Dr. Jimmie R. Nelson '59 Lecture

Department of Chemistry, University of Miami

UNIVERSITY OF MIAMI
COLLEGE of
ARTS & SCIENCES

Professor N. J. Turro

William P. Schweitzer Professor of Chemistry
Columbia University, New York

Paradigms Found and Paradigms Lost: How to Distinguish Between Science Revolutionary and Science Pathological

Friday, February 18, 2011, 2:30 – 3:30 pm
Cox Science Building, Room 318

Reception at 3:30 pm at Cox 3rd floor lobby
All are welcome to attend the lecture and reception

SEMINAR
CHEMISTRY DEPARTMENT
LAS CENTER FOR SCHOLARS
TULANE UNIVERSITY

*Prof. Nicholas J. Turro**
Columbia University

"Space & Magnetic Control of Photochemical Reactions of Radicals in Nanoscopic Reactors"

Monday, April 23th , 2001
4:00 P.M.
102 Jones Hall

"Paradigms Found & Paradigms Lost. Revolutionary & Pathological Science and How to Tell the Difference"

Wednesday, April 25th, 2001
4:00 p.m.
102 Jones Hall

**See back for more information*

Turro, N. J. Geometric and topological thinking in organic chemistry, *Angew Chem Int Ed Engl* 25 (1986):882-901.

Toward a general theory of pathological science, Turro, N. J. 21stC: Issue 3.4 *Strange Science*. (based on the lecture given in Max Planck Int, 1998.

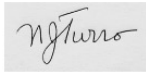
Pathological Science, Stone, S., Flavor Physics For The Millennium: TASI 2000, 2001, World Scientific

Langmuir, Irving, Pathological science. *Physics Today* (1989, Oct) 42, 36-48. (talk given in 1953)

Case Studies in Pathological Rousseau, D. L. *American Scientist*, (1992, January-February), 54-63

Nicholas J. Turro
1938-2012
Biographical Memoir

Ronald G. Lawler and Vaidhyanathan Ramamurthy



Normal, Extraordinary and Pathological Science

Science We Do

Extraordinary

Normal

Pathological

Fraud

Normal science is what most scientists mostly do most of the time

Research firmly based on past scientific achievements/theories that a particular scientific community acknowledges as supplying the foundation for further research.

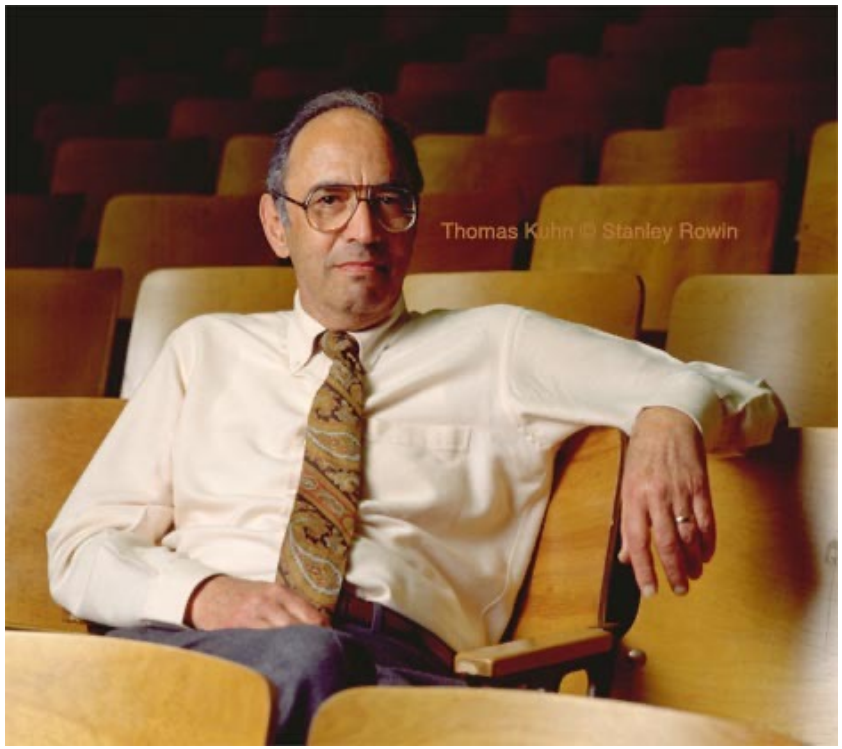
Normal science consists of a problem and possible solutions

An important role of accepted theory is to guarantee a solution to the problem. The (**plausible**) range of anticipated solutions allowed by the theory is small compared to the (**possible**) range that imagination can conceive. This provides a restricted passage to the solution.

A project whose results do not fall in the small range of possibilities that the thoery allows may be considered as **a failure of the skill of the researcher and not as a reflection of nature or the theory**

Concept of carbon valency: di, tri, tetra valent

How science functions?



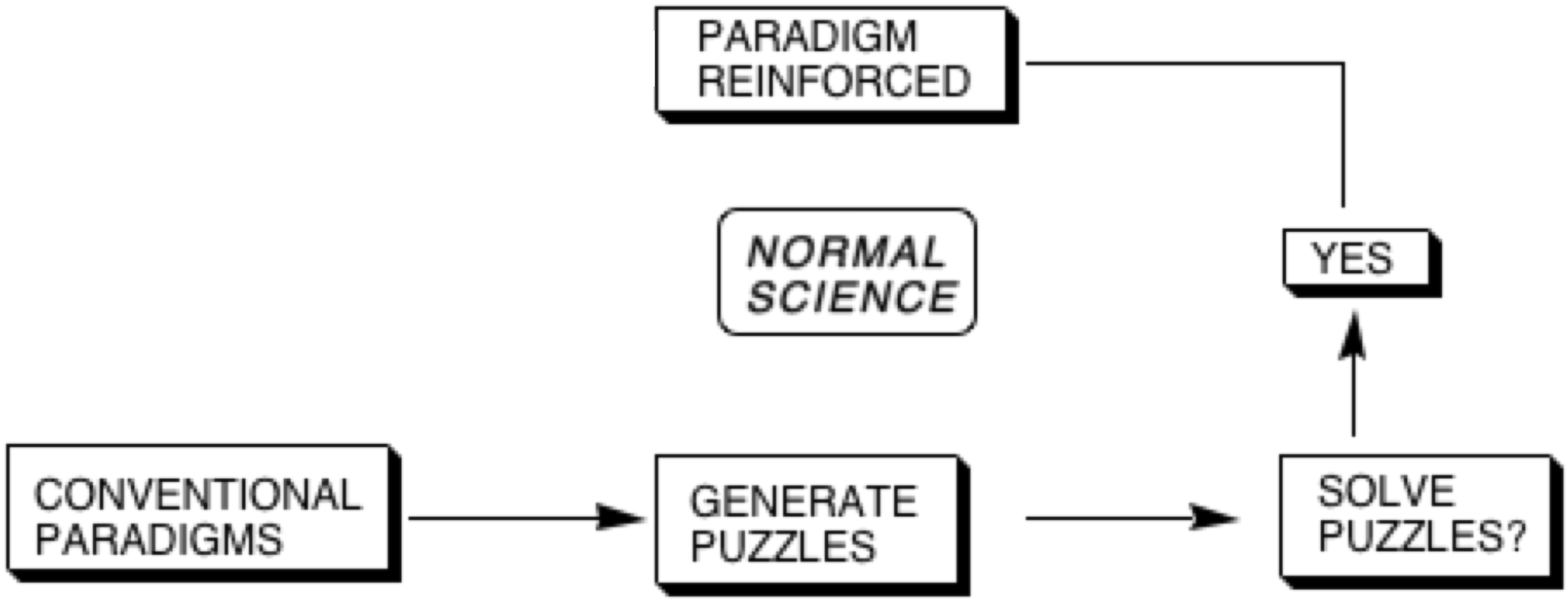
Thomas Kuhn, 1923-1996

The Structure of Scientific Revolution

The scientific process according to Kuhn involves *Paradigms (postulates, theories)*.

An accepted paradigm is what defines a scientific community or discipline.

Flow Diagram for Normal Science

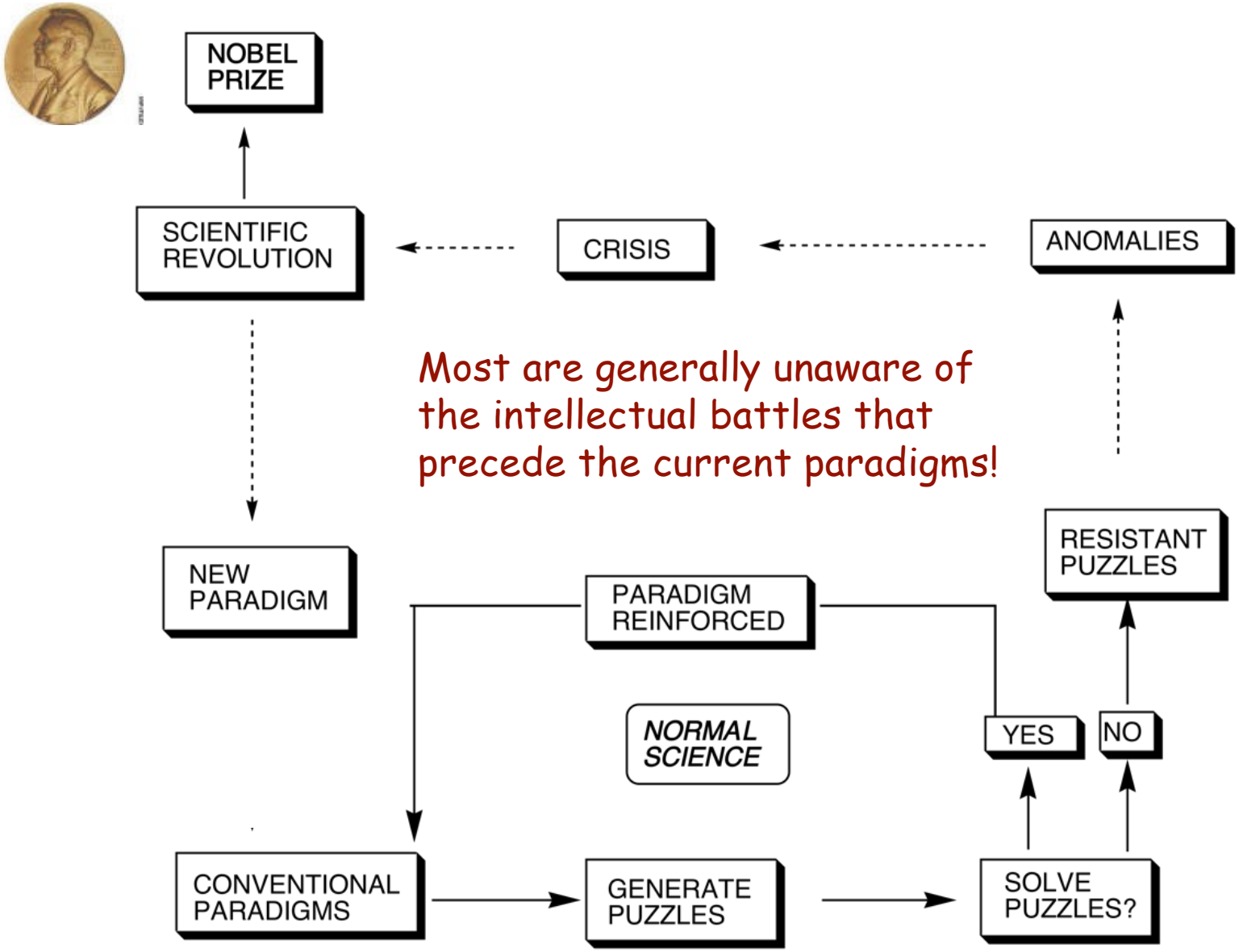


N. J. Turro

How science progresses and changes direction?

A scientific revolution occurs when extraordinary claims cause a change in the way scientists think and act.

The *Nobel Prize* is awarded to scientists whose research and ideas change the way other scientists think and act.



Flow diagram for revolutionary science: Extraordinary claims that become accepted and are integrated into "normal science."

N. J. Turro

The Nobel Prize in Chemistry 2023

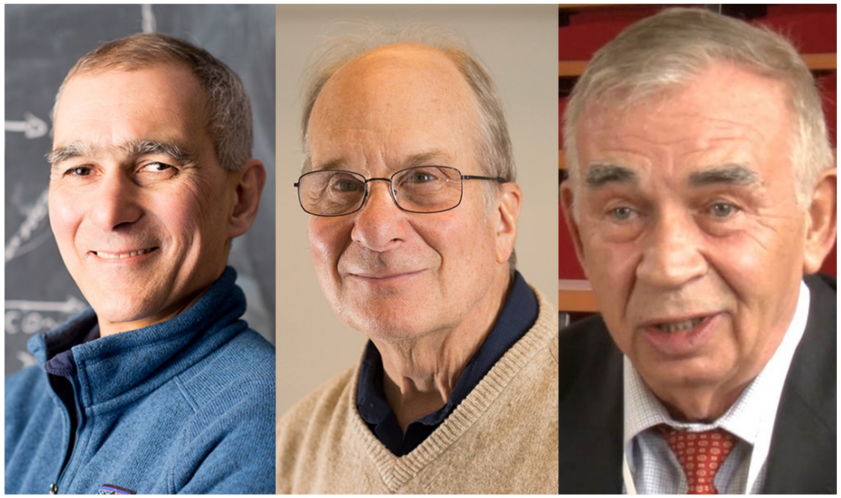
The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Chemistry 2023 to

Moungi G. Bawendi
Massachusetts Institute of Technology (MIT), Cambridge, MA, USA

Louis E. Brus
Columbia University, New York, NY, USA

Alexei I. Ekimov
Nanocrystals Technology Inc., New York, NY, USA

"for the discovery and synthesis of quantum dots"



Left to right: Moungi Bawendi, Louis Brus, and Alexei Ekimov. Credits: Justin Knight, MIT, CC BY-SA 3.0; Columbia University; Nexdot

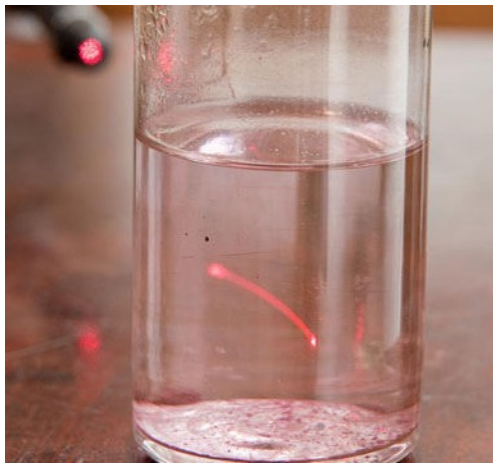
Louis Brus was the first scientist in the world to prove size-dependent quantum effects in particles floating freely in a fluid.

Beginnings of Nanoscience

Gold chloride + Phosphorous = Gold nanoparticle

"No dissolved gold, only diffused gold"

Faraday realized that the fluid contained suspended gold particles that were too small to see with the scientific apparatus of the time but which scattered the light to the side (*Faraday-Tyndall effect*).



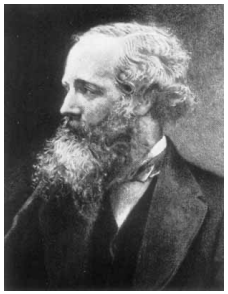
Faraday-Tyndall effect

150+ years old gold nanoparticles of Faraday on display at RI

Photons

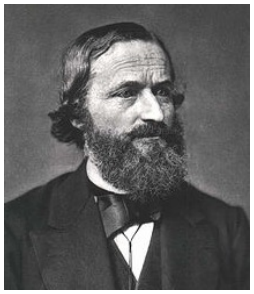
Thomas Young
1773 - 1829

Michael Faraday
1791-1867



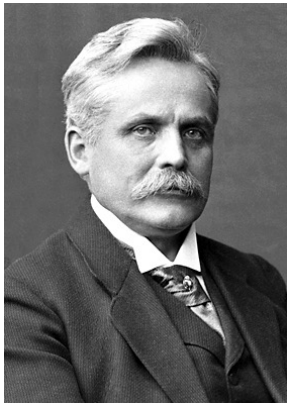
James C. Maxwell
1831-1879

H. R. Hertz
1857-1894

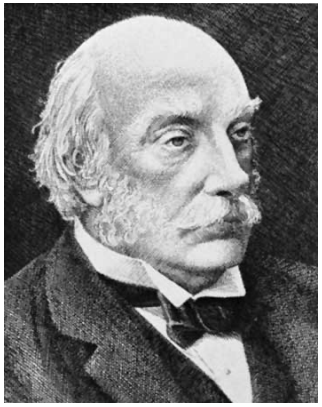


Gustav R. Kirchhoff
1824 –1887

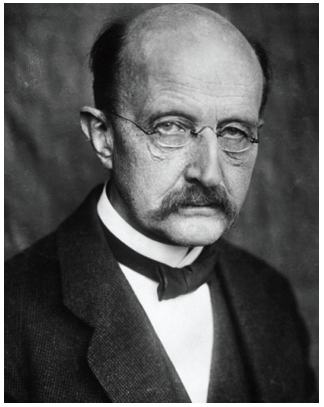
L. Boltzmann
(1844-1906)



W. Wien
(1864-1928)

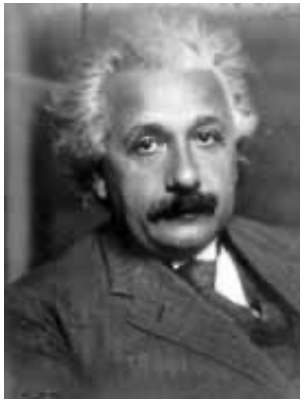


The Lord Rayleigh
(1842-1919)



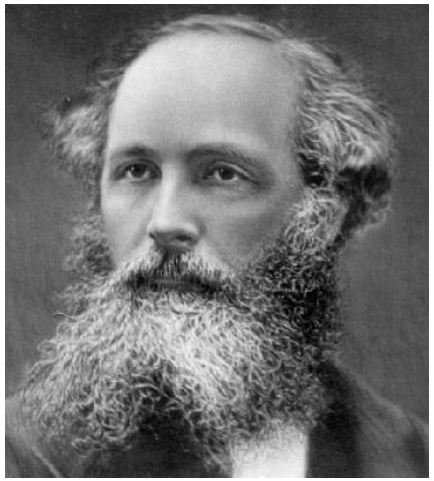
Max Planck
1858-1847

Niels Bohr
1885-1962

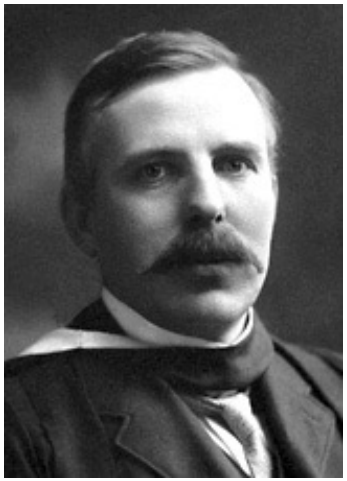


Albert Einstein
1879-1955

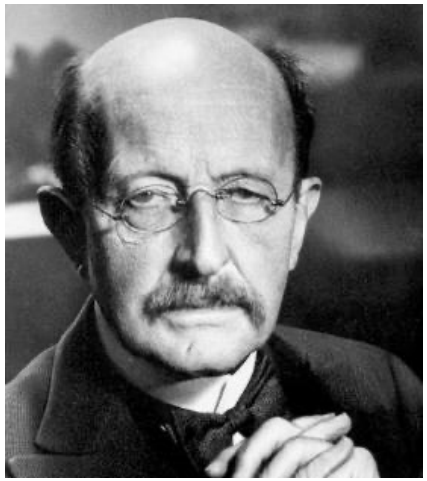
Atoms



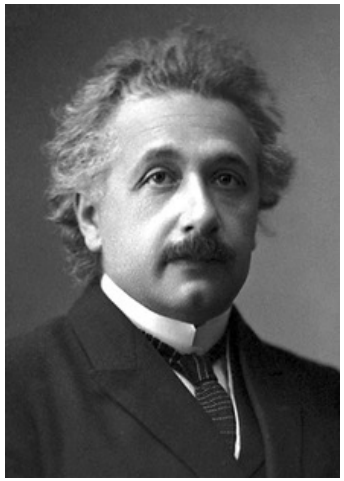
J. C. Maxwell



E. Rutherford



M. Planck

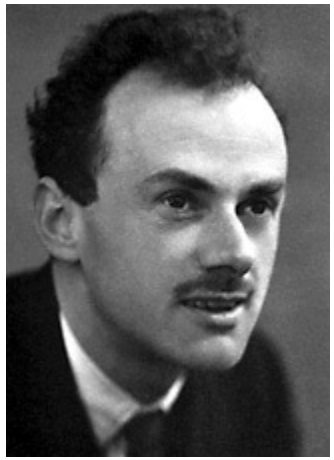


A. Einstein

L. De Broglie

N. Bohr

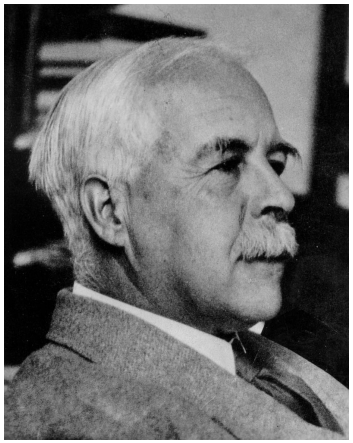
W. Heisenberg



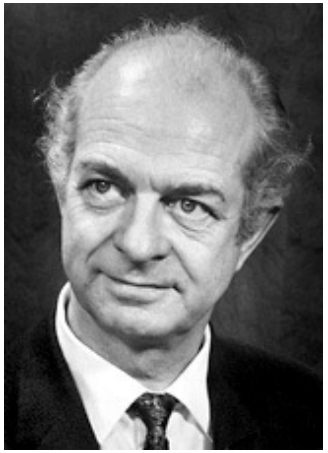
P. Dirac

E. Schrondinger

Molecules

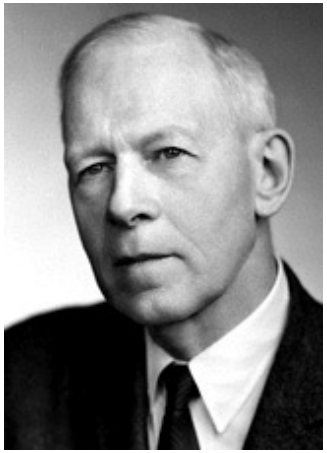


G. N. Lewis



L. Pauling

E. Huckel



R. S. Mulliken

R. Hoffman

K. Fukui

R. B. Woodward

E. J. Corey

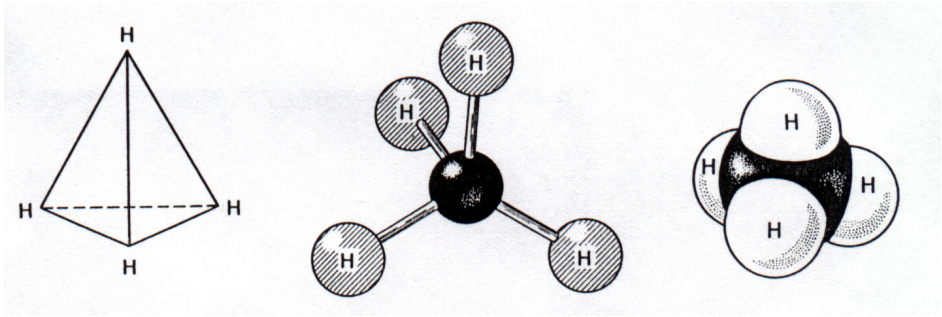
How does science deal with extraordinary claims?

The reigning paradigm is the decider.

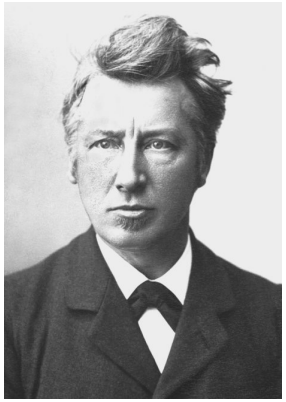
The scientific method is the best way yet for distinguishing new truths (revolutionary science) from fraud and delusion (pathological science).

But before a new paradigm is accepted as the decider, many extraordinary claims may appear to be pathological and will be challenged!

An Extraordinary Claim: Molecules can be represented as geometric objects in 3D space

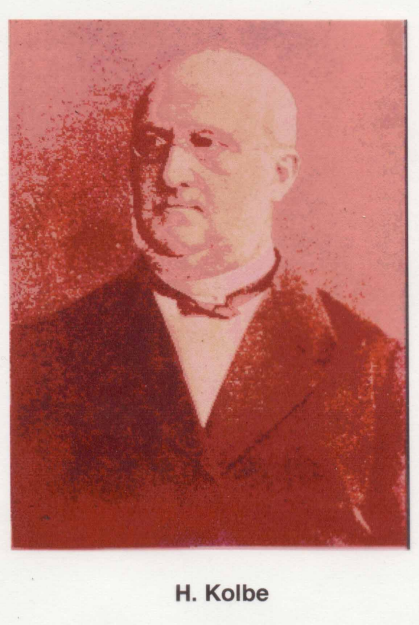


The Origin of Stereochemistry



J. H. van't Hoff

The proposal that the atoms of a substance can be represented as objects distributed in three-dimensional space was once considered an *extraordinary claim*.



H. Kolbe

H. Kolbe,

"A Sign of the Times"

J. Prakt. Chem., 15, 474 (1877).

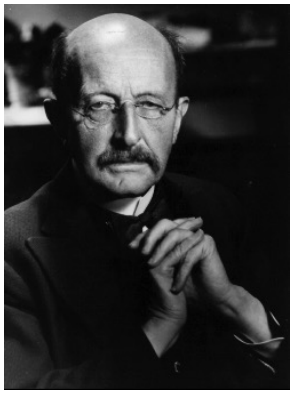
"Not long ago, I expressed the view that the lack of general education and of thorough training in chemistry was one of the reasons of the causes of the deterioration of chemical research in Germany.....Will anyone to whom my worries seem exaggerated please read, if he can, a recent memoir by a Herr van't Hoff on "The Arrangement of Atoms in Space", a document crammed to the hilt with the outpouring of childish fantasy...This Dr. J. H. van't Hoff, employed by the Veterinary College at Utrecht, has, so it seems, no taste for accurate chemical research."

J. H. van't Hoff (1852-1911)

First Nobel Prize in Chemistry, 1901

"in recognition of the extraordinary services he has rendered by the discovery of the laws of chemical dynamics and osmotic pressure in solutions."

An Extraordinary Claim: Light energy is quantized



Planck makes the extraordinary suggestion that light consisted of "bits" or "quanta" of energy, rather than being a continuum of energy.

Publication by Max Planck in 1900

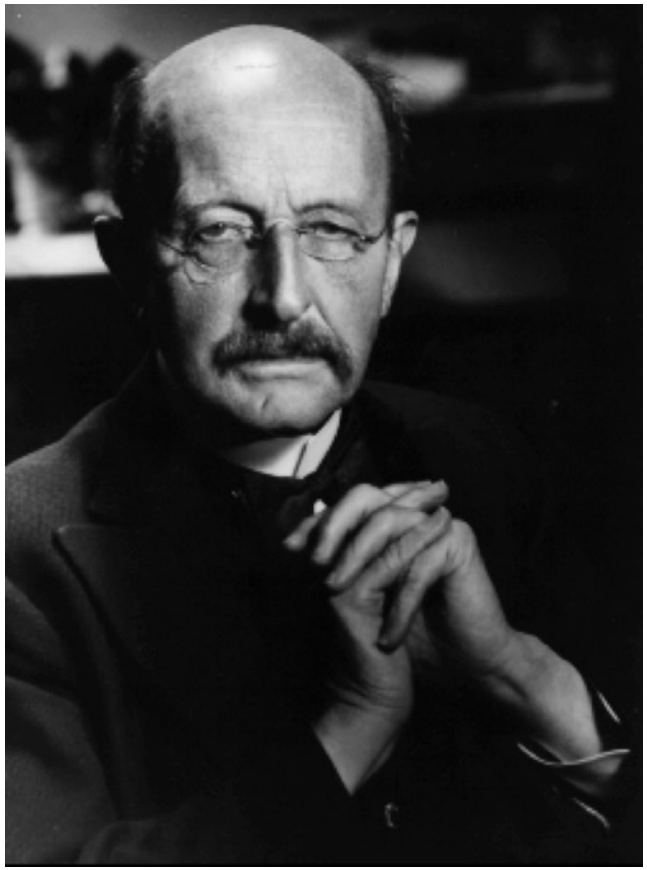
Zur Theorie des Gesetzes der Energieverteilung im Normalspectrum;
von M. Planck.

(Vorgetragen in der Sitzung vom 14. December 1900.)
(Vgl. oben S. 235.)

M. H.! Als ich vor mehreren Wochen die Ehre hatte, Ihre Aufmerksamkeit auf eine neue Formel zu lenken, welche mir geeignet schien, das Gesetz der Verteilung der strahlenden Energie auf alle Gebiete des Normalspectrums auszudrücken [1]), gründete sich meine Ansicht von der Brauchbarkeit der Formel, wie ich schon damals ausführte, nicht allein auf die anscheinend gute Uebereinstimmung der wenigen Zahlen, die ich Ihnen damals mitteilen konnte, mit den bisherigen Messungsresultaten [2]), sondern hauptsächlich auf den einfachen Bau der Formel und insbesondere darauf, dass dieselbe für die Abhängigkeit der Entropie eines bestrahlten monochromatisch schwingenden Resonators von seiner Schwingungsenergie einen sehr einfachen logarithmischen Ausdruck ergiebt, welcher die Möglichkeit einer allgemeinen Deutung jedenfalls eher zu versprechen schien, als jede andere bisher in Vorschlag gebrachte Formel, abgesehen von der WIEN'schen, die aber durch die Thatsachen nicht bestätigt wird.

Entropie bedingt Unordnung, und diese Unordnung glaubte ich erblicken zu müssen in der Unregelmässigkeit, mit der auch im vollkommen stationären Strahlungsfelde die Schwingungen des Resonators ihre Amplitude und ihre Phase wechseln, sofern man Zeitepochen betrachtet, die gross sind gegen die Zeit einer Schwingung, aber klein gegen die Zeit einer Messung. Die constante Energie des stationär schwingenden Resonators

The suggestion was considered <u>bizarre</u> and <u>not physically realistic</u> at the time. But is now universally accepted by the scientific community.



Max Planck

Nobel Prize, Physics, 1918

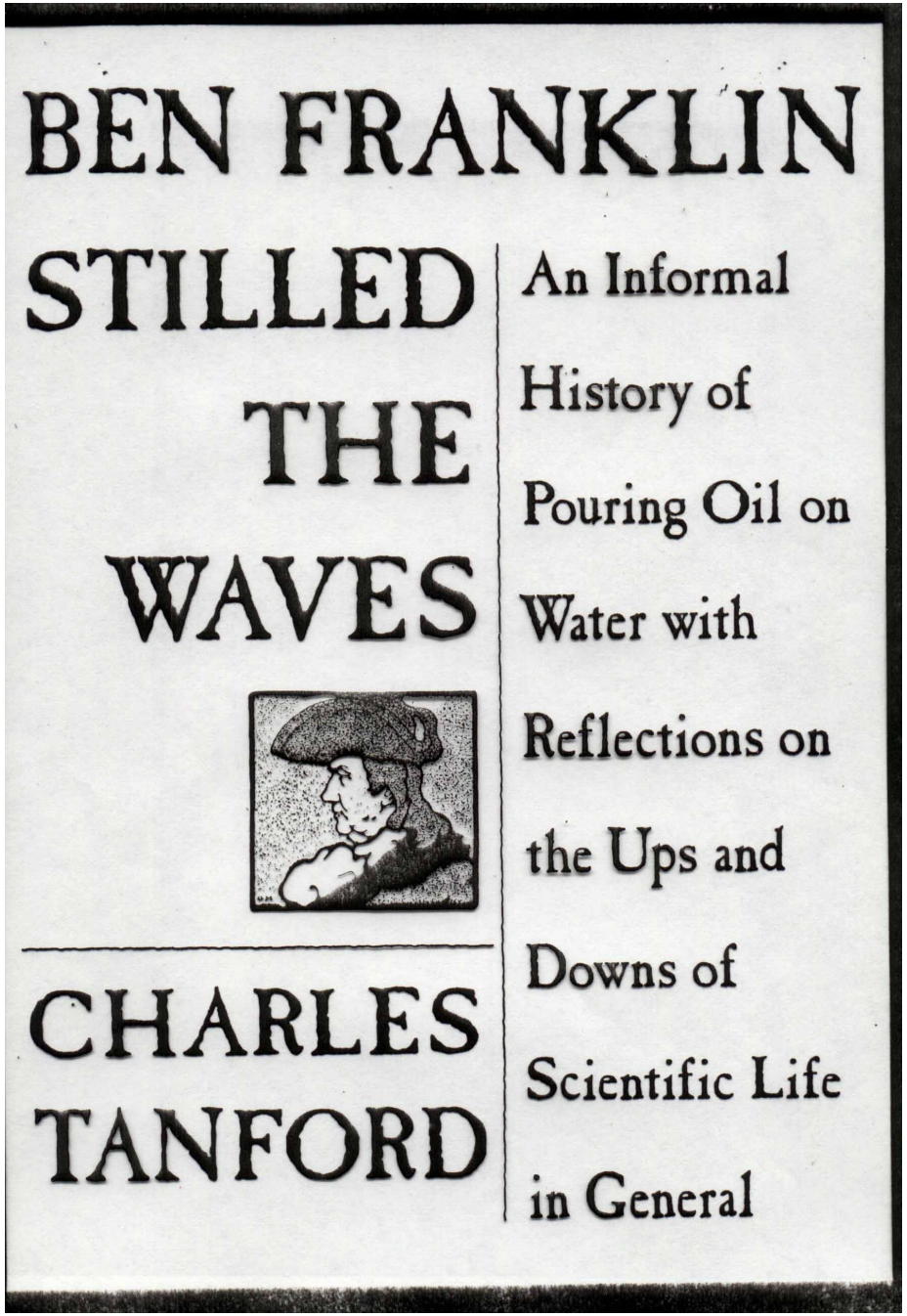
"for the discovery of energy quanta".

" An important scientific innovation rarely makes its way by gradually winning over and converting its opponents: it rarely happens that Saul becomes Paul. What does happen is that its opponents gradually die out and that the growing generation is familiarized with the idea from the beginning."

M. Planck, The Philosophy of Physics, 1936,

An Extraordinary Claim:

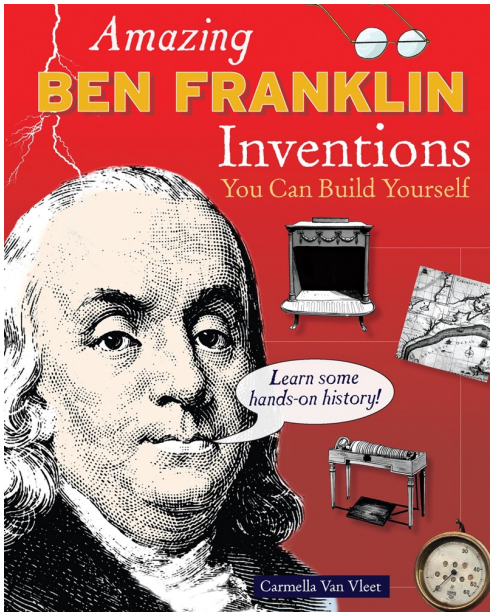
"A spoon of olive oil can still the waves of an angry pond."



“In 1757, being at sea, I observed the wakes of two of the ships to be remarkably smooth while all the others were ruffled by the wind, which blew fresh.

Being puzzled, I pointed it out to our captain, and asked him the meaning of it?

"The cooks,” says he, "have, I suppose, been just emptying greasy water through the scuppers, which has greased the sides of those ships a little, --- ”



Benjamin Franklin

***Philosophical Transactions of the Royal Society of London,* 1776**

Franklin did the first experiment that established the formation of monolayer on water surface !

"...at Clapham I observed a large pond very rough with the wind. I fetched a cruet of oil and dropped a little of it on the water. The oil, though *not more than a teaspoonful*, produced an instant calm over a space of several yards square, and then spread amazingly till it filled a quarter of the pond, *perhaps half an acre*, as smooth as a looking glass. ....

Benjamin Franklin, letter to William Brownrigg, November 7, 1773.

(a) (b)

View of Clapham pond (a) before and (b) after a teaspoon of olive oil was allowed to spread on its surface

Franklin's extraordinary claim and simple and elegant experiment provides a means of understanding fundamental facts about molecules and the forces between them.

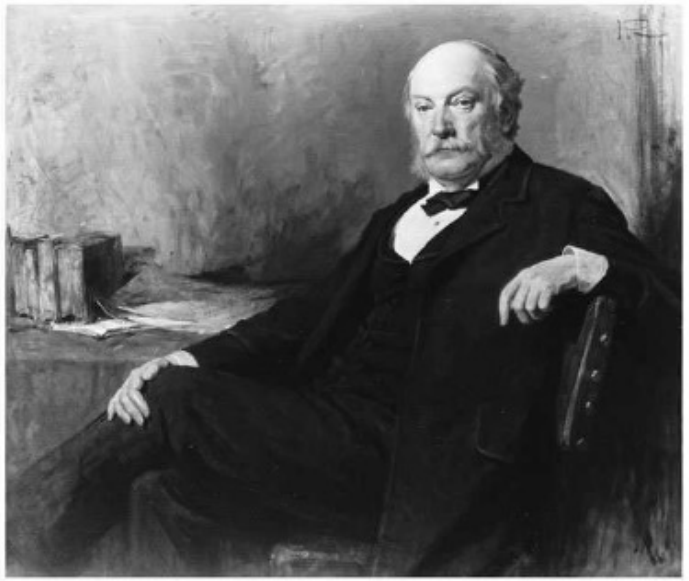
A few years later Franklin fell out of favor with the British public because he enlisted France's help for the American cause in the War of Independence. The British press attacked him, and it seems that his scientific achievements were also belittled. Franklin's researches in surface chemistry became disregarded by British scientists.

Franklin and his observation fell out of favor and his ideas were not respected

Great ideas don't disappear but takes a while to get accepted

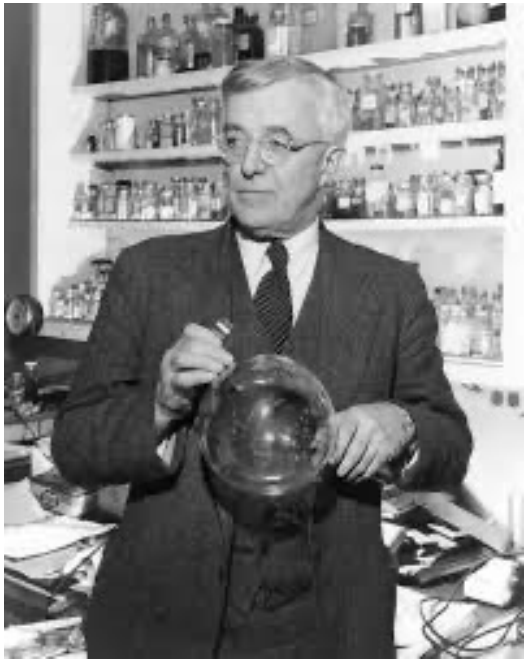
Ben Franklin

Original report: 1773



Lord Rayleigh

Repeated the expt in 1890

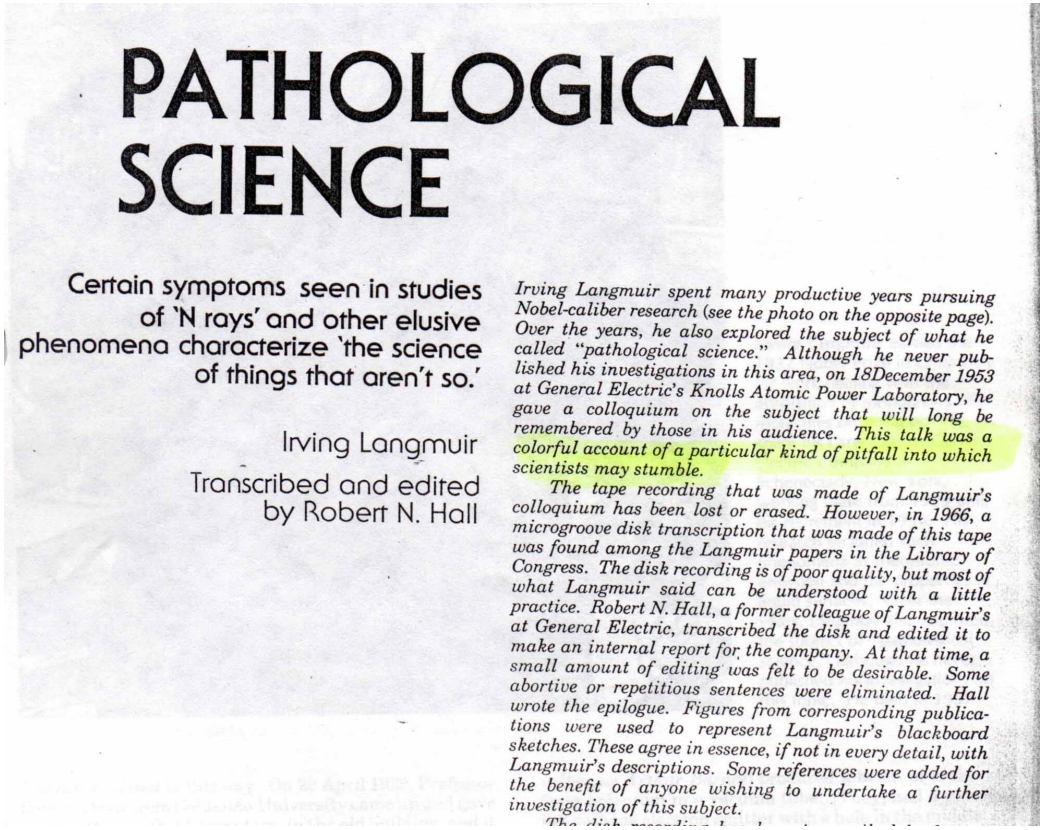


Irving Langmuir

Nobel Prize, 1932

Surface Science

Some extraordinary claims are *pathological science but do not involve fraud*.



PATHOLOGICAL SCIENCE

Certain symptoms seen in studies of 'N rays' and other elusive phenomena characterize 'the science of things that aren't so.'

Irving Langmuir

Transcribed and edited by Robert N. Hall

Irving Langmuir spent many productive years pursuing Nobel-caliber research (see the photo on the opposite page). Over the years, he also explored the subject of what he called "pathological science." Although he never published his investigations in this area, on 18December 1953 at General Electric's Knolls Atomic Power Laboratory, he gave a colloquium on the subject that will long be remembered by those in his audience. This talk was a colorful account of a particular kind of pitfall into which scientists may stumble.

The tape recording that was made of Langmuir's colloquium has been lost or erased. However, in 1966, a microgroove disk transcription that was made of this tape was found among the Langmuir papers in the Library of Congress. The disk recording is of poor quality, but most of what Langmuir said can be understood with a little practice. Robert N. Hall, a former colleague of Langmuir's at General Electric, transcribed the disk and edited it to make an internal report for the company. At that time, a small amount of editing was felt to be desirable. Some abortive or repetitious sentences were eliminated. Hall wrote the epilogue. Figures from corresponding publications were used to represent Langmuir's blackboard sketches. These agree in essence, if not in every detail, with Langmuir's descriptions. Some references were added for the benefit of anyone wishing to undertake a further investigation of this subject.

Physics Today
October, 1989, 36-48

These claims by honest researchers occur more commonly in our experience.

Pathological Science

Irving Langmuir
Nobel Prize, Chemistry 1932

"*...for his discoveries and investigations in surface Chemistry.*"

"There are cases [in scientific research] where dishonesty is not involved

but where people are tricked into false results by a lack of understanding about what human beings can do to themselves in the way of being lead astray by *subjective effects, wishful thinking or threshold interactions....*

These are examples of pathological Science."

Irving Langmuir, "Pathological Science," *Physics Today*, October 1989, 36-48.

Extraordinary Claims in Science

Occasionally...***an extraordinary claim*** in science provokes a stampede, in which members of a scientific community go rushing down a blind alley

…..only to discover sheepishly, in the end, that there is nothing to be found there!

In science one must be prepared to get things wrong, because there are mechanisms for eventually bring error to light.

Furthermore, the more important the error, the greater the need to identify it quickly. Science need a balance and tension between ***conservatism*** of the paradigm and ***skepticism*** for new ideas, and innovation.

Both are essential to a positive ***evolution of an accepted paradigm***.

Polywater

Ordinary water polymerizes into a new form of water upon contact with glass surfaces.

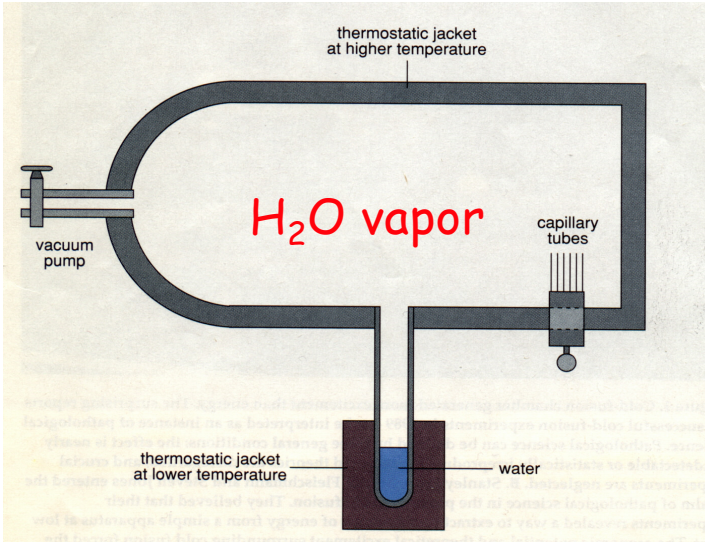
It is possible to imagine life without gasoline, but it would be impossible to imagine life without water.

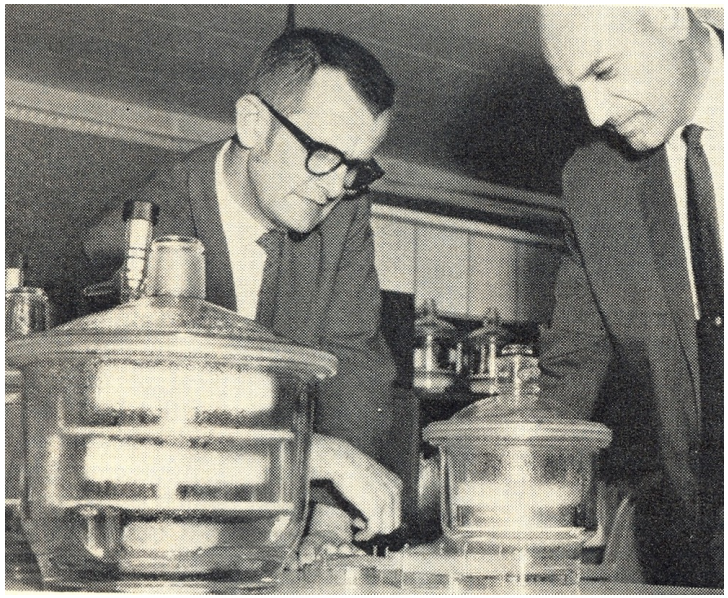
Polywater $[H_2O]_n$

A new form of water, polywater is prepared by placing freshly drawn glass capillary tubes in an atmosphere that is nearly saturated with water. The vapor pressure of the water surrounding the capillary is held slightly below saturation to deter normal condensation of water in the tube. After a few days, a condensate forms inside the capillary tube. Normal water is removed from the condensate through evaporation, leaving only the thick polywater in the tube. Polywater freezes at –50°C and boils at 300°C.

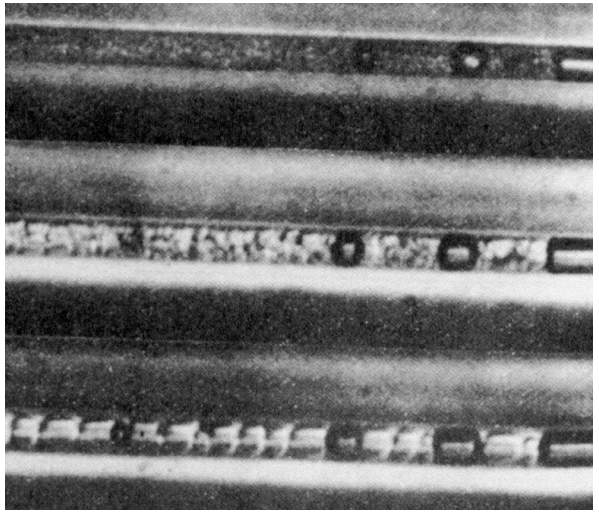
B. V. Derjaguin and N. N. Fedyakin,
Proc. Acad. Sc. USSR, Phys. Chem., 147, 808, (1962)

How is it made?





How does it look?



A Sample of Polywater
In a Thin Capillary Tube

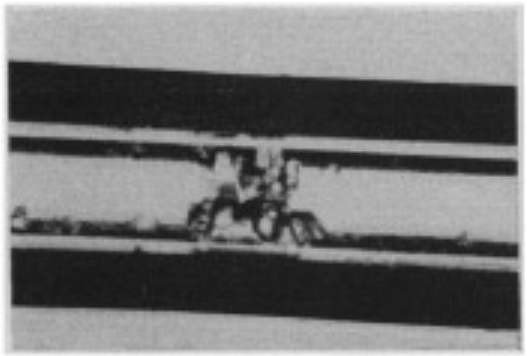


Fig. 1. Vaseline-like polywater sample after removal of normal water. The capillary inside diameter is about 200 μm.

Properties of Polywater

- Freezing "Interval" ~ - 31.5° C to -60.1° C
- Boiling Point ~ 249° C to 299.8° C
- Density 1.4 g/cm^3
- Thermal expansion coefficient ~ 1.5 times normal water

J.D. Barnal

In my opinion this is the most important physical chemical discovery of this century

B.V. Deryagin

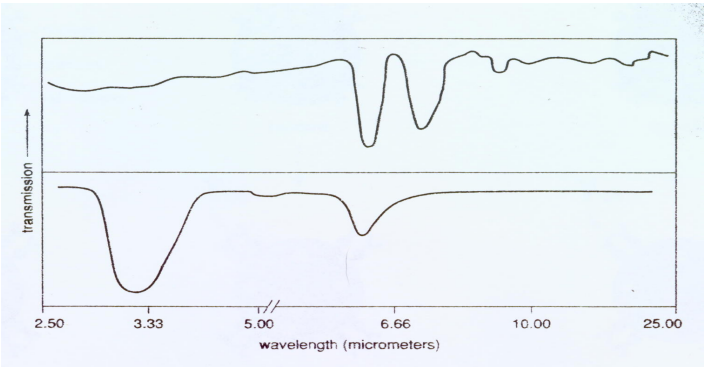
I am very glad to hear you say this ---- as you are the principal specialist on the physics and chemistry of water

The Infrared and Raman Spectra of Polywater!

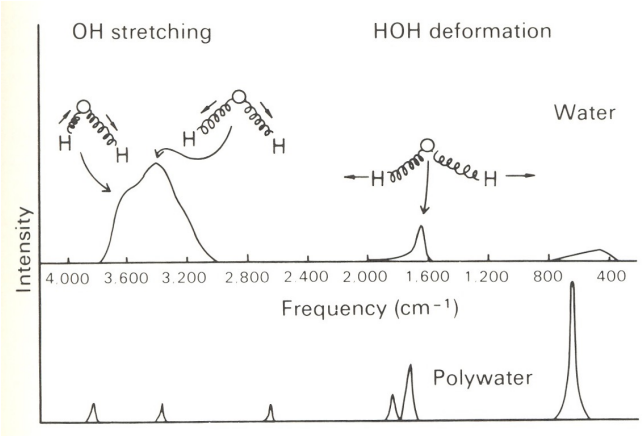
Polywater

E. R. Lippincott et. al.,
Science, *164*, 1482, 1969

IR spectrum

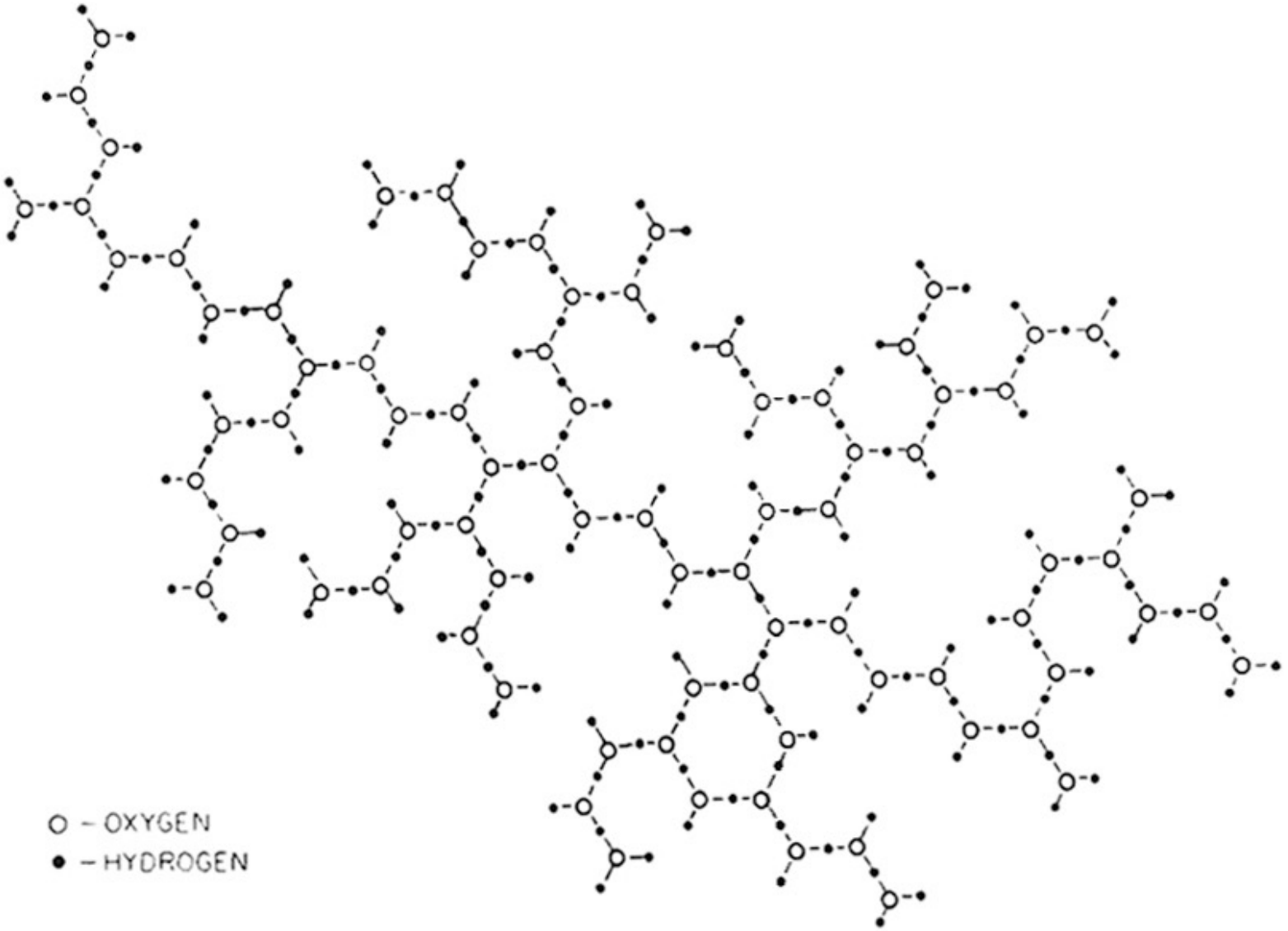


Raman Spectra



"Several structures are proposed which are consistent with the spectral data and the remarkable properties and stability of the material. *It is concluded that the material is a true polymer of water, and, therefore, is named polywater.*"

Structure of polywater



A theoretical explanation of polywater!

A Theory of Anomalous Water

L. C. Allen and Peter A. Kollman

Science, *167*, 1443, 1970

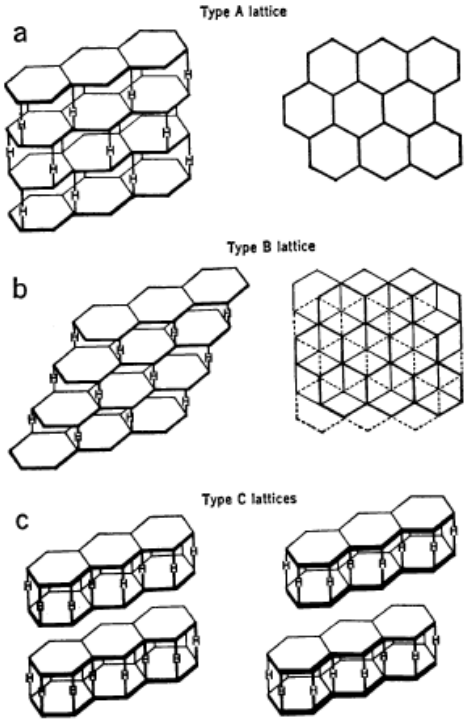


Fig. 1. The three types of anomalous water lattices. (a) Type A lattice; (b) type B lattice; (c) type C lattice.

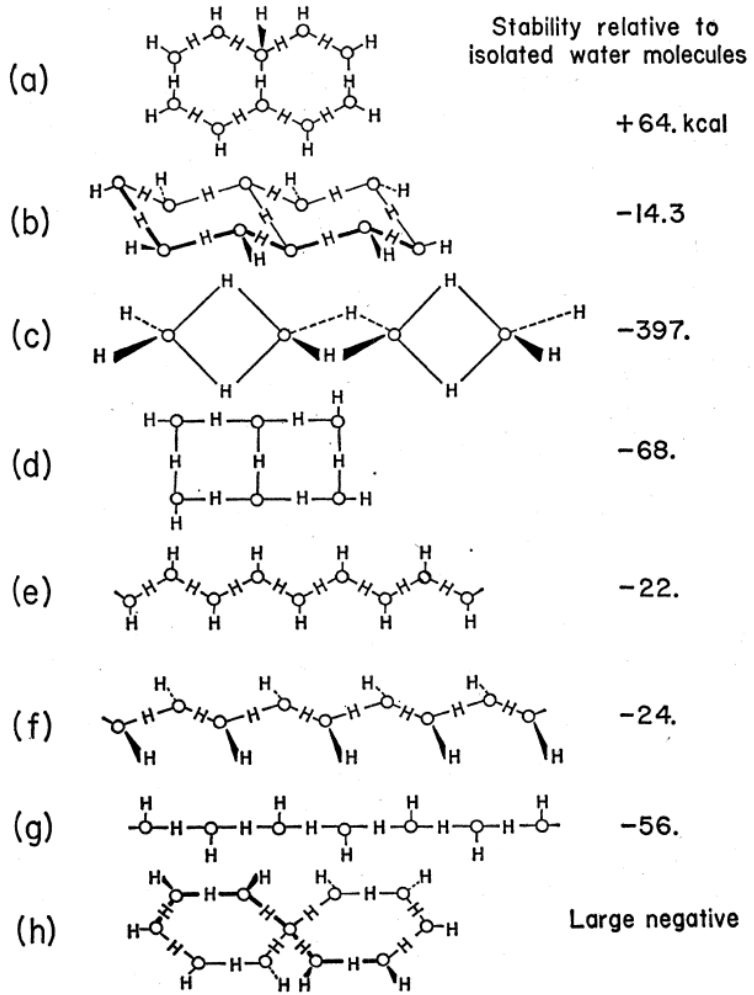


Fig 4. Possible geometries explored in this study.

"Anomalous" Water

F. J. Donahoe, *Nature*, 224, 198 (1969)

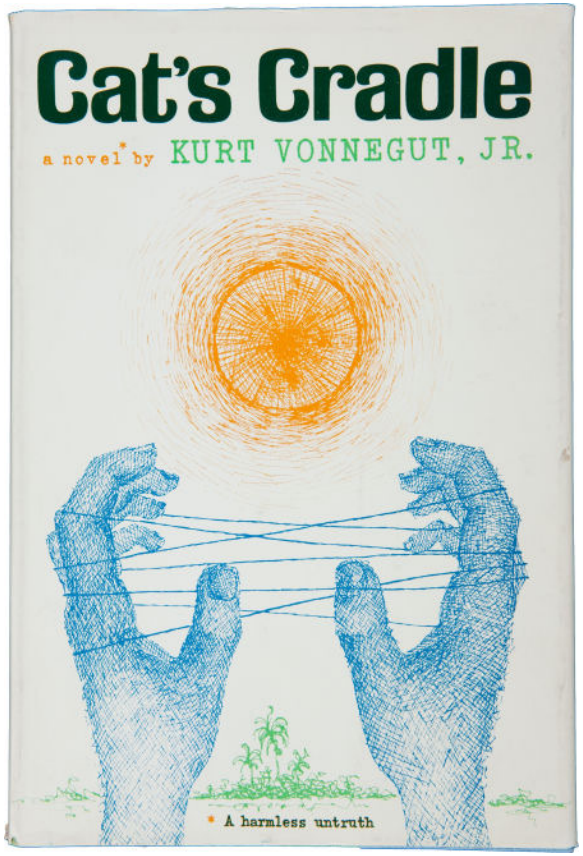
I need not spell out in detail the consequences if the polymer phase can grow at the expense of normal water under any conditions found in the environment. --- **The polymerization of Earth's water would turn her into a reasonable facsimile of Venus**.

After being convinced of the existence of polywater, I am not easily persuaded that it is not dangerous. ---- **I regard the polymer as the most dangerous material on earth**.

Every effort must be made to establish the absolute safety of the material before it is commercially produced. **Once the polymer nuclei become dispersed in the soil it will be too late to do anything**.

Scientists everywhere must be alerted to the need for extreme caution in the disposal of polywater. Treat it as the most-deadly virus until its safety is established.

Polywater poses a threat to homeland security!



Published 1963

"There are several ways in which water can freeze so that its atoms can stack and lock in an orderly, rigid way. Suppose this kind of ice, let's call that sort ice-1, is only one of several types of ice that can exist. Suppose water on earth always froze as ice-1 because it never had seeds to teach it how to form other forms of ice, you know, ice-2, ice-3, ice-4, and so on. Now suppose there was one special form of ice, let's call it ice-9, exists somewhere and that ice-9 is hard as a diamond and suppose that someday a tiny seed of ice-9 was somehow got into one of the oceans....."

Paraphrased from Kurt Vonnegut, *Cat's Cradle*

Polywater in the National News

American chemists have confirmed that there is a form of water with properties quite different from that of the fluid everyone takes for granted.

New York Times, Sep 22, 1969

Good news. The U.S. has apparently closed the polywater gap and the Pentagon is bankrolling efforts to push this country's polywater technology ahead of the ...

Wall Street Journal, June 30, 1969

An American scholar---suggests that polywater, if once let out of the laboratory will go on a wild rampage across the globe, transforming the cool clear liquid that we drink into polywater, thereby destroying all earthly life.

Guardian, 1969

The Miami Herald

July 30, 1969

Miami Scientific Team Creates Mysterious New Form of Water

- If water is ever found on moon it would be polywater
- It might chemically convert ordinary water into polywater
- It would not dry up the ocean but might decrease its volume by 40%
- At this stage who knows what the future holds for this stuff

Press conference at the American Chemical Society's symposium at Lehigh University, 1970.

Press conference at the American Chemical Society's symposium at Lehigh University, 1970. *From left*: Albert Zettlemoyer, Lehigh University provost and the future ACS president; Boris Deryagin; Denis Rousseau of Bell Labs; Frederick Fowkes, chair of Lehigh's chemistry department.

Is it real?

Challenged by critics to let impartial scientists analyze his polywater, Deryagin had turned over 25 tiny samples of the substance to investigators. The results showed that Deryagin's polywater was badly contaminated by organic compounds, including lipids and phospholipids, which are ingredients of human perspiration.

Time Magazine, October 19, 1970

Scientist says mystery of polywater has been solved: Russian's test samples contained sweat.

New York Times, September 27, 1970

Polywater drains away.

Nature, March 5, 1971

The extraordinary claim is withdrawn.

Our investigations led to the discovery in 1962 of what we claimed to be an anomalous new, stable form of water with a density almost one and a half times that of ordinary water and which possessed a molecular structure that could only be described as polymeric.

- We have now established that there are no samples, both free of impurity atoms and simultaneously exhibiting anomalous properties.

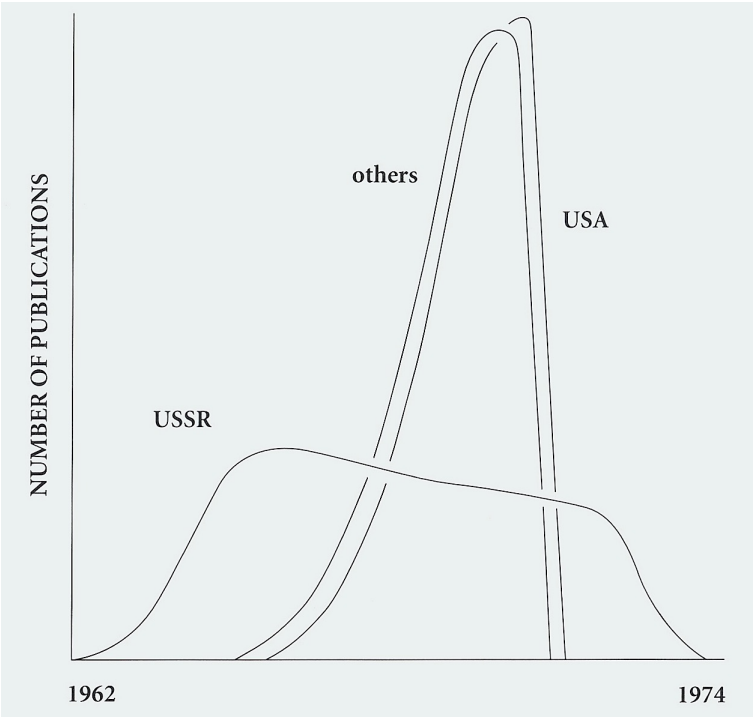
- Consequently, the claimed properties should be attributed to impurities in ordinary water rather than to the existence of polymeric water molecules..."

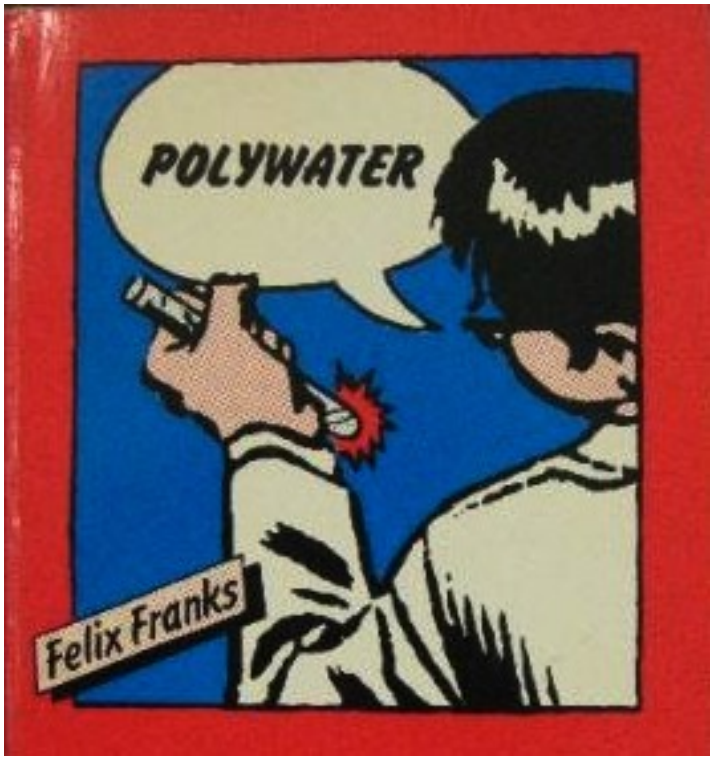
B. Derjaguin and N. Churaev, "Nature of Anomalous Water", *Nature*, 244, 430, 1973.

Obituary: Polywater 1962-73

Recently Academician Deryagin himself has announced that his latest reserachers have shown that **doubters were right and he was wrong**. Now if only politicians behaved with the candor science requires of all true scientists.

New York Times, July 28, 1973





WATER

The Rise and Fall of Polywater

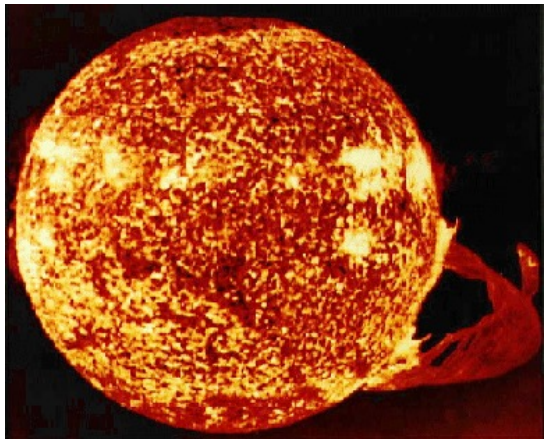
What happens when an earth-shattering discovery runs up against the scientifically impossible?

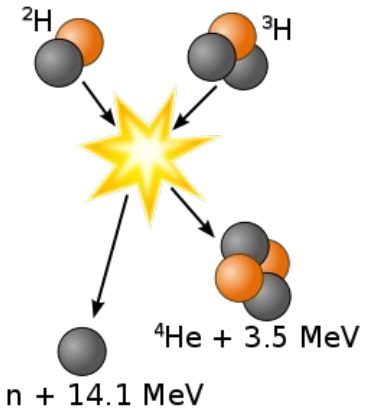
By Ainissa Ramirez | February 25, 2020

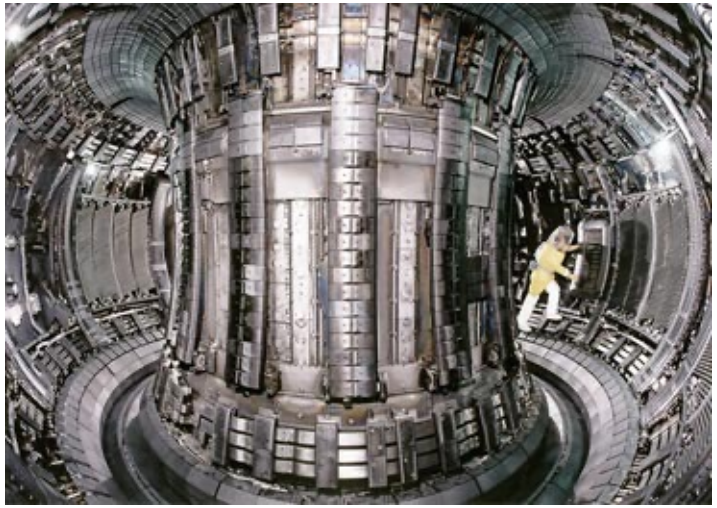
One could charitably argue that the polywater saga wasn't really a scientific failure, but a success. Scientists continually come up with new theories and disprove them—that's the scientific method, the way we improve our understanding of the world around us

---

Fusion





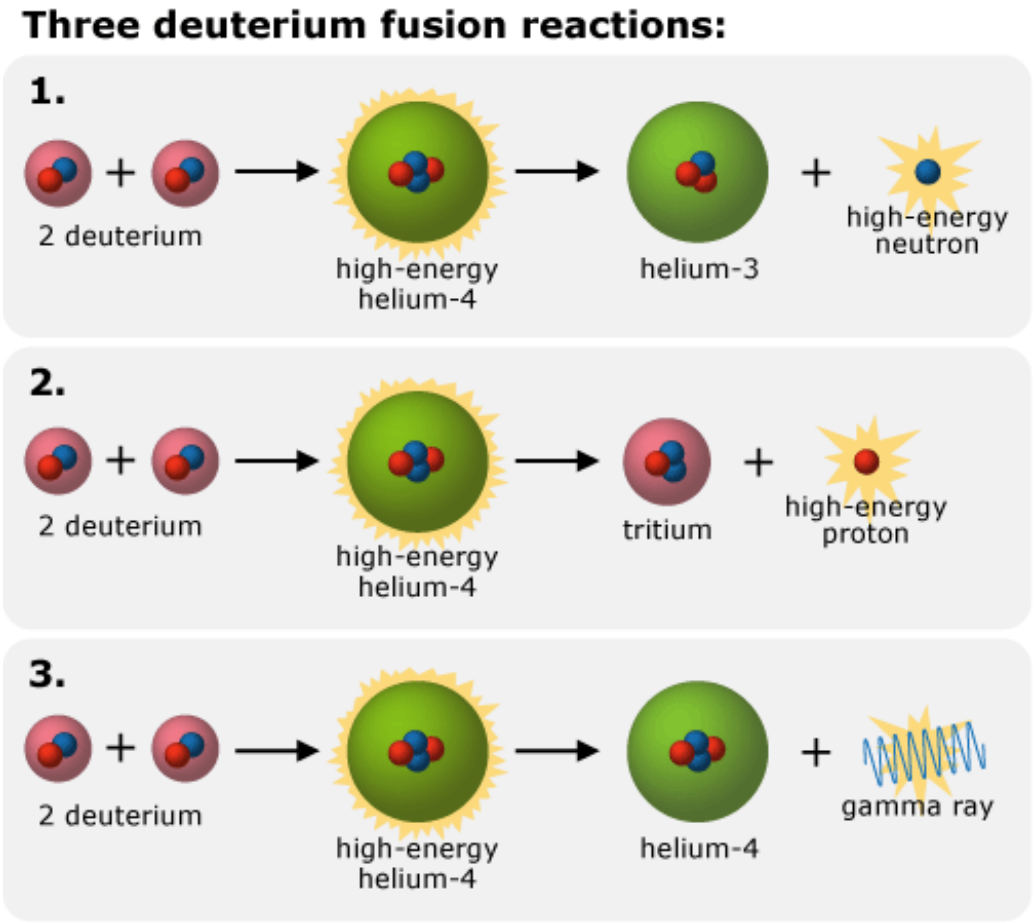


International Thermonuclear Experimental Reactor

Hot fusion: A physicist's paradigm

- In nuclear fusion two light nuclei are combined into a heavier nucleus, releasing energy.

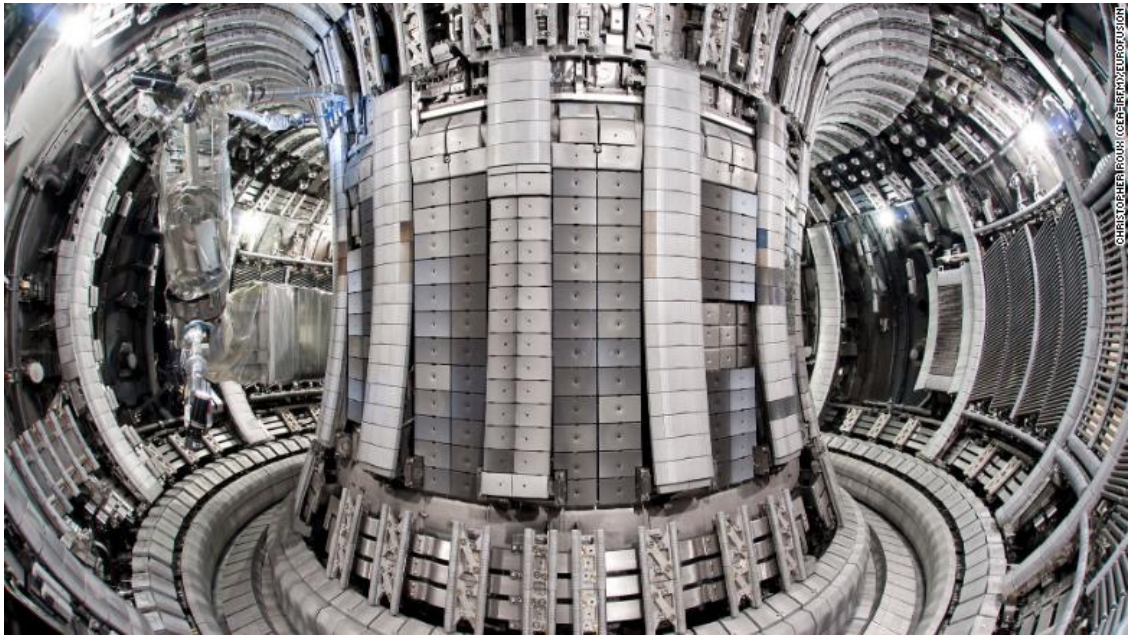
- Deuterium, ^{2}H, can be used in D-D fusion to release approximately 4.00 MeV per fusion.



A giant donut-shaped machine just proved a near-limitless clean power source is possible

CNN-Wed February 9, 2022

Nuclear fusion reactor

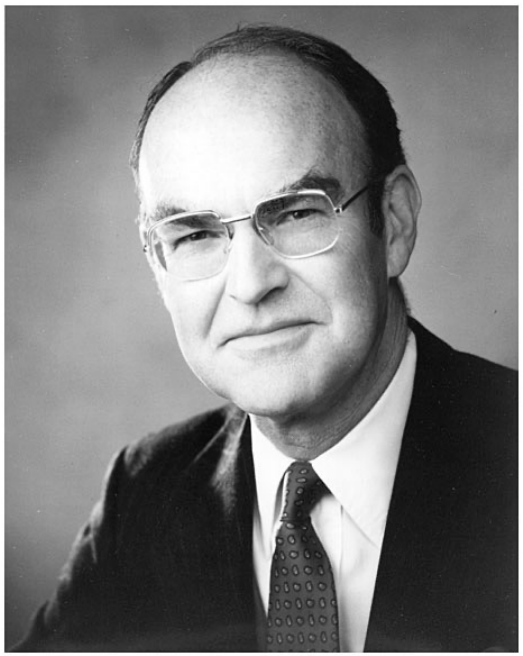


Replicating the fusion processes of the Sun to create energy

Approximate total cost $45 –$65 billion

The Announcement

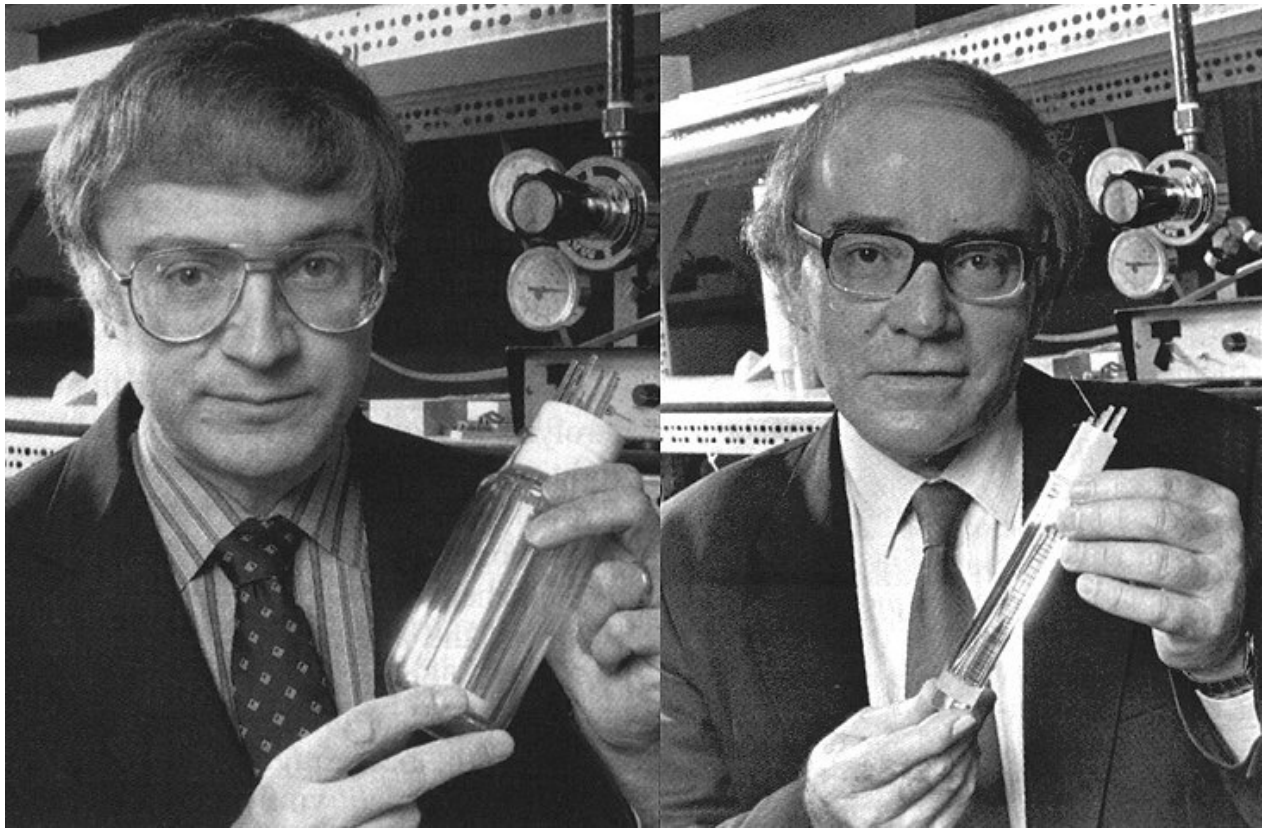
University of Utah N-Fusion Press Conference
March 23, 1989, Salt Lake City, Utah



Chase Petersen
President, University of Utah

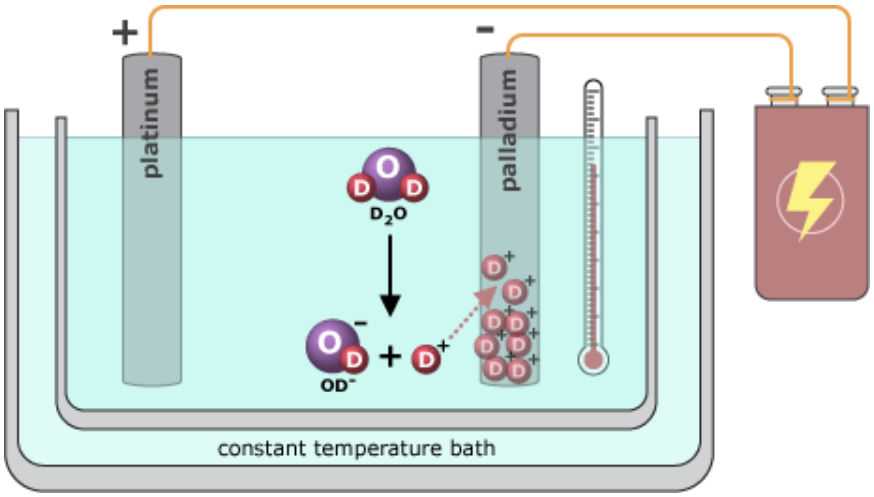
- **"Two scientists have successfully created a sustained nuclear fusion reaction at room temperature in a chemistry laboratory at the University of Utah."**
- **"The greatest invention since the discovery of fire."**
- **"There are billions of dollars at stake and Nobels in the offing."**

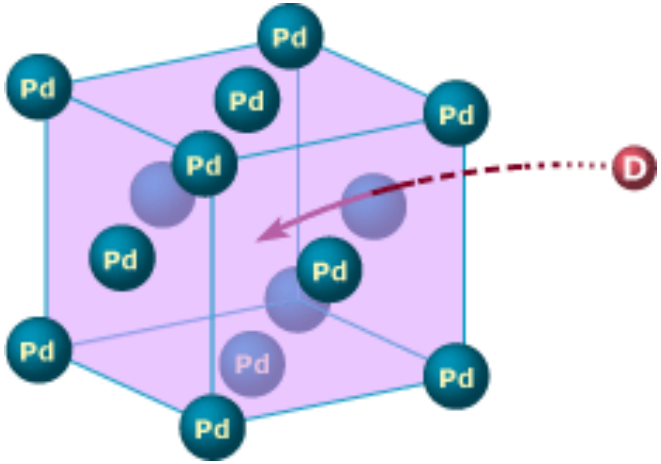
Pons and Fleischmann



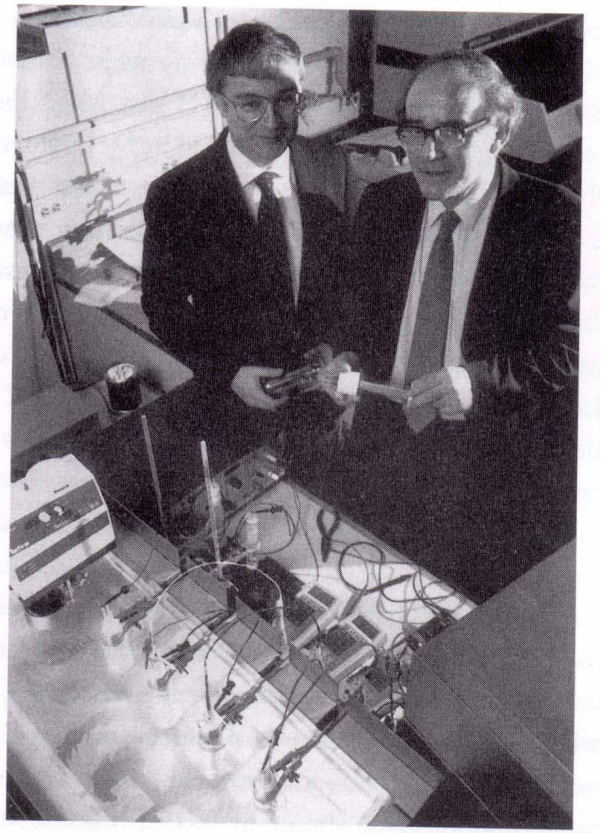
An Extraordinary Claim: Atoms can undergo nuclear fusion at room temperature in a jam jar. A new paradigm of COLD FUSION!

Cold Fusion Machine





Pons and Fleischmann declare they have a solution to energy crisis



Stanley Pons (left) and Martin Fleischmann in the laboratory.

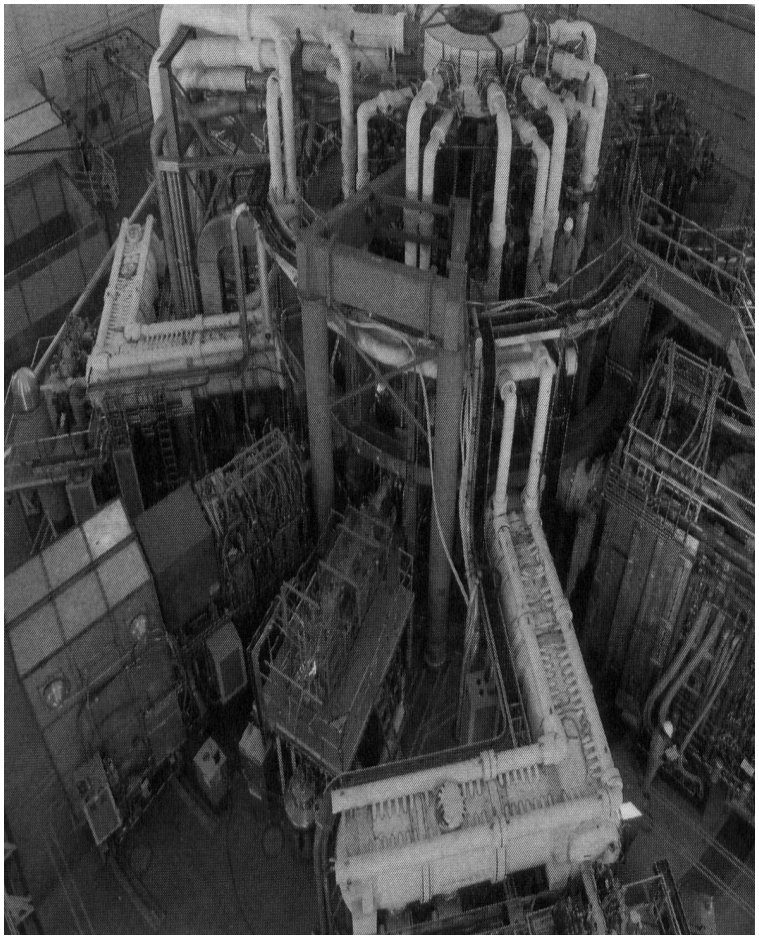
"Basically, *we have established a sustained nuclear fusion reaction by means which are considerably simpler than conventional means.* Deuterium, which is a component of heavy water, is driven into a metal rod-exactly like the one that I have in my hand-to such an extent that fusion between these components, these deuterons in heavy water, are fused to form a single new atom. And with his process there is a considerable release of energy: and we've demonstrated that this can be sustained on its own. *In other words, much more energy is coming out than we are putting in*."

University of Utah Press Conference

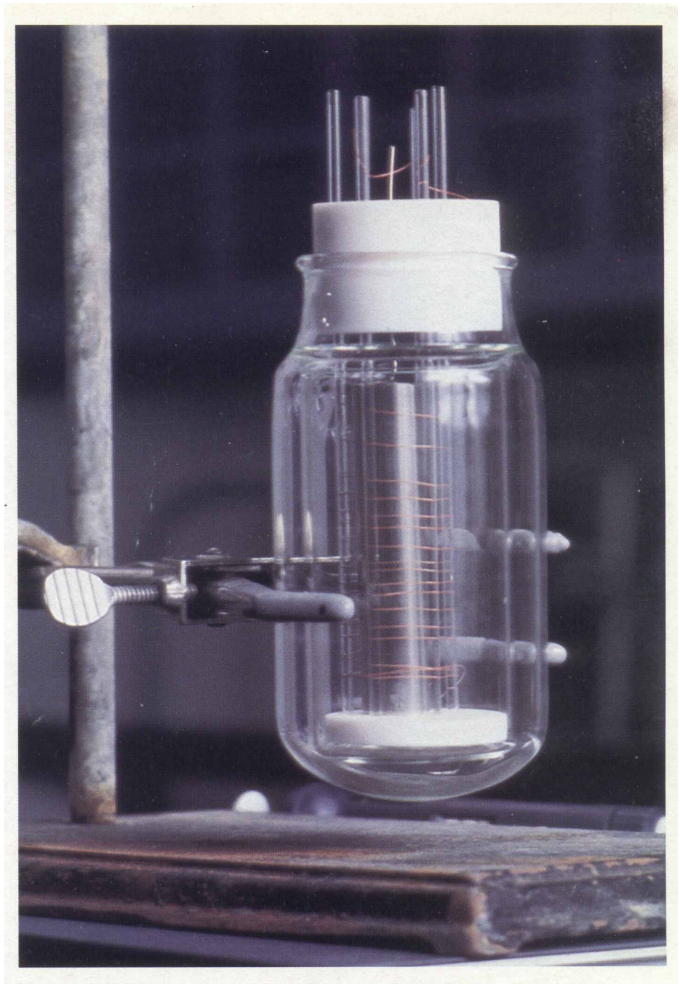
March 23, 1989, Salt Lake City, Utah

Fusion: The Physics Paradigm

- The fusion of two nuclei of deuterium together to form helium releases enormous amount of energy.
- The paradigm requires that a huge input of energy is required to overcome the strong repulsion between positive charges as the nuclei approach and attempt to fuse and lower the energy.
- ***Fusion is performed within the paradigm under the condition of "high energy physics", i.e., 100 million degrees Celsius (10,000 times hotter than the surface of the sun).***
- *Cold fusion was reported to perform the fusion of deuterium at room temperature through the use of a simple electrochemical cell* made of palladium.

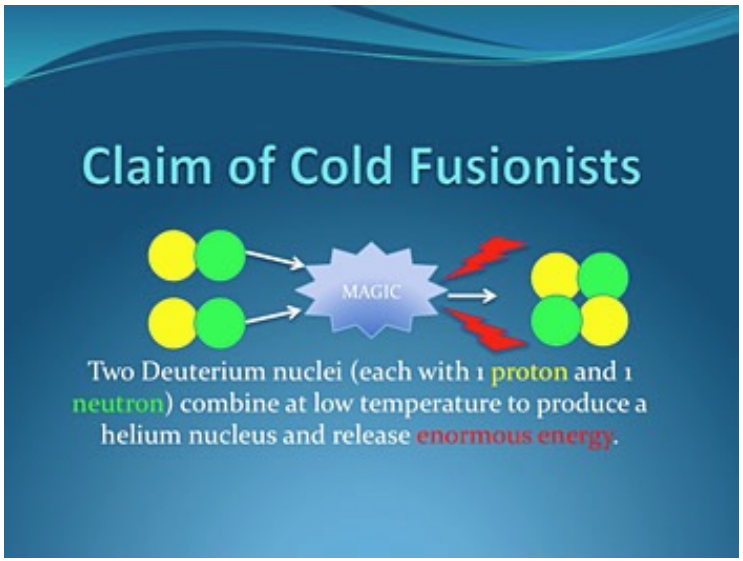


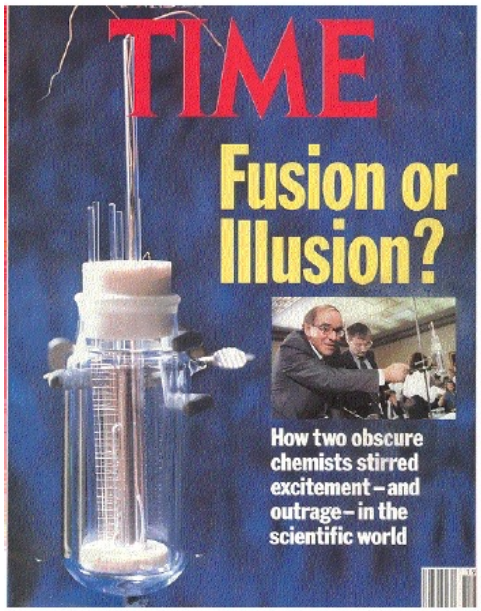
Physicist's Paradigm for Fusion: Princeton Tokomak Reactor. A billion dollar operation.

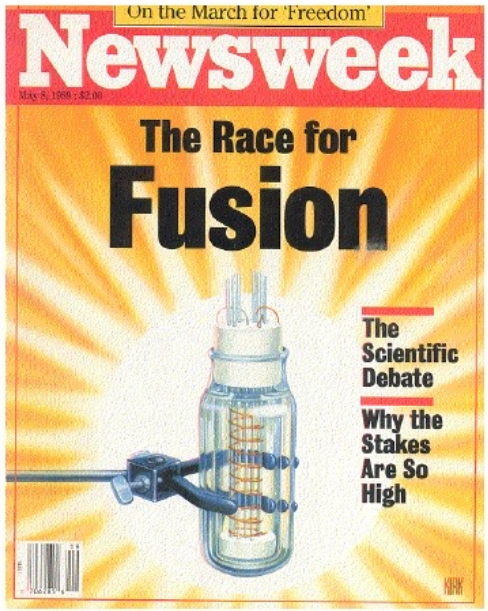


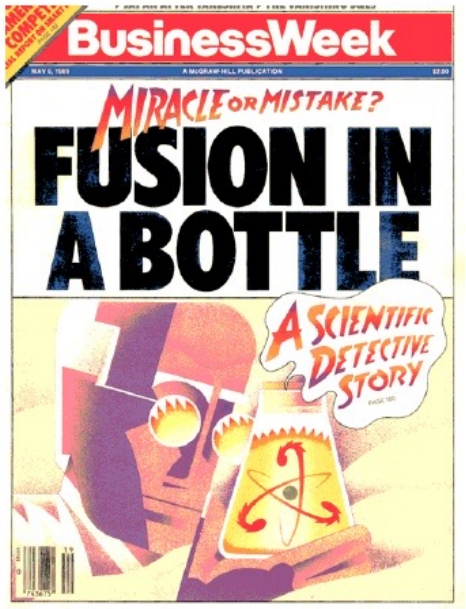
Chemist's Paradigm for Cold Fusion: Utah Tokomak. Energy straight from the faucet.

Science hijacked









Hot fusion: A physicist's paradigm

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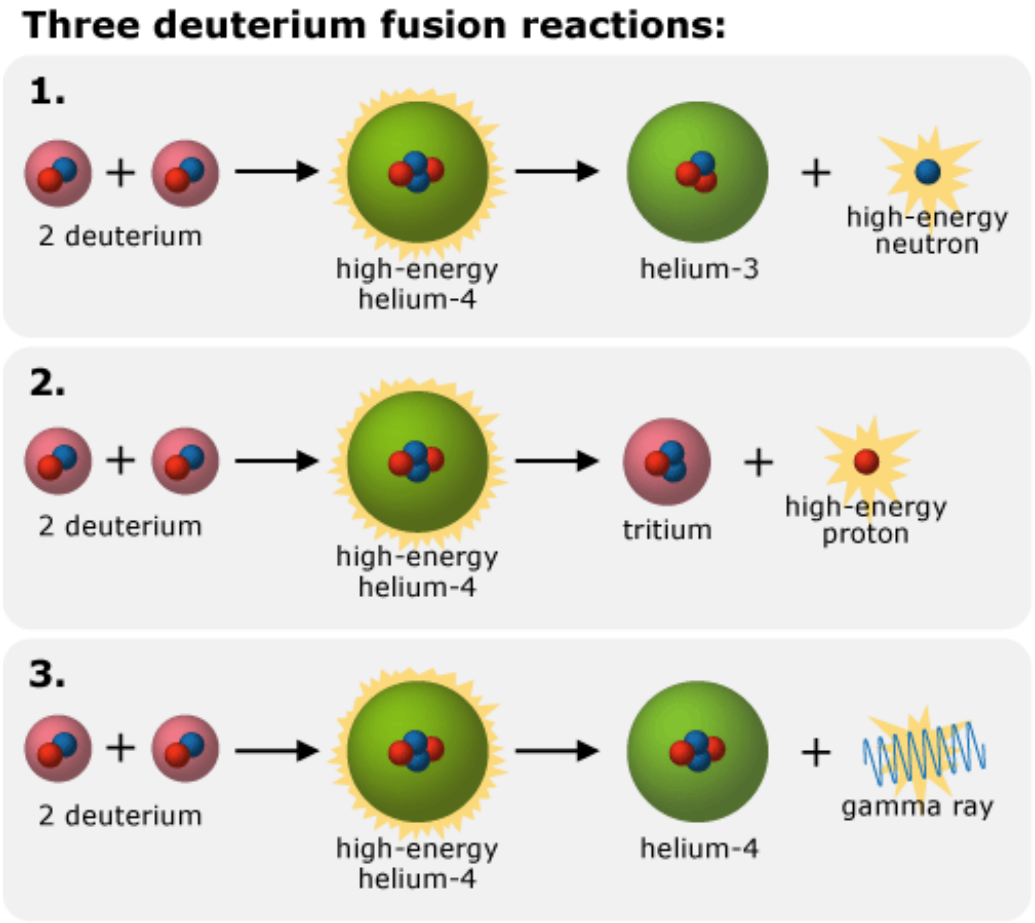


Fusion Phenomenon Confirmed within a Month - 1989

- **Excess Heat** (Texas A & M; April 10, Wall Street Journal "Cold Fusion Expriments Duplicated")
- **Neutrons** (Georgia Tech; April 10, Press Conference)
- **Tritium** (Uni. Washington, Seattle: April 14, Press Conference)
- **^{4}He** (Uni. Utah; April 17)

Utah Governor Bangerter signs five million dollar bill for fusion research

U. Utah President requests Federal Government for $25 million

RECENT DEVELOPMENTS IN FUSION ENERGY RESEARCH

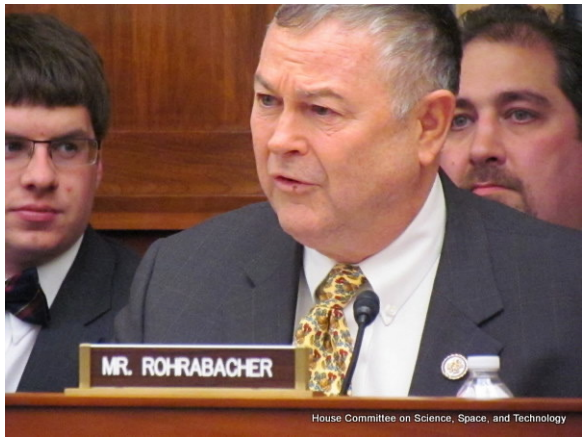
HEARING
BEFORE THE
U.S. CONGRESS, HOUSE COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
ONE HUNDRED FIRST CONGRESS
FIRST SESSION

APRIL 26, 1989

[No. 46]

Printed for the use of the
Committee on Science, Space, and Technology

Congressional hearing



Prof. Seaborg to President Bush: I am skeptical, but I believe that the phenomenon had to be investigated and I am recommending that a special panel be created to look into it.

Retractions

- **Excess Heat** (Texas A & M)

  Electronic thermometer problem

- **Neutrons** (Georgia Tech)

  Background; no proper control

- **Tritium** (Uni. Washington, Seattle)

  Mass spec calibration problem

- **^{4}He** (Uni. Utah; April 17, C. Walling)

  Air leak; never ran the mass spec to check for N_2 and O_2 along with He.

Britons Abandon 'Cold' Quest

New York Times, June 20, 1989

- **Harwell Laboratory**, one of the British Government's top science centers, announced that it was ending attempts to duplicate the disputed experiment after three months of repeated failures.

- The Harwell scientists tried eight different types of palladium metal, in which the fusion was said to occur. They searched, to no avail, for fusion by products with a bevy of sensitive detectors. They failed to find neutrons and excess heat.

Cold fusion has problems in America too!

"It is a simple chemical reaction that has nothing to do with fusion."

N. S. Lewis, Caltech

Caltech chemists failed to find any symptoms of fusion. The scientists found no emitted neutrons, gamma rays, tritium or helium, although the Utah group reported all these emissions at high levels.

Scientists at M. I. T., Lawrence Berkeley Laboratory, the University of Rochester, a joint research group of Brookhaven National Laboratory and Yale University failed to find evidence of the existence of cold fusion.

How did it get started?

Steven Jones, BYU

- Pons proposal comes to Jones for review in 1988.
- Recommends rejection.
- The Program Officer encourages collaboration between Pons and Jones
- To avoid priority Pons and Jones agree to submit independent manuscripts at the same time.
- However, Utah President announces the results in a press conference one day before the agreed date.

Professor Steven Jones and fellow BYU physicists with their neutron detection equipment. From left are Jones, J. Bart Czirr, Gary L. Jensen, Daniel L. Decker, and E. Paul Palmer.

"Look, I don't mean to be rude, but we have been looking at this process for years now, and it is just not an energy producer. If you could ever get enough energy to light a flashlight, I would be extremely surprised."

Chapter Ends

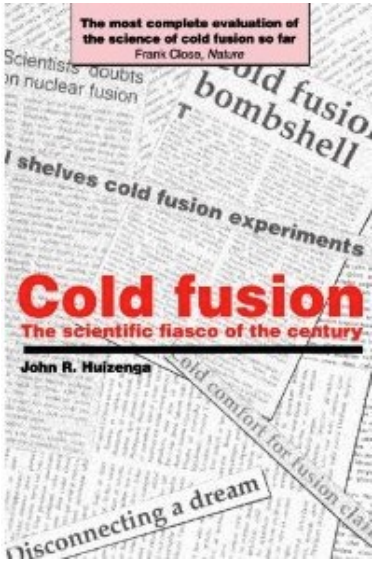
Dr. Fleischmann ultimately acknowledged that his data was slippery and his secrecy counterproductive. Dr. Fleischmann died at age 85 on Aug. 3, 2012 at his home in Tisbury, England.

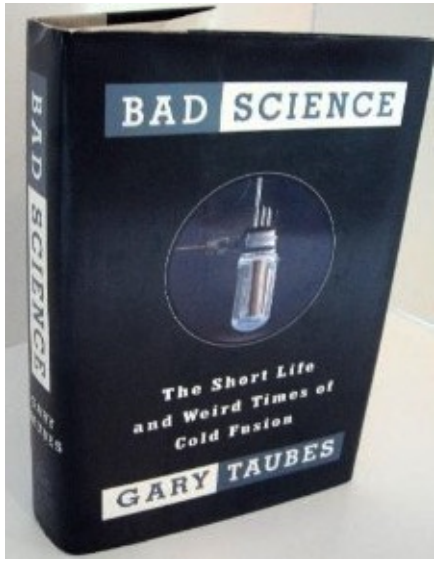
Dr. Pons resigned from the University in 1991 and moved to France in 1992, along with Fleischmann, to work at a Toyota-sponsored laboratory that closed in 1998. He gave up his US citizenship and became a French citizen.

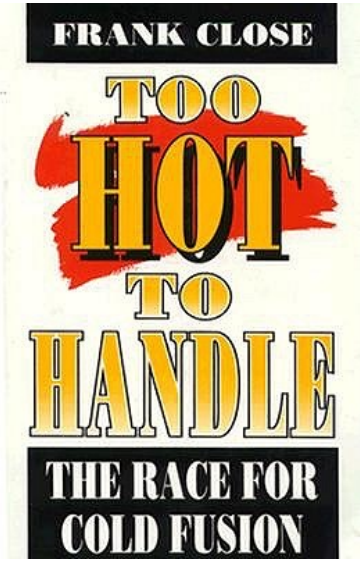
Dr. Peterson: Cold fusion funding fuss leads to the resignation of University of Utah President (June, 1990).

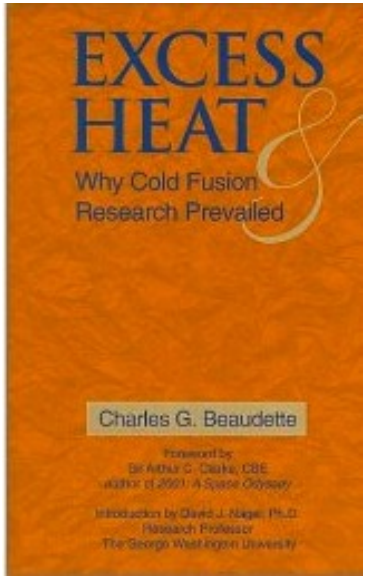
Dr. Jones, who suggested President Bush and his men, planned and orchestrated 911 and used the hijacked planes as a diversion resigned from BYU, six weeks after the school placed him on leave.

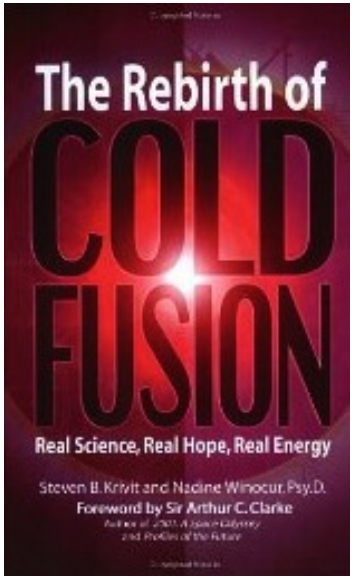
True believers persist

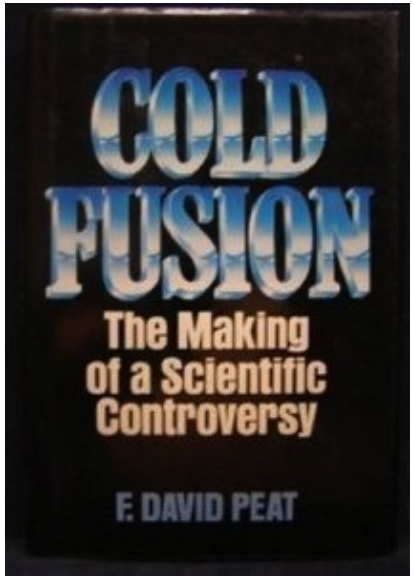


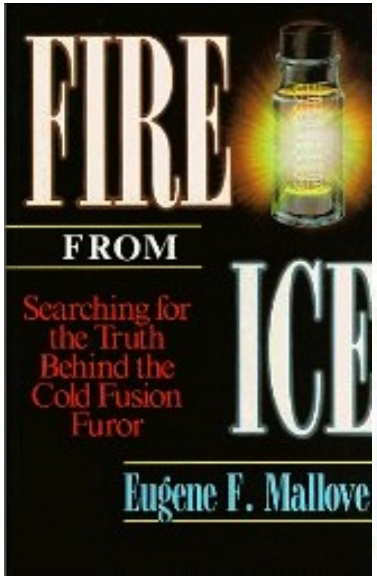


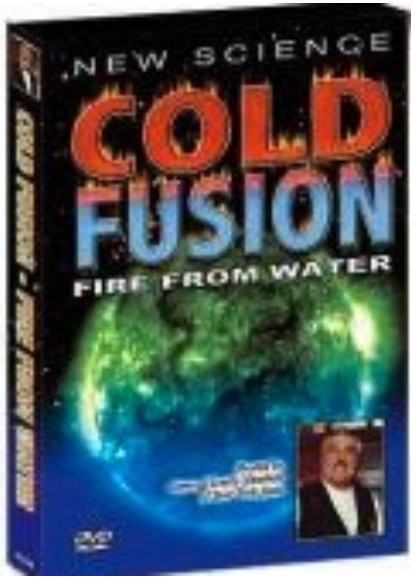












Healthy skepticism

- **Be skeptical of your own work**
- **Test relentlessly for systematics**
- **Avoid early press conferences**

Extraordinary claims require extraordinary evidence.

Carl Sagan

Pathological Science

These aren't instances of outright fraud, but of unconscious bias. A scientist misinterprets a small amount of data as a paradigm shifting discovery, and once in that mindset, he or she sees all subsequent information through the same lens.

Scientific Method

- **Pay attention to what other people have already done.**

- **Expose your ideas to testing.** Strive to describe and perform the tests that might suggest you are wrong and/or allow others to do so.

- **Openly communicate ideas and tests to others.** Communication is important for many reasons.

- **Play fair: Act with scientific integrity.** Hiding evidence, selectively reporting evidence, and faking data directly thwart science's main goal, which is to construct accurate knowledge about the natural world.

References

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- *Betrayers of Truth,* W. J. Broad and N. Wade*, 1982*
- *Impure Science: Fraud, Compromise and Political Influence in Scientific Research*, R. Bell, 1992
- *Voodoo Science: The Road from Foolishness to Fraud*, R. L. Park, 2000
- *The Undergrowth of Science,* W. Gratzer*, 2000*
- *The Great Betrayal, H. F. Judson, 2004*
- *On Fact and Fraud,* D. Goodstein, 2010
- *Ethics in Science,* J. D'Angelo, 2012
- *The Scientific Attitude,* Lee McIntyre, 2019

Fraud in Science

Ethics

David Baltimore

Ronald Breslow

Dalibor Sames

Leo Paquette

Charles Lieber

David Baltimore

Professor of Biology
Caltech

Former President of Caltech
Former President of Rockefeller Uni
Former Director of Whitehead Inst, MIT

Nobelist Entangled in Fraud Case Resigns as Head of Rockefeller U.

President of Rockefeller U. Retracts Scientific Paper That NIH Office Says Contains Fabricated Data

By DAVID L. WHEELER

'I Am Innocent,' Embattled Biologist Says

The Baltimore affair

Ignoble

The New York Times

A Scientific Watergate?

Hero in Exposing Science Hoax Paid Dearly

By PHILIP J. HILTS

US finds fraud in research at MIT

Report also assails Nobel laureate

By Peter G. Gosselin
GLOBE STAFF

Did Imanishi-Kari Get a Fair "Trial"?

For challenging her boss's data, a scientist lost her job and home.

Nobel Scientist Apologizes to Whistle-Blower

Co-Author of Flawed Study Concedes His Oversight Was Inadequat

Associated Press

David Baltimore, a Nobel laureate who was co-author of a study that prompted a prolonged investigation of possible scientific misconduct, has apologized to the young scientist who prompted the investigation and admitted that he made mistakes in defending the flawed work of a co-author.

Baltimore, now president of Rockefeller University in New York

1975 Nobel Prize in Physiology or Medicine

National Medal of Science, 1999

David Baltimore

Thereza Imanishi-Kari

Margot O’Toole

A native of Brazil, Thereza Imanishi-Kari earned a BS degree in biology from the University of Sao Paulo. Subsequently, she received her Ph. D. from University of Helsinki in Finland. Before joining Tufts she had been a faculty member at the MIT where D. Baltimore was also on faculty.

Dr. O'Toole was educated in Ireland, then in Brookline public schools, Brandeis University, and Tufts University, where she earned her doctorate in cellular immunology. She was a postdoctoral fellow at the MIT in 1985 and 1986 under Dr. Imanishi-Kari.

April 25, 1986
Publication of Weaver D, Reis MH, Albanese C, Costantini F, Baltimore D, Imanishi-Kari T. Altered repertoire of endogenous immunoglobulin gene expression in transgenic mice containing a rearranged mu heavy chain gene. *Cell* 1986;45:247.

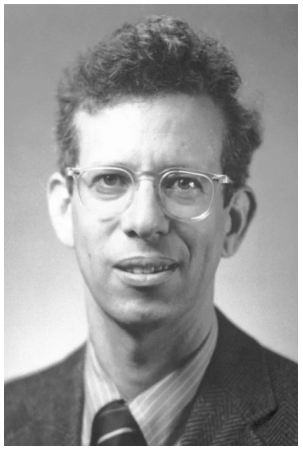
Summer-Autumn 1986
M.I.T. postdoc Margot O'Toole challenges key findings after discovering 17 notebook pages of conflicting data. O'Toole in a meeting with Baltimore, Imanishi-Kari and others, urged that a correction be published. Imanishi-Kari admitted the discrepancy between the 17 pages and the published report. Baltimore told her that "this kind of thing" (i.e., the discrepancy) was not unusual, and threatened to oppose her attempts to correct the paper.

1986 and 1996
Too many things happened between 1986 and 1994. Investigation by NIH panel, Congressional hearing, Secret service investigation, NIH's Office of Scientific Integrity Investigation, appeal and final judgement by Health and Human Services Appeals panel.

The New York Times

The Fraud Case That Evaporated

David's misconduct was- When an experiment is challenged no matter who it is challenged by, it's your responsibility to check. That is an ironclad rule of science that, when you publish some thing you are responsible for it. And one of the great strengths of American science, as opposed to Russian and German and Japanese science, is that even the most senior professor if challenged by the lowliest technician or graduate student, is required to treat them seriously and to consider their criticisms. It is one of the most fundamental aspects of science in America.



Howard Temin, 16 March 1993

The Nobel Prize in
Physiology or Medicine 1975

Ronald D. Breslow

Professor of Chemistry, Columbia University

Breslow published a series of three papers with graduate student Monica Mehta in 1986. They reported that the use of metal–ligand bonding to attach templates to the steroids was able to provide one billion catalytic turnovers. These astonishingly good results were soon determined to be the result of scientific misconduct, and Breslow retracted all these publications in late 1986.

RETURN TO ISSUE | < PREV **NEWS** NEXT >

Research results to be withdrawn from JACS

Cite this: *Chem. Eng. News* 1986, 64, 49, 6
Publication Date: December 8, 1986
https://doi.org/10.1021/cen-v064n049.p006

c&en ARCHIVES

PDF (107 KB)

SUBJECTS: Catalysts, Steroids

Abstract

A rare example of the appearance in a major chemical research journal of allegedly falsified data became known last week when Ronald Breslow, professor of chemistry at Columbia University, informed C&EN that he is withdrawing three communications published this year in the *Journal of the American Chemical Society* (see letter page 2). Breslow's only coauthor is Monica P. Mehta.

The three communications [*J. Am. Chem. Soc.* , 108, 2485, 6417, 6418 (1986)] are concerned with catalytic steroid reactions. They involve catalysts that one of the publications describes as having "astonishing apparent effective molarities." The work also has been presented by Breslow at seminars in both the U.S. and overseas. It is funded by the National Science Foundation.

Breslow is a distinguished organic chemist. He earned his Ph.D. at Harvard in 1955 under Robert B. Woodward. He joined the Columbia faculty in 1956 and since 1967 has been S. L. Mitchill professor of chemistry. He recently added ...

Additions and Corrections

Catalytic Directed Steroid Chlorination with Billiofold Turnovers [*J. Am. Chem. Soc.* **1986**, *108*, 2485]. RONALD BRESLOW* and MONICA P. MEHTA

Thioxanthones as High Turnover Catalytic Templates in Directed Chlorination Reactions [*J. Am. Chem. Soc.* **1986**, *108*, 6417–6418]. RONALD BRESLOW* and MONICA P. MEHTA

A Novel Bifunctional Chlorination Mechanism in Template Catalyzed Directed Functionalization with High Effective Molarities and Rates Approaching Diffusion Control [*J. Am. Chem. Soc.* **1986**, *108*, 6418–6420]. RONALD BRESLOW* and MONICA P. MEHTA

Several findings reported in these papers cannot be reconfirmed, including some that affect the principal conclusions. Accordingly, these papers are retracted.

Ronald D. Breslow
Professor of Chemistry
Columbia University

C&EN
CHEMICAL & ENGINEERING NEWS

April 27, 2012 | Latest News

Breslow Paper In *JACS* Questioned

Critics cite similarities between Perspective and two previously published papers

Breslow is a titan in the chemistry enterprise and a major figure at ACS. He served as the society's president in 1996 and was the recipient of the society's highest award, the Priestley Medal, in 1999. He is a member of the National Academy of Sciences and a recipient of the National Medal of Science (1991).

April 27, 2012 | Latest News

Breslow Paper In *JACS* Questioned

Critics cite similarities between Perspective and two previously published papers

A number of paragraphs in the JACS perspective that seemed to be virtually identical to those published in two previous Breslow publications.

One person noted similarities between Breslow's JACS Perspective and a paper Breslow had published on the same subject in Tetrahedron Letters in 2010. Subsequently, Stuart Cantrill, chief editor of Nature Chemistry, pointed out in his personal Twitter feed that the JACS Perspective was identical in large part to a review Breslow had published in 2011 in the Israel Journal of Chemistry. A number of chemistry-oriented blogs such as In the Pipeline and ChemBark subsequently weighed in on the controversy.

ACS "Ethical Guidelines to Publication of Chemical Research" state that "it is unacceptable for an author to include significant verbatim or near-verbatim portions of his/her work … without acknowledging the source."

Leo Paquette
Professor of Chemistry, OSU

NSF, Paquette Settle Misconduct Case

Chem. Eng. News 1998, 76, 10, 25

In 1991, the Ohio State University investigatory panel found that Paquette had plagiarized a NSF proposal, that he was also a reviewer for, and included sections in a paper he published in the Journal of the American Chemical Society.

In 1993, an Ohio State University investigation found that Paquette had plagiarized sections from an unfunded NIH grant application, for which he was a reviewer, and included the text in his own NIH grant application.

Leo Paquette
Professor of Chemistry, OSU

NSF, Paquette Settle Misconduct Case

Chem. Eng. News 1998, 76, 10, 25

A grant application by S. F. Martin was rejected by a committee headed by Paquette. Sometime later, Martin received a grant proposal by Paquette for evaluation. Whole sections of the text were identical with parts of Martin's rejected application. A variety of excuses were proffered, including graduate student and postdoctoral interference, but Paquette was found guilty of misconduct and banned from participation in granting committees for ten years. Also, he supposedly agreed with his university to reduce his research group from 40 co-workers to a more modest 20 who he had time to properly supervise.

Dalibor Sames
Professor of Chemistry
Columbia University

Bengu Sezen Found Guilty of Fraud

Scientific Misconduct: Columbia University case

is one of the worst for chemistry;

Ph. D. withdrawn, 2011

Seven papers published in 2002-2005

1. Sezen, B. and D. Sames (2005). "Selective and catalytic arylation of N-phenylpyrrolidine: sp(3) C-H bond functionalization in the absence of a directing group." Journal of the American Chemical Society 127(15): 5284-5285.

2. Godula, K., B. Sezen, et al. (2005). "Site-specific phenylation of pyridine catalyzed by phosphido-bridged ruthenium dimer complexes: A prototype for C-H arylation of electron-deficient heteroarenes." Journal of the American Chemical Society 127(11): 3648-3649

3. Sezen, B. and D. Sames (2004). "Oxidative C-arylation of free (NH)-heterocycles via direct (sp(3)) C-H bond functionalization." Journal of the American Chemical Society 126(41): 13244-13246.

Retracted in Mar 8, 2006

4. Sezen, B. and D. Sames (2003). "Selective C-arylation of free (NH)-heteroarenes via catalytic C-H bond functionalization." Journal of the American Chemical Society 125(18): 5274-5275.

5. Sezen, B. and D. Sames (2003). "Diversity synthesis via C-H bond functionalization: Concept-guided development of new C-arylation methods for imidazoles." Journal of the American Chemical Society 125(35): 10580-10585.

Retracted in June 22, 28 2006

6. Sezen, B. and D. Sames (2003). "Cobalt-catalyzed arylation of azole heteroarenes via direct C-H bond functionalization." Organic Letters 5(20): 3607-3610.

7. Sezen, B., R. Franz, et al. (2002). "C-C bond formation via C-H bond activation: Catalytic arylation and alkenylation of alkane segments." Journal of the American Chemical Society 124(45): 13372-13373.

Prof. Dalibor Sames and Dr. Sezen Columbia University

Both federal Office of Research Integrity and Columbia concluded that Dr. Sezen fabricated most of her research while at Columbia. For example, most of the spectra she produced to demonstrate the presence of chemical intermediates or final compounds were fabricated by pasting together fragments of irrelevant NMR spectra.

The documents paint a picture of Sezen as a master of deception, a woman very much at ease with manipulating colleagues and supervisors alike to hide her fraudulent activity; a practiced liar who would defend the integrity of her research results in the face of all evidence to the contrary.

Office of Research Integrity Report

The reports detail how Sezen logged into NMR spectrometry equipment under the name of at least one former Sames group member, then merged NMR data and used correction fluid to create fake spectra showing her desired reaction products.

Although every Columbia graduate student who uses the facility must undergo training and receive a password, the investigators learned that no NMR account had ever been assigned to Sezen.

Sezen was confronted with an NMR spectrum that she claimed was obtained from a 400-MHz instrument. The spectrum, however, matched that in another published research paper, except that it was recorded as being obtained from a 300-MHz instrument. The two instruments would have given very different spectra. Sezen had no explanation for this.

Prof. Dalibor Sames' role

Sources described Sezen as Sames' "golden child," a brilliant student favored by a mentor who believed that her intellect and laboratory acumen provoked the envy of others in his research group. They said it was hard to avoid the conclusion that Sames retaliated when other members of his group questioned the validity of Sezen's work.

Two graduate students, [redacted], were asked by [redacted] to leave his group at the beginning of the third year of their graduate study and one graduate student, [redacted] decided to leave the [redacted] after passing the second-year qualifying examinations. Each of these students had spent much time unsuccessfully trying to reproduce and extend Dr. Sezen's work

Charles M. Lieber
Professor Chemistry
Harvard Uni
Nanoscience expert
Potential Nobel Prize Winner

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Justice.gov > U.S. Attorneys > District of Massachusetts > Press Releases > Harvard University Professor Convicted of Making False Statements and Tax Offenses

PRESS RELEASE

Harvard University Professor Convicted of Making False Statements and Tax Offenses

Harvard Professor Charles Lieber Found Guilty of Lying About China Ties

Federal prosecutors said Lieber, chased money and Nobel hopes past the limits of the law by concealing his ties to China's Thousand Talents Program in misleading statements to investigators and falsely-reported tax returns.

Lieber told FBI agents it "looks like I was very dishonest" in a separate interview with DOD investigators in 2018.

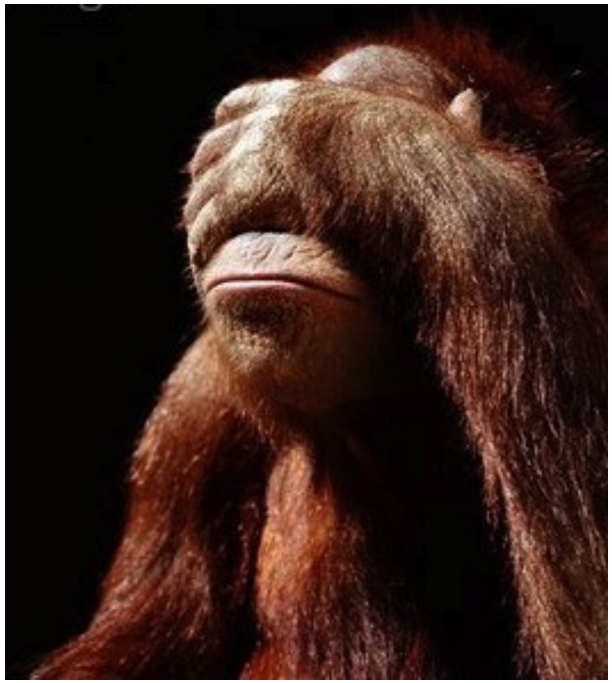
"I wasn't completely transparent by any stretch of the imagination," Lieber said in the interrogation.

Lieber admitted to traveling from Wuhan to Boston with bags of cash containing between $50,000 and $100,000, which he said he never disclosed to the IRS.

His conviction carries a maximum prison sentence of 26 years and up to $1.2 million in fines.

Normal, Extraordinary and Pathological Science

Fame



Shame

Science Is As Flawed As Scientists Who Do It