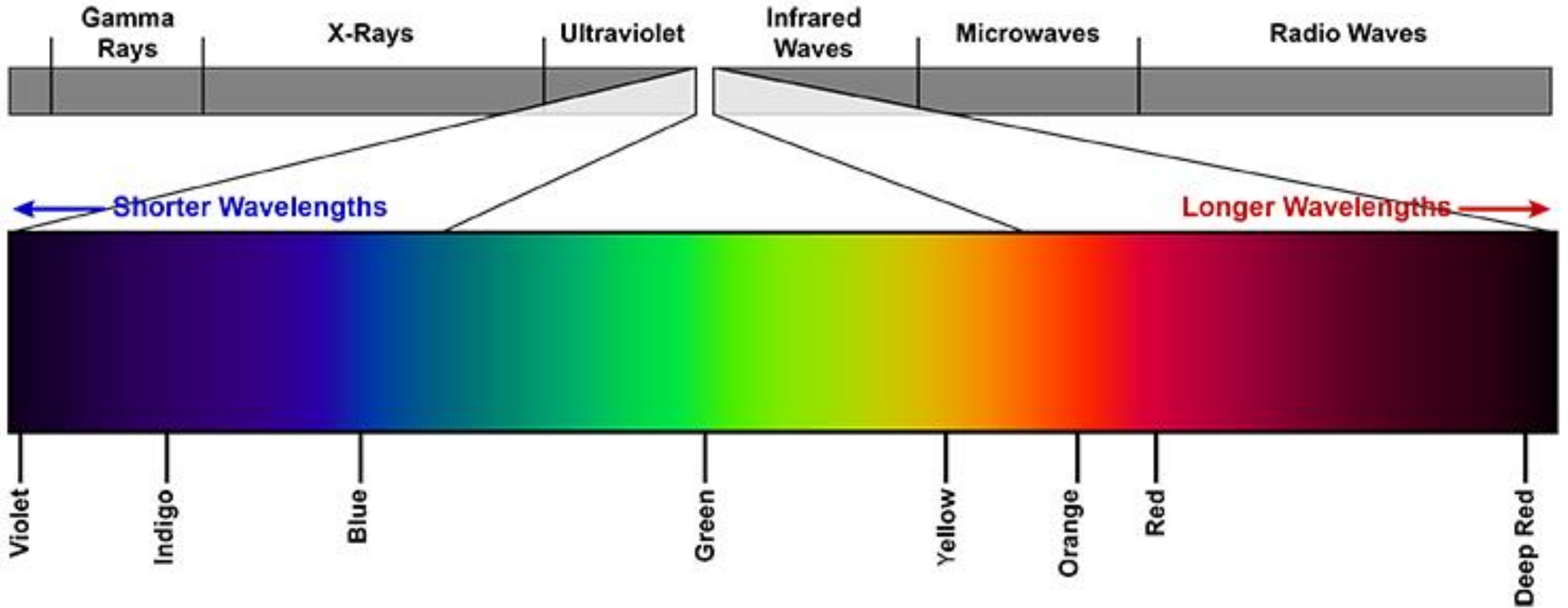
- RADIO FREQUENCY 1,420.4 MHz (21 cm)
- EMISSION OF NEUTRAL HYDROGEN
- HYDROGEN IS THE MOST COMMON ELEMENT IN THE UNIVERSE
- A LOGICAL LANDMARK IN THE RADIO SPECTRUM



TERRESTRIAL MICROWAVE WINDOW



ELECTROMAGNETIC SPECTRUM



THEIR CONCLUSION

“THE PROBABILITY OF SUCCESS IS DIFFICULT TO ESTIMATE; BUT IF WE NEVER SEARCH THE CHANCE OF SUCCESS IS ZERO.”

BIOASTRONOMY NEWS – 3RD QUARTER 1995

**TWO GIANTS IN THE WORLD OF SCIENCE ARGUED
OVER WHETHER SETI –
THE SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE –
HAS A CHANCE OF SUCCEEDING.**

BACKGROUND AND SETI

SETI BELIEVERS – PHYSICISTS, CHEMISTS, ASTRONOMERS,
MATHEMATICANS

SETI NONBELIEVERS – EVOLUTIONARY BIOLOGISTS

SETI ON A ROLLER FUNDING COASTER

- 1975 – NASA FUNDED DESIGN STUDIES
- 1978 – SENATOR PROXMIRE AWARDED SETI HIS GOLDEN FLEECE AWARD
- 1981 – PROGRAM WAS KILLED
- 1988 – NASA ENDORSED SETI PROGRAM
- 1993 – CONGRESS CANCELLED SETI

CAN SETI SUCEED?

SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE

**A DEBATE BETWEEN
CARL SAGAN AND ERNST MAYR**

THE ABUNDANCE OF LIFE-BEARING PLANETS

CARL SAGAN

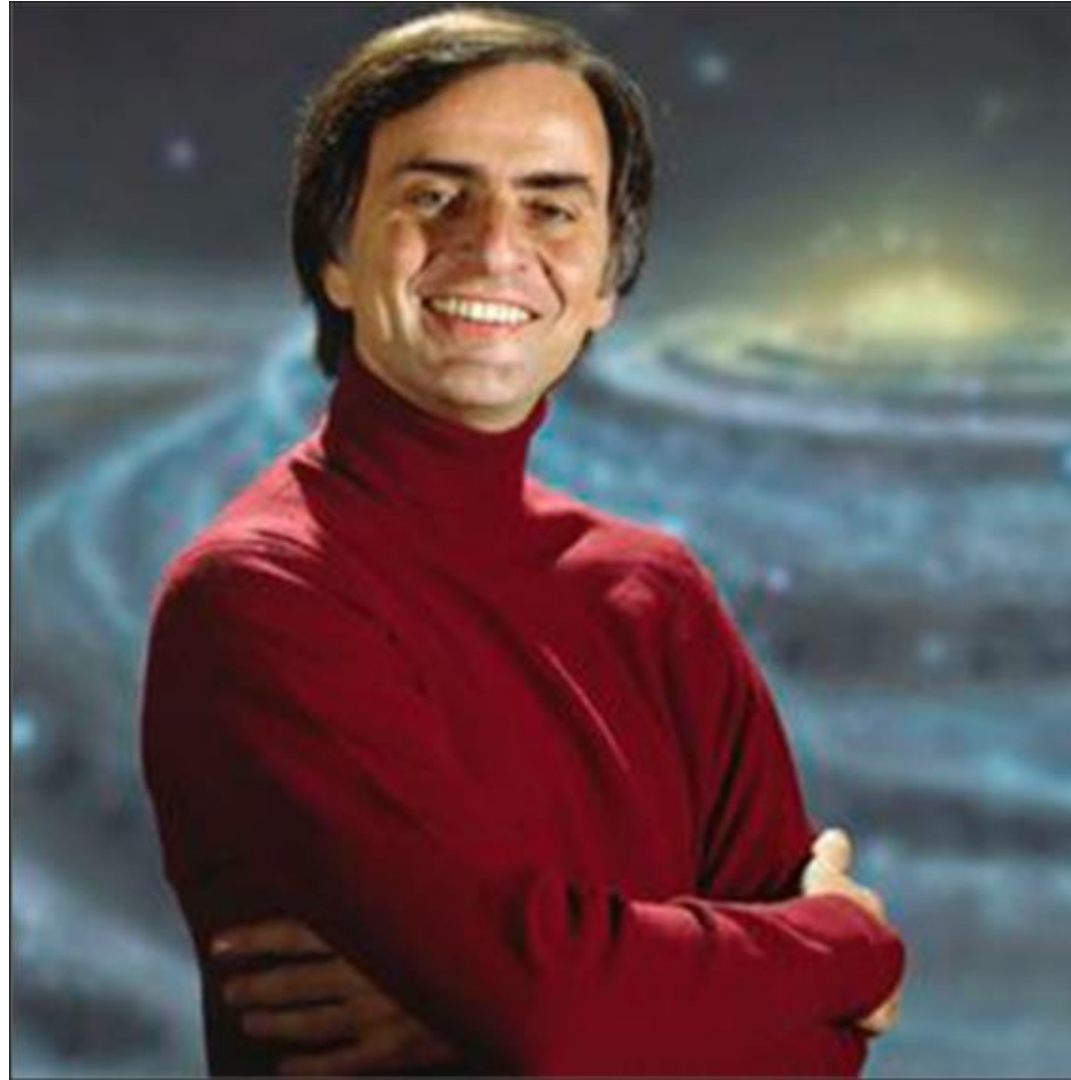
MEDIOCRITY PRINCIPLE

CAN SETI SUCEED? NOT LIKELY

ERNST MAYR

RARE EARTH HYPOTHESIS

CARL SAGAN (1934-1996)



CARL SAGAN (1934-1996)

- ADVISED NASA ON THE VIKING MISSION THAT LANDED TWO SPACECRAFT ON MARS
- DISCOVERED HIGH SURFACE TEMPERATURE OF THE PLANET VENUS
- INVESTIGATED THE ATMOSPHERES OF VENUS AND JUPITER, AND SEASONAL CHANGES ON MARS
- AUTHOR, SCIENCE POPULARIZER, AND SCIENCE COMMUNICATOR

INTELLIGENT LIFE IN THE UNIVERSE

- HALF THE NEARBY SUN-LIKE STARS HAVE DISKS OF GAS
- 4,000 EXOPLANETS HAVE BEEN DISCOVERED
- ONE OR TWO BLUE WORLDS AROUND EVERY SUN LIKE STAR
- LIFE AROSE AS SOON AS CONDITIONS PERMITTED
- FUNCTIONAL EQUIVALENT OF HUMANS
- IT'S BETTER TO BE SMART THAN TO BE STUPID

INTELLIGENT LIFE IN THE UNIVERSE (CONCLUDED)

- ANY LONG LIVED CIVILIZATION WILL NEED TO DEVELOP TECHNOLOGY TO DEAL WITH AND DESTROY NEAR EARTH OBJECTS
- PROPONENTS OF SETI INCLUDE BIOLOGISTS
- NO ARGUMENT CAN SUBSTITUTE FOR AN OBSERVATIONAL PROGRAM

EXTRATERRESTRIAL INTELLIGENCE: AN INTERNATIONAL PETITION

...WE URGE THE ORGANIZATION OF A COORDINATED,
WORLDWIDE, AND SYSTEMIC SEARCH FOR EXTRATERRESTRIAL
INTELLIGENCE.

CARL SAGAN, 1982

CENTER FOR RADIO PHYSICS AND SPACE

MEDIOCRITY PRINCIPLE

- THE PROPERTIES AND EVOLUTION OF THE SOLAR SYSTEM ARE NOT UNUSUAL IN ANY IMPORTANT WAY.
- CONSEQUENTLY, THE PROCESSES ON EARTH THAT LED TO LIFE, AND EVENTUALLY TO THINKING BEINGS, COULD HAVE OCCURRED THROUGHOUT THE COSMOS.

FRANK DRAKE, BORN 1930



DRAKE EQUATION



$$N = R^* \times f_p \times n_e \times f_l \times f_i \times f_c \times L$$

Number of **technologically advanced civilizations** in the Milky Way galaxy

Rate of formation of **stars** in the galaxy

Fraction of those stars with **planetary systems**

Number of planets, per solar system, with an **environment suitable for life**

Fraction of suitable planets on which **life actually appears**

Fraction of life-bearing planets on which **intelligent life** emerges

Fraction of civilizations that develop a **technology that releases detectable signs** of their existence into

Length of time such civilizations release detectable signals into space

**N = NUMBER OF ADVANCED CIVILIZATIONS
IN MILKY WAY**



**R^* = AVERAGE RATE OF STAR FORMATION IN
OUR GALAXY**



f_p = FRACTION OF THOSE STARS THAT HAVE PLANETS



n_e = NUMBER OF PLANETS THAT CAN
SUPPORT LIFE



f_1 = FRACTION OF PLANETS THAT DEVELOP
LIFE



f_i = FRACTION OF PLANETS WITH LIFE THAT
DEVELOP CIVILIZATIONS



f_c = FRACTION OF CIVILIZATIONS THAT CAN SEND
AND RECEIVE ELECTROMAGNETIC SIGNALS



**L = THE LENGTH OF TIME CIVILIZATIONS CAN
SEND SIGNALS**



MILKY WAY
100 TO 400 BILLION STARS



SIZE OF MILKY WAY

200,000 light years

BUT A FEW PROBLEMS

OVER POPULATION

OVER HEATING

SLOW POISONING

SAGAN - LAST WORDS

“LET’S USE OUR TECHNOLOGY TO TRY AND ACTUALLY FIND ANSWERS.”

SEARCH TOOLS

ALLEN TELESCOPE ARRAY



PARKES OBSERVATORY, AUSTRALIA



OAK RIDGE, HARVARD, MA



GREEN BANK OBSERVATORY, WV



THE VERY LARGE ARRAY NEAR SOCORRO, NM



LOVELL TELESCOPE, UNITED KINGDOM



OHIO STATE UNIVERSITY RADIO OBSERVATORY BIG EAR



RECEIVED AUGUST 15, 1977 FOR 72 SEC

Wow!

1		2			1	4	3
1	16	1			1		1
1	11	1		1		11	1
	1					3	1
1	6	2			1	31	
1	E24	3	12		1	21	1
	Q	1	1	2	1	1	1
	U	3	1		3	7	1
2	J	1	31	3	111	11	11
	5	1				1	1
	14		1		113		2
	1	3	1		1	1	
	1	4		1	1	1	11
		4	1	1	1	11	111
		1			1		2
	1	1	1			11	1
				1			14

WHAT HAVE WE HEARD IN 60 YEARS?

NARY A PEEP

CAN SETI SUCEED? NOT LIKELY

ERNST MAYR

RARE EARTH HYPOTHESIS

ERNST MAYR (1904-2005)



ERNST MYER (1904-2005)

- ONE OF THE MOST PROMINENT EVOLUTIONARY BIOLOGISTS OF THE 20th CENTURY
- FORMER DIRECTOR OF THE HARVARD MUSEUM OF COMPARATIVE ZOOLOGY
- WINNER OF THE CRAFOORD PRIZE (HONORS BASIC RESEARCH IN FIELDS THAT DO NOT QUALIFY FOR NOBEL PRIZES.)

RARE EARTH HYPOTHESIS

COMPLEXITY AND DEVELOPMENT OF HUMAN INTELLIGENCE,

REQUIRED AN IMPROBABLE COMBINATION OF BIOLOGICAL, ASTROPHYSICAL AND GEOLOGICAL EVENTS.

EVOLUTION OF INTELLIGENCE

- EVOLUTION NEVER MOVES IN A STRAIGHT LINE LIKE A CHEMICAL PROCESS.
- EVOLUTIONARY PATHWAYS RESEMBLE A TREE WITH BRANCHES AND TWIGS.

CHARLES DARWIN



I THINK



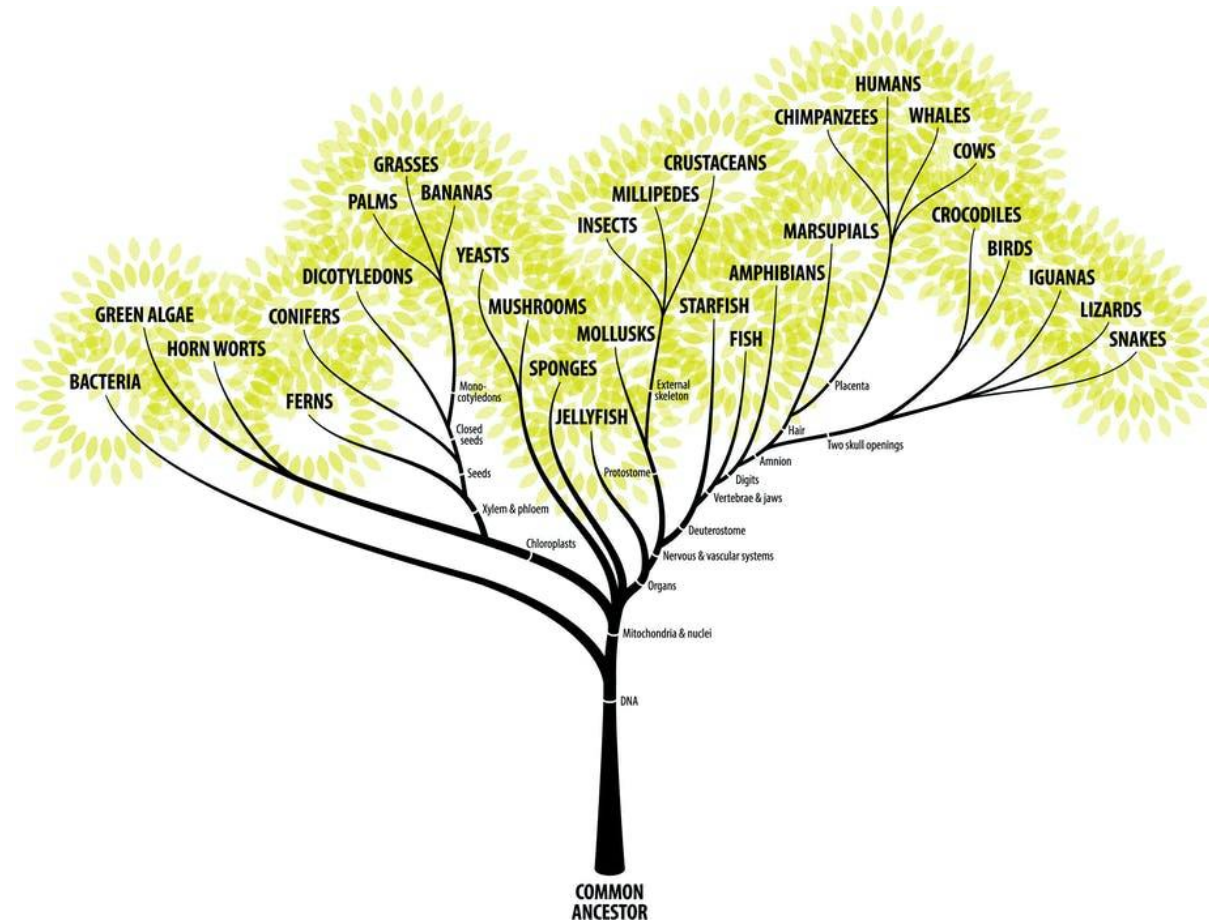
FROM DARWIN'S NOTEBOOK

“MY THEORY WOULD GIVE
ZEST TO RECENT & FOSSIL
COMPARATIVE ANATOMY:”

ON THE ORIGIN OF SPECIES

DARWIN POSTULATED THAT LIFE ON EARTH EVOLVED FROM ANCIENT SPECIES THAT DIVERGED OVER TIME — LIKE TREE BRANCHES FROM A SINGLE TRUNK.

DARWIN'S GREAT TREE OF LIFE



INTELLIGENT LIFE ON EARTH

- LIFE ON EARTH BEGAN 3.8 BILLION YEARS AGO
- FOR TWO BILLION YEARS THERE WERE ONLY CELLS WITHOUT AN ORGANIZED NUCLEUS
- OWING TO AN ASTONISHING EVENT 1.8 BILLION YEARS AGO, A CREATURE WITH AN ORGANIZED NUCLEUS DEVELOPED
- FROM THIS THERE DEVELOPED MULTICELLULAR ORGANISMS: FUNGI, PLANTS, ANIMALS
- THE ANIMALS BRANCHED OUT TO ABOUT 80 LINEAGES
- ONLY THE CHORDATES WITH THEIR CENTRAL NERVOUS SYSTEM LED TO INTELLIGENCE

INTELLIGENT LIFE ON EARTH - CONTINUED

- ONLY ONE LINEAGE LED TO THE VERTEBRATES
- VERTEBRATES INCLUDE FISHES, AMPHIBIANS, REPTILES, BIRDS, AND MAMMALS
- ABOUT 20 MILLION YEARS AGO HIGHER INTELLEGENGE DEVELOPED IN ONE OF THE ORDERS OF MAMMALS, THE HOMINIDS
- ELABORATION OF THE BRAIN OF HOMINIDS BEGAN 3 MILLION YEARS AGO

INTELLIGENT LIFE ON EARTH - CONCLUDED

MAYR SPECULATES THAT THERE HAVE BEEN 50 BILLION SPECIES

MILLIONS OF SPECIES GET ALONG FINE WITHOUT HIGH INTELLIGENCE

**ONLY ONE SPECIES ACHIEVED THE INTELLIGENCE TO ESTABLISH A
CIVILIZATION**

**ONLY ONE CIVILIZATION DEVELOPED THE TECHNOLOGY TO TRANSMIT
SIGNALS INTO SPACE AND RECEIVE THEM**

LAST WORD – ERNST MAYR

IT CAN BE SHOWN THAT THE SUCCESS OF AN OBSERVATIONAL PROGRAM IS SO TOTALLY IMPROBABLE THAT IT CAN BE CONSIDERED ZERO.

COMMUNICATION WITH EXTRATERRESTRIALS

137



137

- 137 WOULD SIGNAL TO ALIENS OUR UNDERSTANDING OF QUANTUM MECHANICS.
- THE ALIENS WOULD KNOW THE NUMBER, IF THEY DEVELOPED ADVANCED SCIENCES.

FINE STRUCTURE CONSTANT, α

MEASURE OF THE STRENGTH OF THE ELECTROMAGNETIC FORCE THAT GOVERNS HOW ELECTRICALLY CHARGED PARTICLES AND PHOTONS INTERACT.

ITS UNIQUENESS

FINE STRUCTURE CONSTANT IS DIMENSIONLESS.

IT CAN BE EXPRESSED AS A NUMBER.

FINE STRUCTURE CONSTANT

$$\alpha = e^2/4\pi\epsilon_0\hbar c = 0.0072973525693$$

$$1/\alpha = 1/0.007297 \approx 137$$

$$(137)_{10} = (10001001)_2$$

10001001 10001001 10001001 10001001

MAY DAY



...10001001 10001001 10001001...

WE ARE HERE AND WE ARE INTELLIGENT.

**LIVES OF A CELL: NOTES OF A BIOLOGY WATCHER
LEWIS THOMAS (1913-1993)**



CONTACTING EXTRATERRESTRIALS

PERHAPS THE SAFEST THING TO DO IS TO
SEND MUSIC.

THIS LANGUAGE MAY BE THE BEST WE HAVE
FOR EXPLAINING WHAT WE ARE LIKE.

I WOULD VOTE FOR BACH.

WE WOULD BE BRAGGING.

WE CAN TELL THE HARDER TRUTHS LATER.

EXTRATERRESTRIAL DIALOG

AFTER ALL, THE MAIN QUESTION WILL BE THE OPENER,
“HELLO, ARE YOU THERE?”

IF THE REPLY SHOULD TURN OUT TO BE, “YES, HELLO”

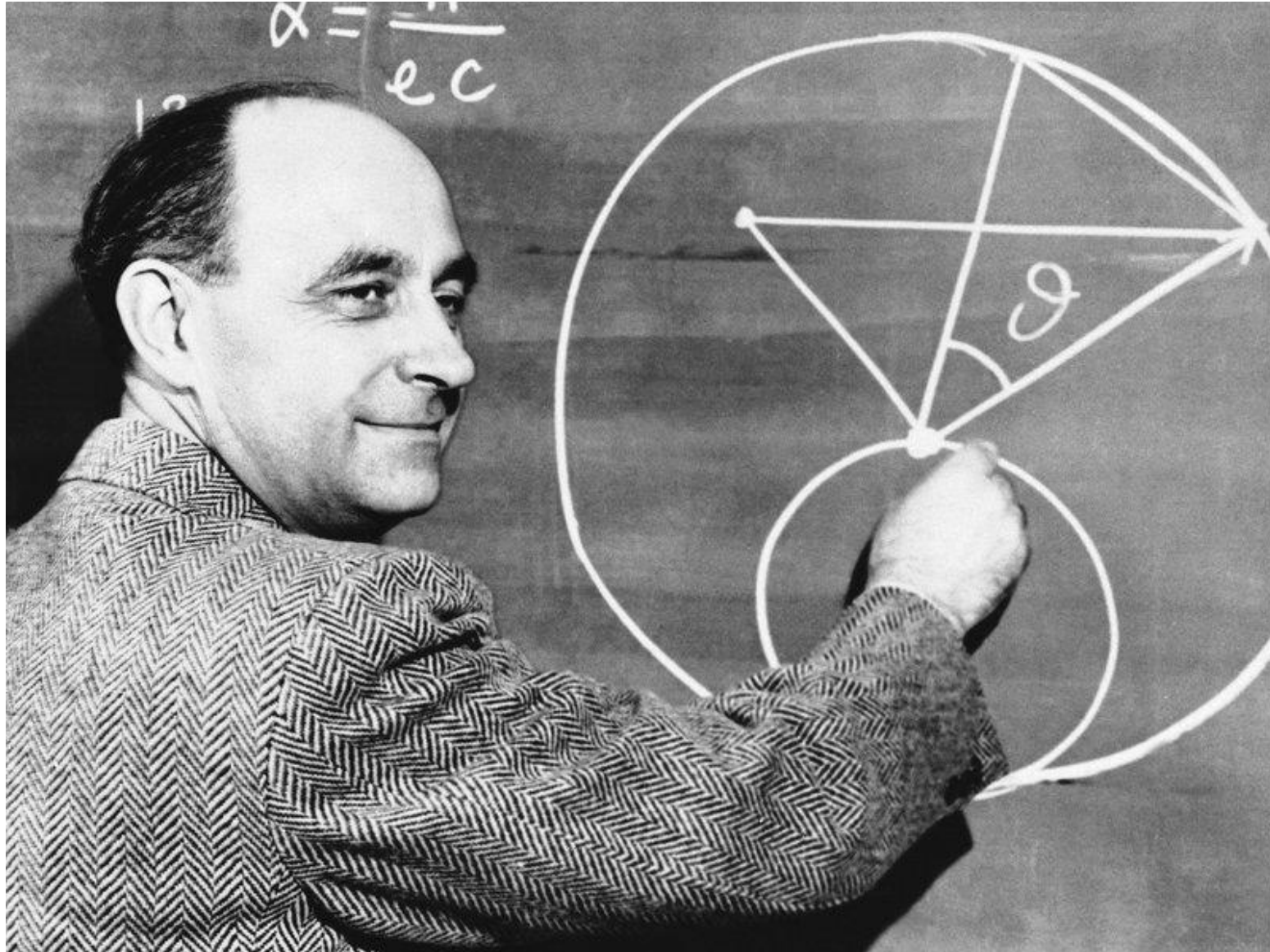
WE MIGHT WANT TO STOP THERE AND THINK ABOUT
THAT, FOR QUITE A LONG TIME.

SAD CONCLUSIONS FOR ME

- **THERE IS NO INTELLIGENT CIVILIZATION ON EARTH.**
- **THERE IS PROBABLY NO INTELLIGENT LIFE BEYOND OUR PLANET.**

ALMOST THE END

ENRICO FERMI (1901-1954)



FERMI PARADOX

THE APPARENT CONTRADICTION BETWEEN

- **THE LACK OF EVIDENCE FOR EXTRATERRESTRIAL CIVILIZATIONS, AND**
- **VARIOUS HIGH ESTIMATES FOR THEIR PROBABILITY.**

WHERE IS EVERYBODY?

WHAT DO YOU THINK?

ARE WE ALONE?

DO WE HAVE COMPANY?

THE END