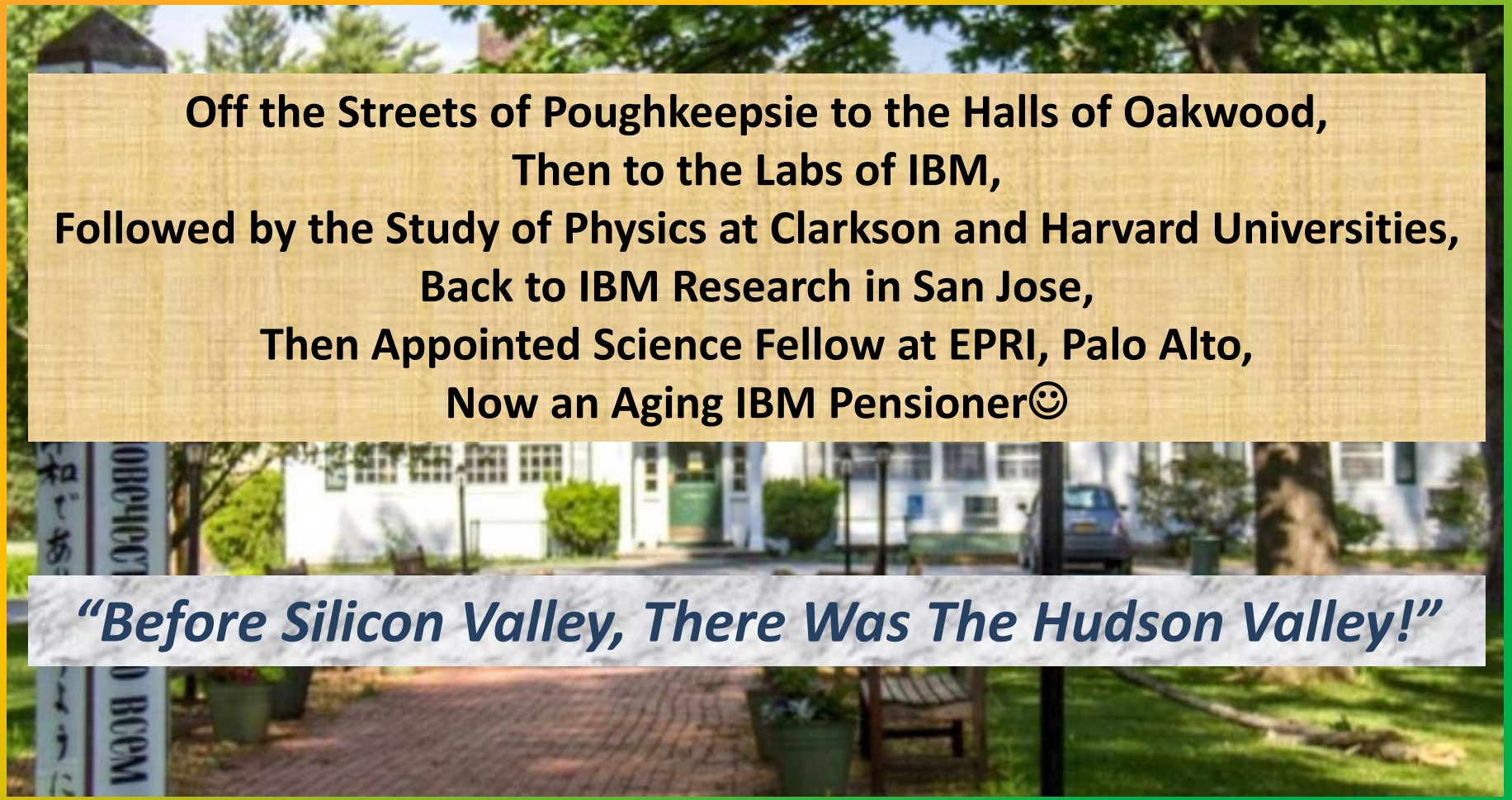
Setup

2018 Oakwood Herzog Lecture

"A Life Journey in Physics and Beyond"

Paul Michael Grant, '53

www.w2agz.com



Off the Streets of Poughkeepsie to the Halls of Oakwood,
Then to the Labs of IBM,
Followed by the Study of Physics at Clarkson and Harvard Universities,
Back to IBM Research in San Jose,
Then Appointed Science Fellow at EPRI, Palo Alto,
Now an Aging IBM Pensioner☺

"Before Silicon Valley, There Was The Hudson Valley!"

Born May 9th, 1935 in Poughkeepsie …and then followed life in their shoes…

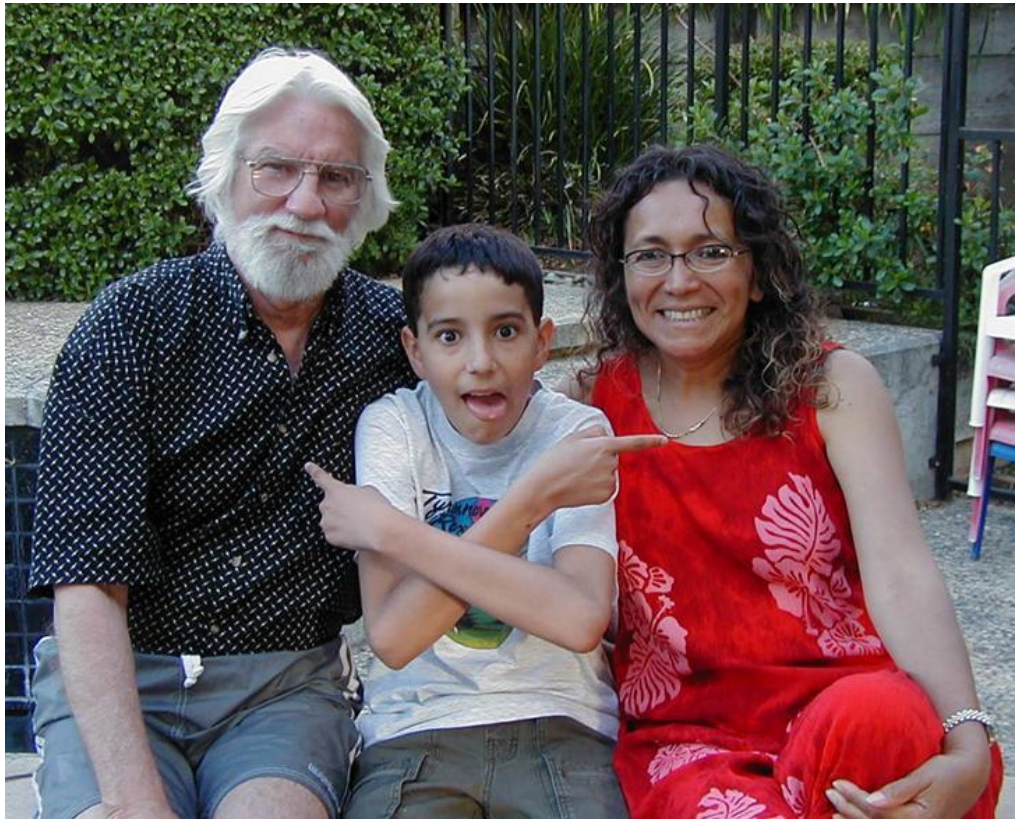
- Paul Archibald Grant
  - W2AGZ
  - US Navy, WWII
  - IBM, 1948-1974
  - Ski Patrol, 1948-1970
- Mary Ann Whalen Grant
  - CYO BB Champ, 1921
  - NYS Bowling Champ, 1939
  - Women's Baseball, '33-'47
  - Eastman School, '21-'22
  - CHG&E, 1923-1965

“Heaven’s “ XX Board Members

Bridget Ann Mullen-Whalen

Mary Ann Whalen Grant

21st Centrury
“Mexican-American Alliance”



It’s 1949

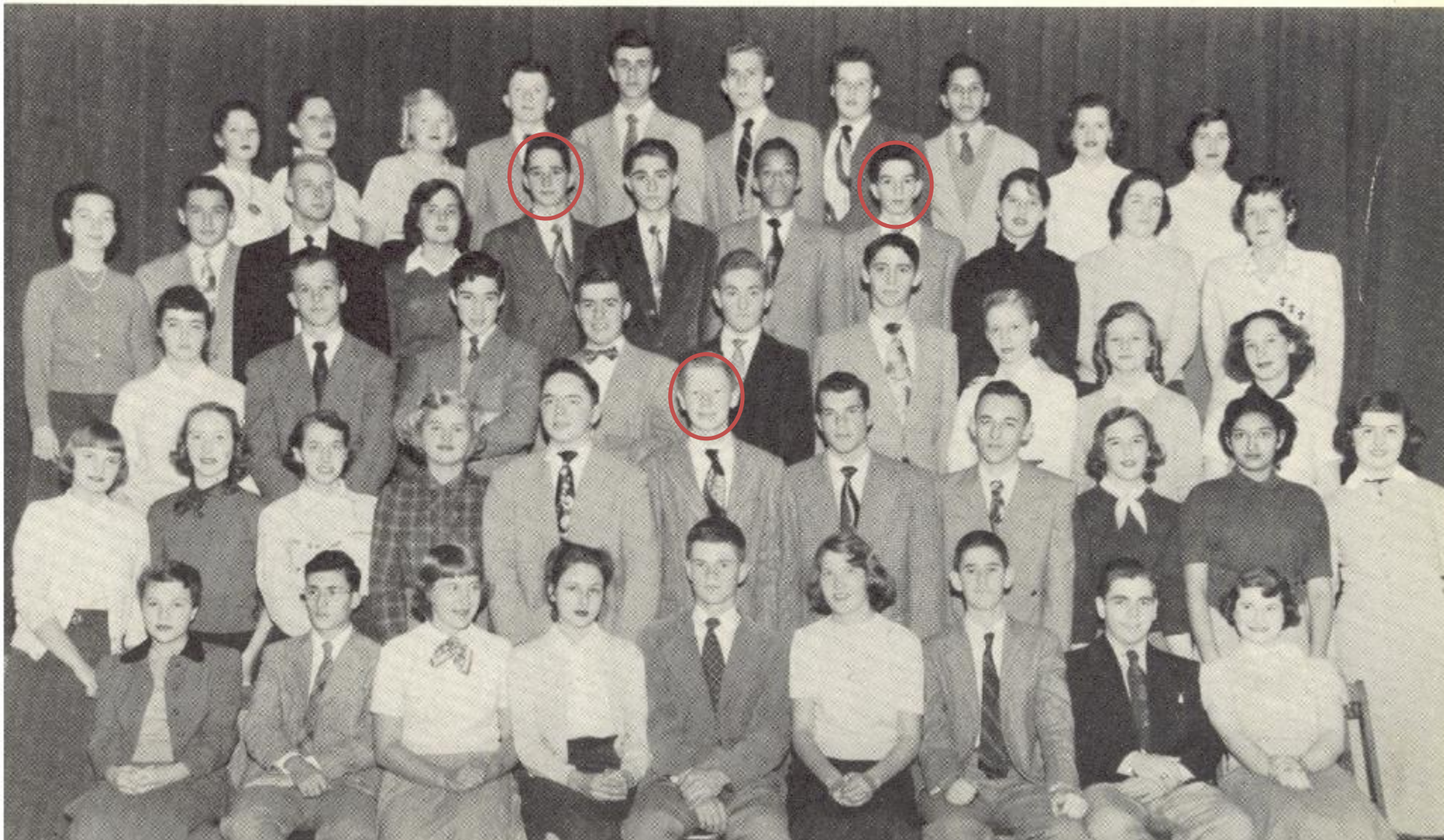
PMG Path Forward

- Clinton (1949)
- Oakwood (1949-53)
- IBM (1953-56)
- Clarkson (1956-60) (Summers at IBM P-K)
- Harvard (1960-65) (Sample Prep at IBM Kingston)
- IBM Research SJ (1965-93)
- EPRI PA (1993-2005)
- W2AGZ Tech (2005-Present)

PMG@Oakwood: 1949-53

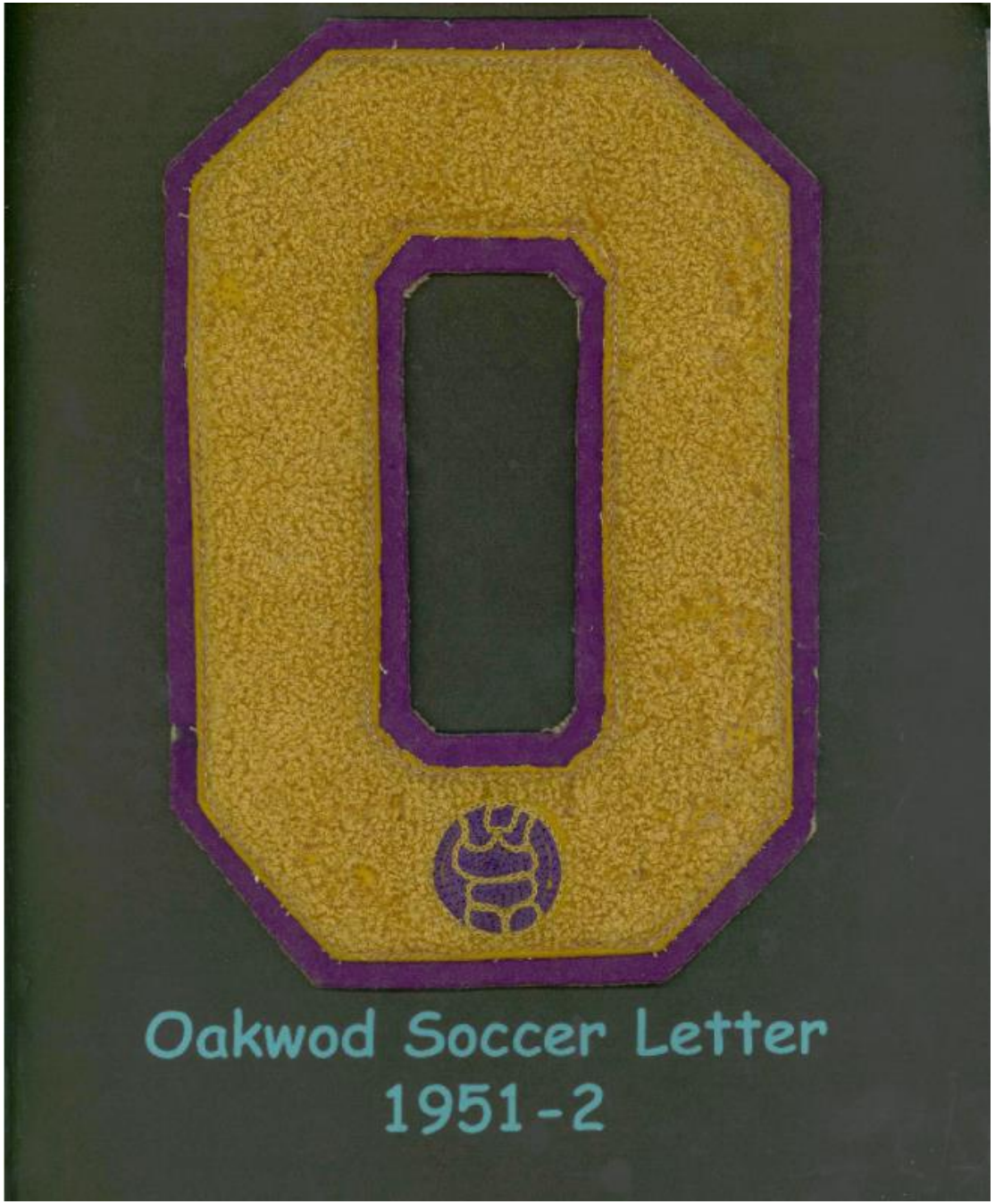
Oakwood Interlude and Memories

First row: left to right: D. Williams, S. Serman, A. Stokey, B. Finch, Secretary; D. Dustin, Vice President; P. Fuson, President; J. Bernstein, Treasurer; S. Sniffen, J. Haines. Second row: C. Ball, K. Pike, J. Tambling, M. Oberkotter, C. Blom, W. Blank, D. Lewittes, H. Chertock, G. Owen, P. Mongol, M. Rocco. Third row: M. Getty, F. Spross, K. Miller, H. Putterman, J. Collins, P. Dobrin, Y. Thunick, S. Sherrill, S. Friduss. Fourth row: Miss McNamara, R. Fernandez, B. Van Kleeck, A. Barnard, R. Gosse, G. Smith, B. Dent, P. Grant, D. Kerr, E. Wright, Miss McKinstry. Fifth row: N. Lawford, J. Strand, E. Tiedemann, L. Kirby, J. Knapp, O. Kirsten, D. Swartz, J. Pinkett, M. Foster, A. Robinson



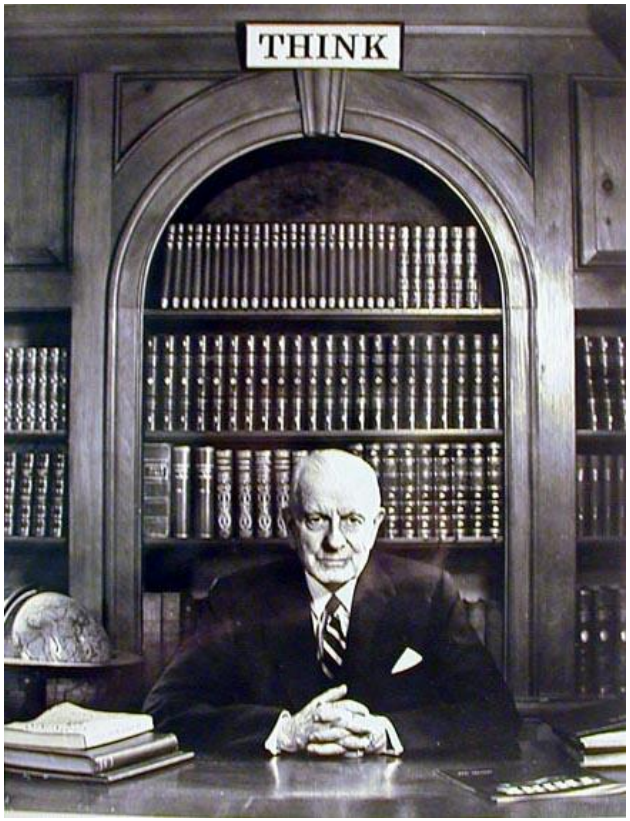
1ST ROW: Mr. Taylor, Mrs. Taylor, A. Barnard, Secy., E. Cunningham, Pres., J. Collins, Treas. 2ND ROW: L. Kirby, B. VanKleeck, J. Pinkett, E. Egee, D. Williams, S. Serman, J. Bernstein, J. Melniker, S. Sherrill, E. Wright, D. Kerr, R. Church. 3RD ROW: E. Tiedemann, M. Barnard, M. Getty, Y. Thunick, M. Oberkotter, M. Swint, J. Coulter. 4TH ROW: B. Blom, N. Lawford, M. Foster, P. Fuson, B. Finch,

1951



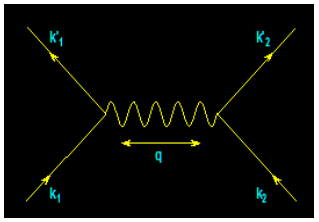
Oops!!
That's
"Oakwood,"
and I did get A's in English...sigh...

While At Oakwood...Watson Golf Trophy -1952-

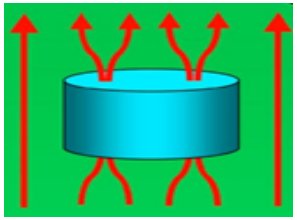


Life After Oakwood
-- IBM, EPRI, and Beyond --

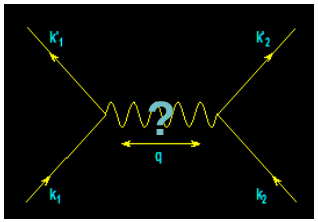
From Electrons Paired



To Electric Power Delivered



…And… Back Again



IBM (1953-1993)

- Joined 1953 (age 17)
- SAGE/NORAD (MIT)
- Clarkson/Harvard
- Magneto-optics
- Displays/Printers
- Organic Conductors
- DFT
- Superconductivity
- High-Tc
- Sabbatical (UNAM)

EPRI (1993-2005)

- High-Tc Power Apps
- Wide Bandgap SCs
- Power Electronics
- "Hot" Fusion
- "Smart Grid"
- "SuperGrid"
- "Climate Change"
- Visionary Energy Societies

W2AGZ (2005-?)

- Due Diligence
- Tet-CuO (Stanford)
- "Proxy" DFT
- RTSC via DFT
- IASS Potsdam
- ***Dual Use of NG Pipeline ROWs for Co-transport of Electricity via HTSC Cables (e.g., Keystone)***

PMG@IBM: 1953-56

- July, 1953: At age 18, hired as mail boy, Project High laboratory, Poughkeepsie
- November, 1953: Promoted to bench technician...
  - Helped build pluggable unit and core memory test equipment for XD-1 assembly line.
  - Worked on assembly line of XD-2, Poughkeepsie Manufacturing.

- Summer, 1954: Attended first SAGE support programming class, IBM Poughkeepsie, taught by Art Samuel, pioneer of "Checkers AI" gaming.
  - **With a TvN machine instruction set of only three operations (store, subtract, branch on minus), you can compute anything!**
- Spring, 1955: Posted to MIT Lincoln Lab as member of XD-1 service team.
- August, 1956: Now 21, began pursuit of undergraduate degrees in EE and physics at Clarkson as IBM employee on educational leave.

Prologue: 1949-50

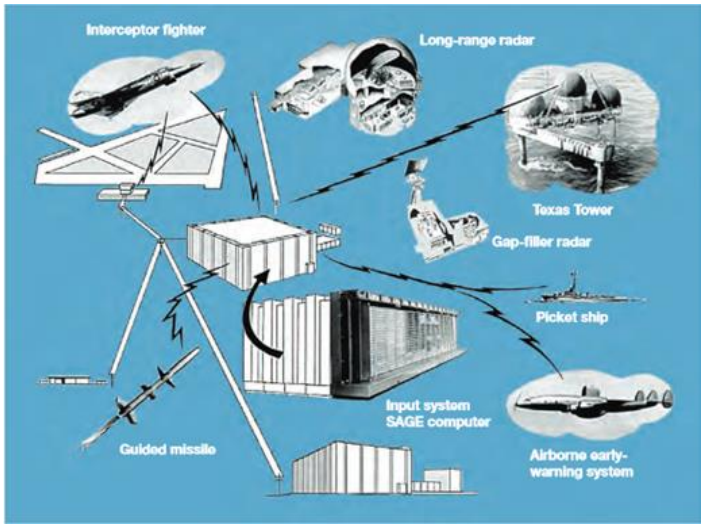
- It's 1949: The USSR has developed nuclear weapons.
- Deliverable via supersonic bombers and elementary ballistic missiles.
- Here was our defense at the time!

Obviously, we needed a new technological approach...

(and not just by substituting XXs with XYs)!

Proposal: 1951-53

- George Valley and Jay Forrester of MIT propose:
  - A net of radars and other data sources, along with computers,
  - That receive radar and additional information to detect and track aircraft,
  - Process such data to depict the total challenge to confront militarily,
  - Then guide weapons to destroy incoming enemy munitions.
- Wow! Ambitious! Their vision became SAGE (Semi-Automatic Ground Environment), first prototyped as XD-1 at MIT Lincoln Labs in 1954.

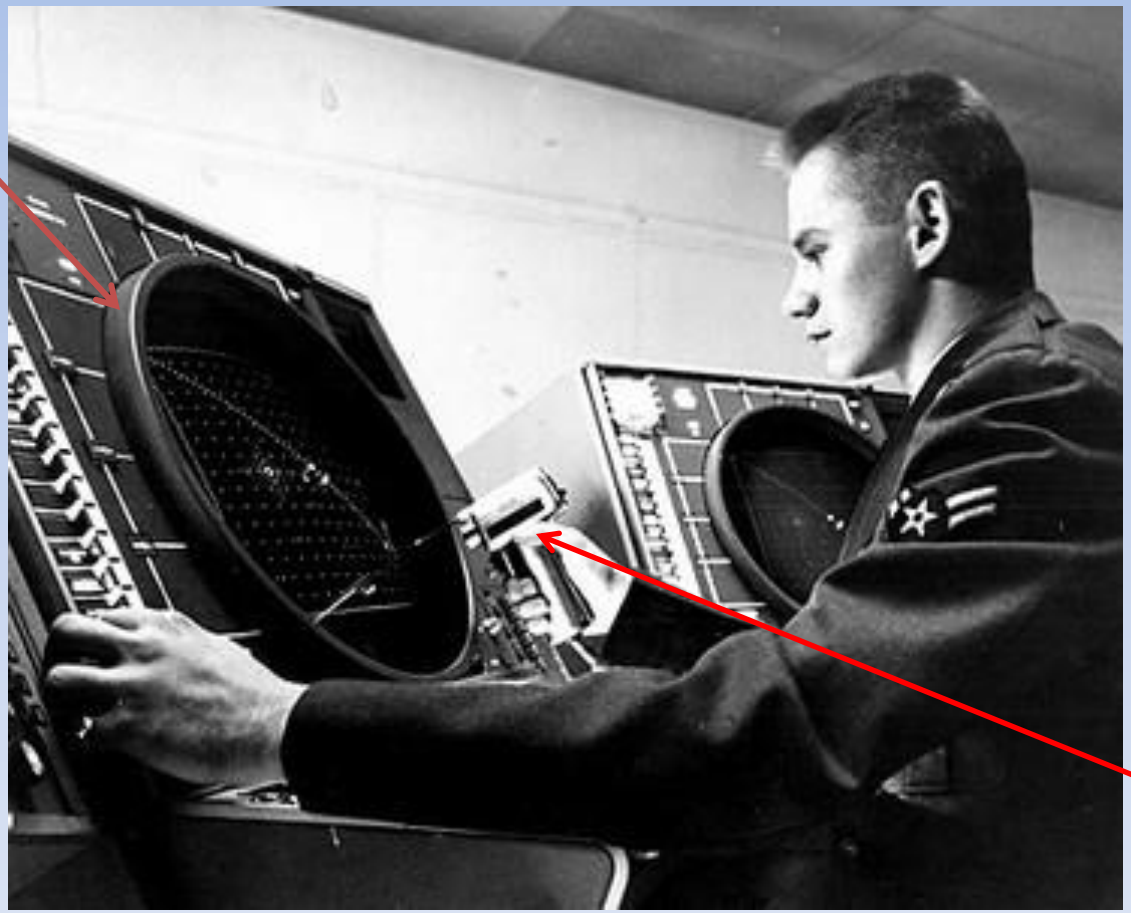


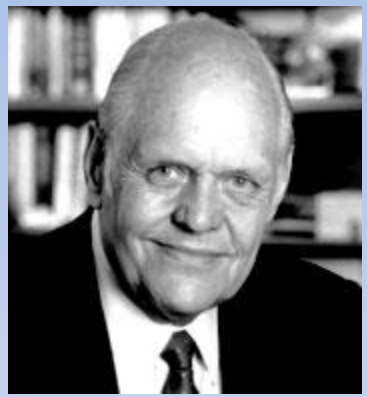
Hmmm...seems like a lot of “things” “netted” together. **That’s why “t=0” of the IoT began back then!**

1953

Project Sage – IBM/MIT

SAGE Console (1954)





Ken Olsen

AN/FSQ-7 Architecture

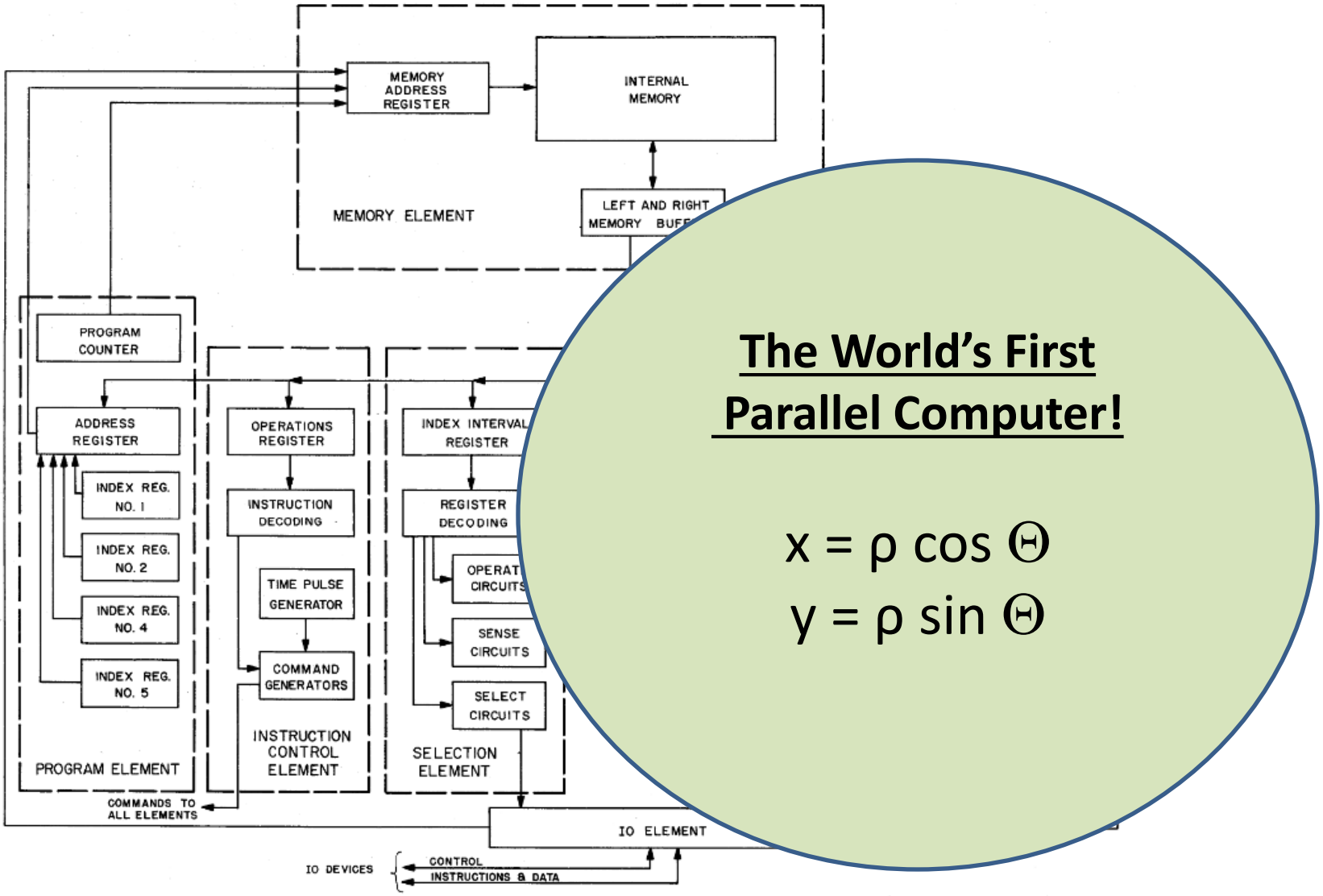


Figure 2–10. Overall Information Flow, Central Computer

The World's First Parallel Computer!

$$x = \rho \cos \Theta$$

$$y = \rho \sin \Theta$$

SAGE XD1 AN/FSQ-7 Instruction Set

TABLE 2–20. SUMMARY OF BASIC INSTRUCTIONS

INSTRUCTION NAME	MNEMONIC NAME	OCTAL CODE	EXECUTION TIME	INDEXABLE	CAUSE OVERFLOW
Halt	*HLT*	000	12 μsec	No	No
Clear and Add	*CAD*	100	12 μsec	Yes	No
Add	*ADD*	104	12 μsec	Yes	Yes
Twin and Add	*TAD*	110	12 μsec	Yes	Yes
Clear and Subtract	*CSU*	130	12 μsec	Yes	No
Subtract	*SUB*	134	12 μsec	Yes	Yes
Twin and Subtract	*TSU*	140	12 μsec	Yes	Yes
Full Store	*FST*	324	12 μsec	Yes	No
Left Store	*LST*	330	18 μsec	Yes	No
Right Store	*RST*	334	18 μsec	Yes	No
Add One Right	*AOR*	344	18 μsec	Yes	Yes
Branch on Positive Index	*BPX*	51-	6 μsec	No	No
Branch on Full Zero	*BFZ*	540	12 μsec	No	No
Branch on Full Minus	*BFM*	544	6 μsec	No	No
Branch on Left Minus	*BLM*	550	6 μsec	No	No
Branch on Right Minus	*BRM*	554	6 μsec	No	No
Reset Index Register	*XIN*	754	6 μsec	No	No

In 1955, I was able to use the above parallel instruction set to calculate pi(π) to ~1500 decimal places, but...

It’s 2018 = SAGE + 65 Years

Is the IoT of today any different from the IoT of SAGE?

I.E., Does Ecclesiastes 1:9 Hold? Depends...

SAGE
AN/FSQ-7

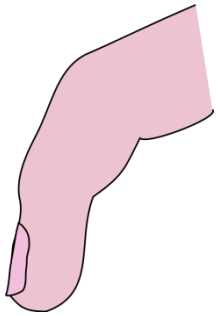
- Weighed 250 tons
- Consumed 3 MW
- 60,000 vacuum tubes
- 75,000 instructions per second (6 µsec/memory cycle)
- 3rd class phone linkage: (400-3400 Hz)
- IBM card reader, card punch, line printer, magnetic tape units
- 70,000 15-bit words of magnetic core RAM
- 100,000 15-bit words of magnetic drum SATA storage
- > 50 CRT display consoles, keyboards, light guns
- Total Cost of NORAD: 10x10^9 USD

wow!

Now We Have!

Our iToys + Wireless + The Cloud

...and...oh, yeah...APPS!



12-Year Old Devin Grant's
" Big Data" Homework Assignment

- How many of GrandPa's *really silly* 1953 IBM Punched Cards does it take...
- ...to fill up a 32 gig iPhone?
- Well?
- **A stack about 30 miles high!**
- **> 3000 miles in a 4 TB home CLOUD!**
- **Wow!* That's really "Big Data! "**

So What's Next?
Putting Your 1's & 0's in a Black Hole?

*Assumptions:
- 120 bytes/card
- Thickness = 0.007 inches

Herzog Homework Problem

- So, based on what you just saw Devin do...
- How many SAGE computers could you stuff into your:
  - Apple idiotPhone?
  - Android dumbPhone?
- Send me the numbers when you have the answer.

PMG@Clarkson: 1956-60

- During the summer of 1956, my IBM management in the Hudson Valley offered to send me to college (only in New York State) as an employee under a special “leave of absence” for “townies” that underwrote my tuition, books, and incidental expenses, and guaranteed me promotion and increased salary on return each summer to IBM in the Hudson Valley.
- I accepted the IBM offer, but had difficulty getting admitted, because of my “advanced age (I was now 21)” and marginal high school grades. I applied to, and was rejected by RPI, Union and Clarkson.
- At the last minute, Clarkson admitted me “under the bar” within an exemption for Korean War Vets, inasmuch I was about “the same age.”
- Based on my summer work at IBM, I undertook a Senior Thesis, unusual for that time.
- I majored in both Electrical Engineering and Physics. Under Clarkson’s present Honors Program, I would have received two diplomas, however, at IBM’s insistence, I chose a BSEE degree.

Clarkson Senior Thesis

CLARKSON COLLEGE OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING

A STUDY OF THE ELECTRONIC PROCESSES IN EXTRINSIC GERMANIUM AS EXHIBITED BY THE HALL AND MAGNETORESISTANCE EFFECTS

A SENIOR THESIS

by

PAUL M. GRANT

Submitted in partial fulfillment of the requirements

for the degree of

Bachelor of Electrical Engineering

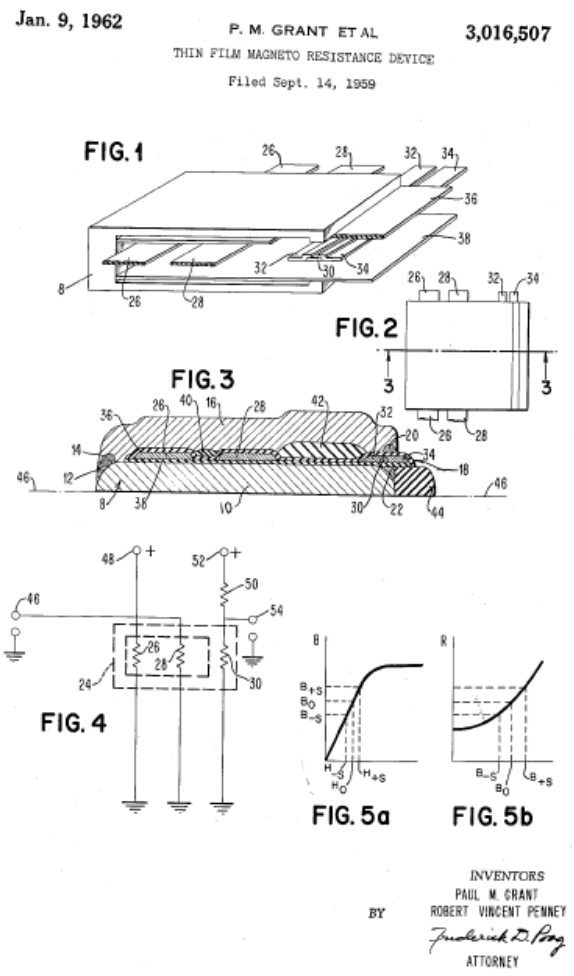
January 20, 1960

Approved by Thesis Advisor Date

Albert R. Martin 26 Jan 60

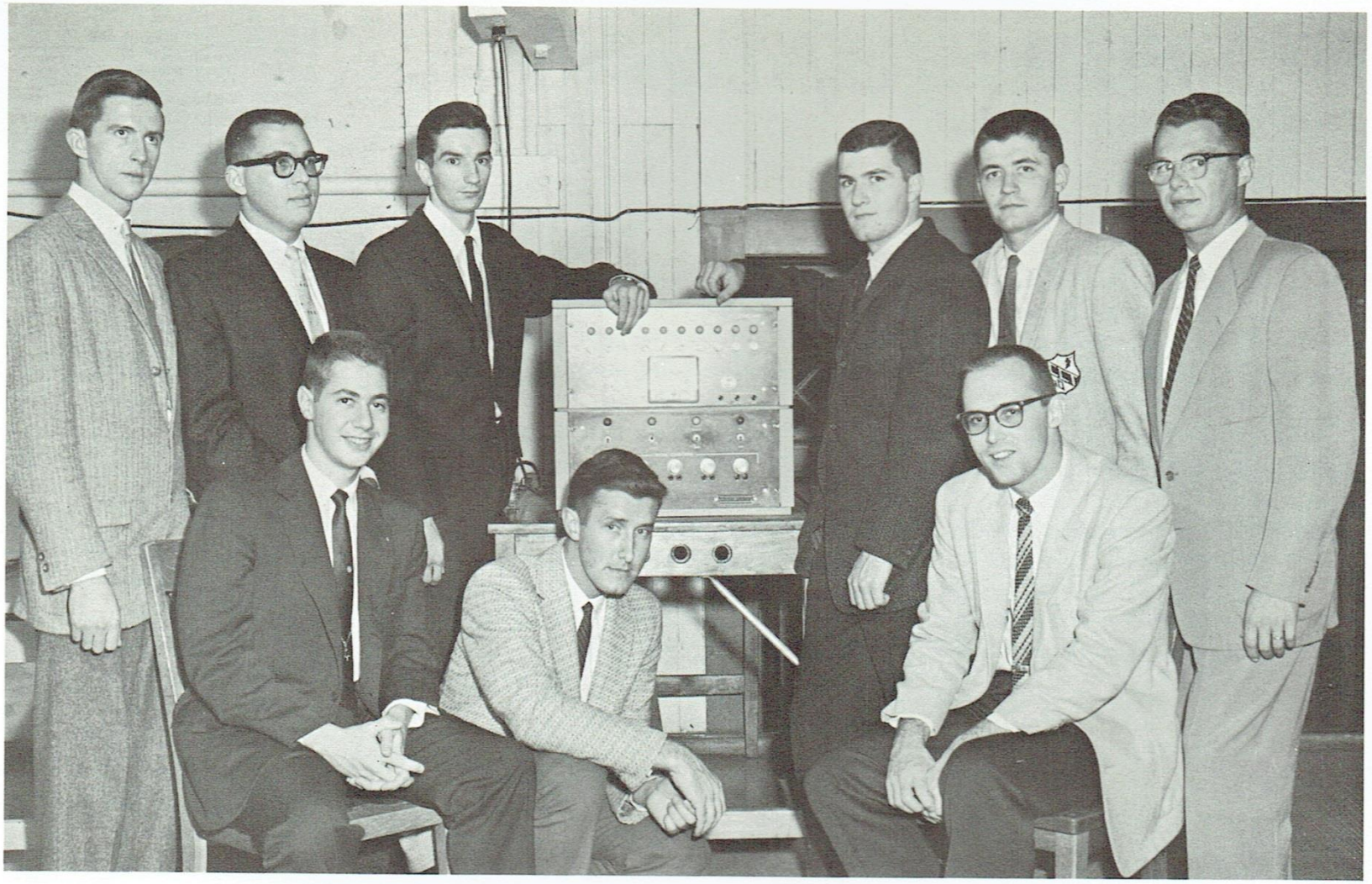
George W. Reed 26 Jan '60

Department Chairman



My Senior Thesis Morphed Into the GMR Read Head Employed in Hard Drives Today!

Eta Kappa Nu, '60



Graduated Valedictorian Class of 1960
GPA: 3.93/4.00

PMG@Harvard: 1960-65

- I applied successfully for admission into the physics graduate programs at RPI and and MIT, with a national defense fellowship. I was going to leave IBM.
- However, IBM offered to underwrite my attendance as an employee, if could get accepted at Harvard, which had an outstanding program in semiconductor physics, a field of vital importance to IBM at the time. I applied and was immediately accepted.
- My Thesis research involved the epitaxial deposition of semiconductor thin films, which innaugurated the effort on topological physics for which the Harvard Gordon McKay Center is now world renown.
- Historical Events while at Harvard:
  - Cuban Missile Crisis, 27 October 1962 (the end of the world was at hand).
  - Assassination of JFK, November 22, 1963.

Harvard Thesis Advisors (1962-65)

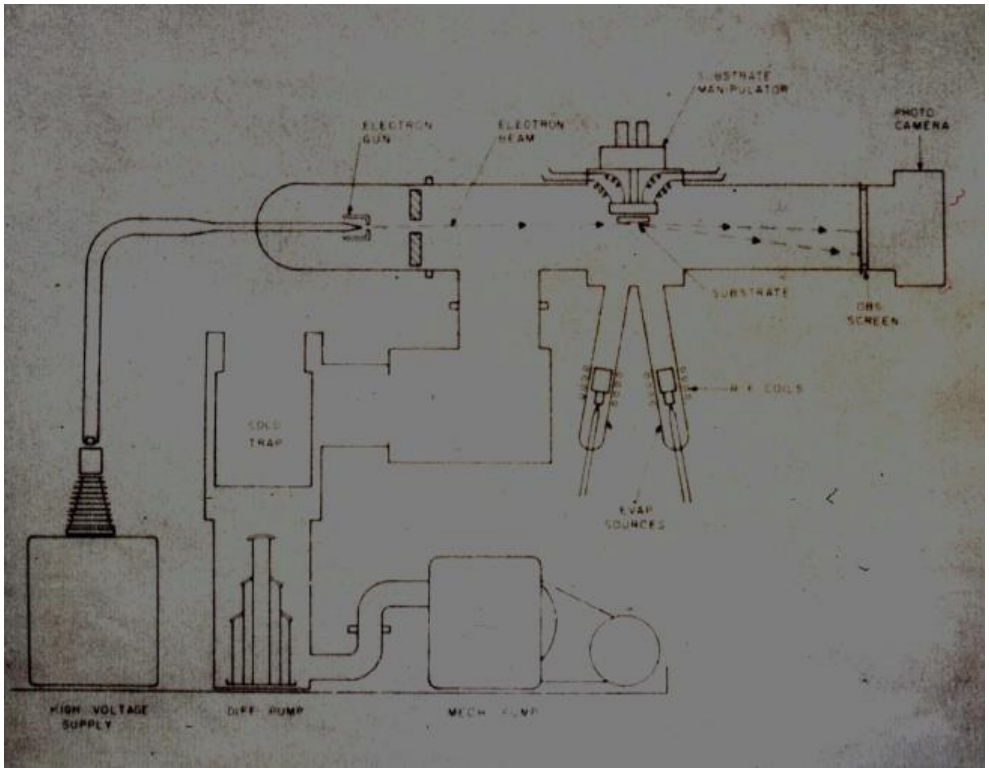
William "Bill" Paul
High Pressure Physics
Topological Structures

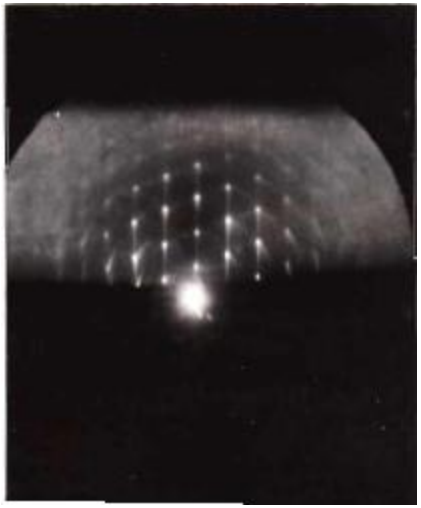
Harvey Brooks
Nuclear Power Pioneer
Science Advisor to JFK

Paul Michael Grant
PhD Thesis
"The Optical Properties of Thin Germanium Films"

"Niko" Bloembergen
Nobel Laurate NMR
Great Squash Player

IBM Kingston MBE Tools





Office of Naval Research
Contract Nonr-1858 (10) NR-017-308

THE OPTICAL PROPERTIES OF THIN GERMANIUM FILMS

By

Paul Michael Grant

June, 1965

Technical Report No. HP-14

Gordon McKay Laboratory
Division of Engineering and Applied Physics
Harvard University • Cambridge, Massachusetts

PMG@IBM#2: 1960-93

All Work Performed at IBM Research San Jose/Almaden Valley, California

- Laboratory Automation
- Organic Conductors & Superconductors
- Polymer Field Effect Transistor
- High Temperature Superconductivity
- Explore novel materials/mechanisms for magnetic storage

Semi-Anthology of 1800 Lab DAC Papers from IBM San Jose Research published in IBM J. Res. Devel., 1968 Special Issue

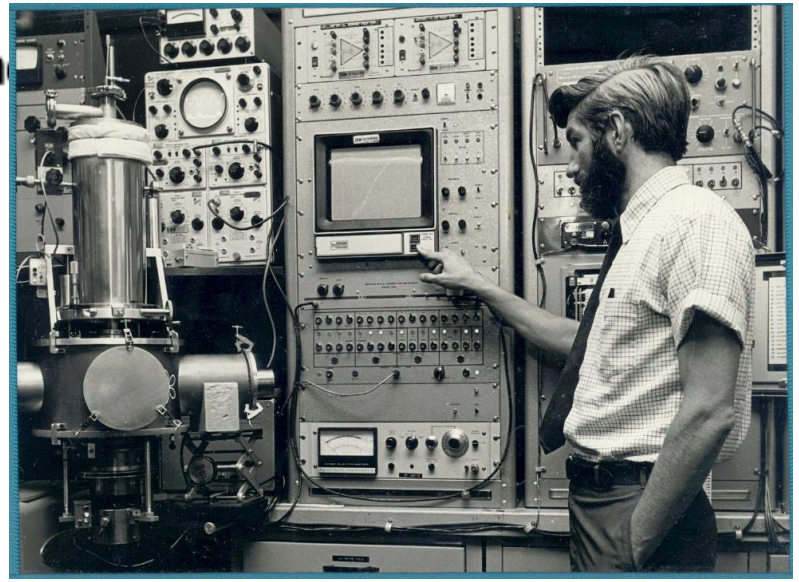
Authors: Grant, Schechtman, Ramondi, Winters, Clarke, Gladney...
... and many others

Interleaving Slow- and Rapid-data-rate Experiments with a Time-sharing Laboratory Automation System

Automation of Data Acquisition in Transient Photoconductive Decay Experim

Automation of a Residual Gas Analyzer on a Time-shared Computer

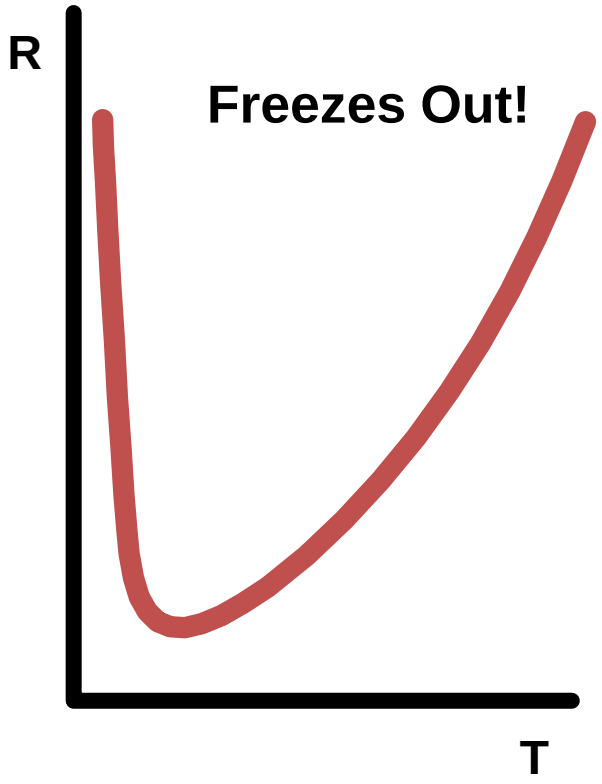
Automation of a Wide-range, General-purpose Spectrophotometric System

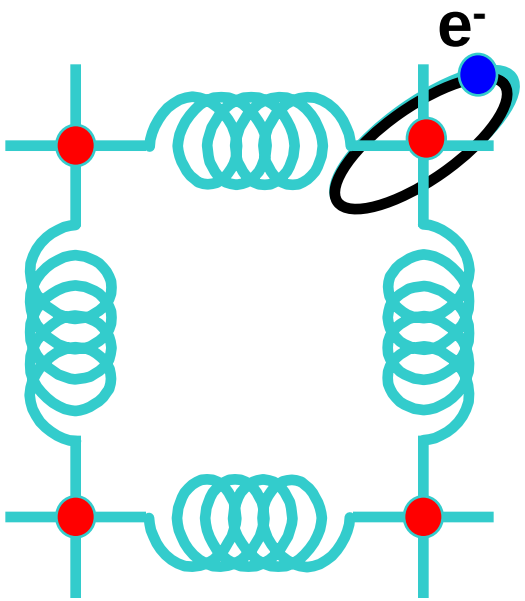


Superconductivity 101

Models of Electrical Conductivity

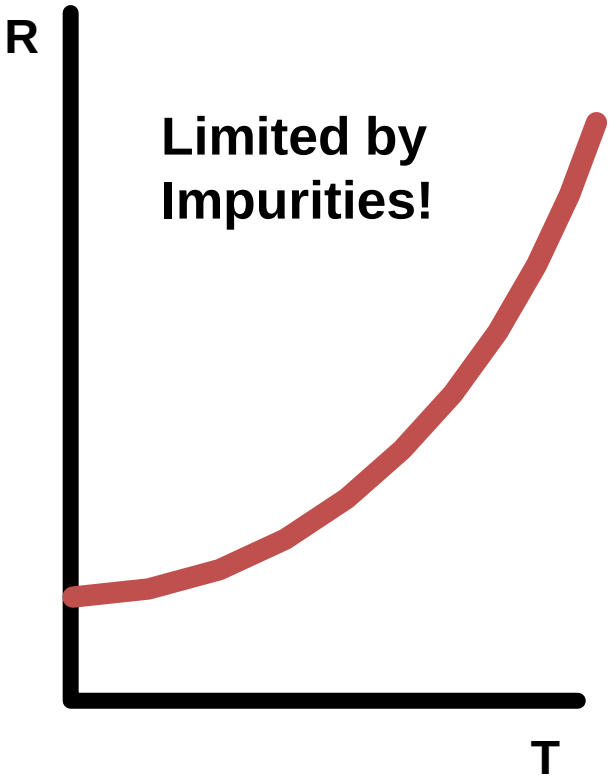
The Most Popular:

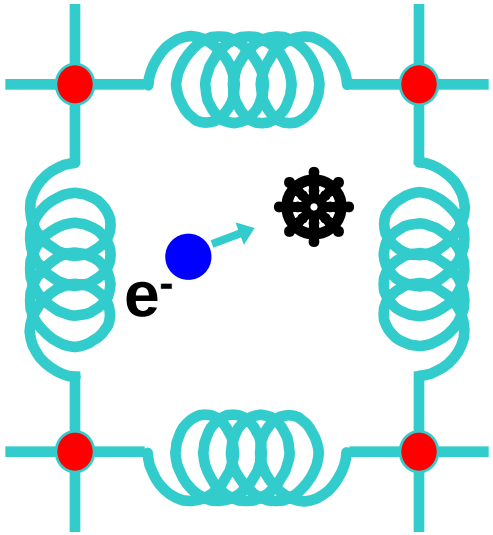




Models of Electrical Conductivity

Reality:

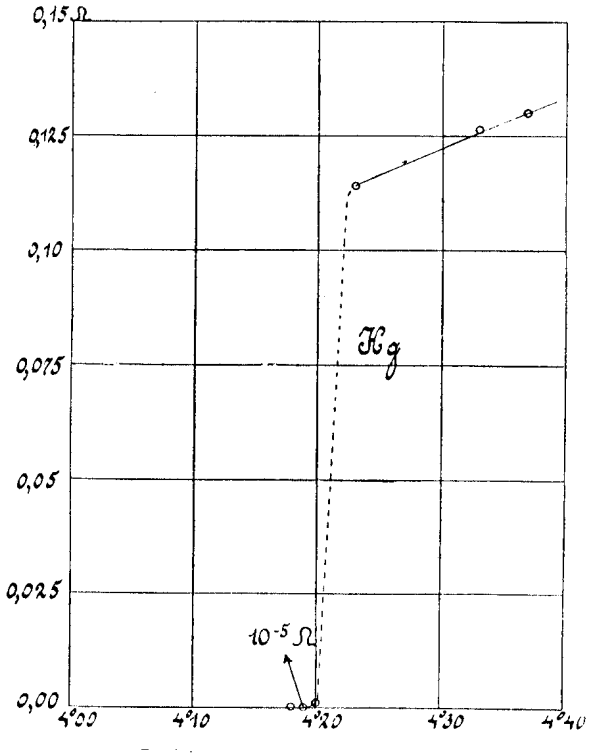




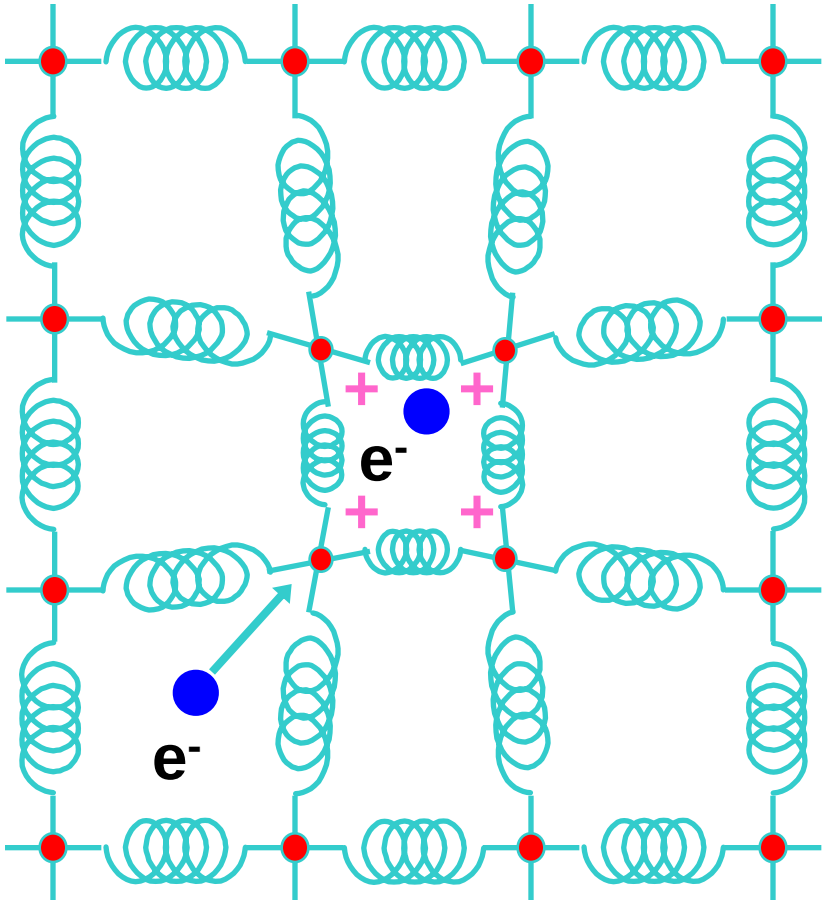
1911
A Big Surprise!

Thus the mercury at 4.2 K has entered a new state, which, owing to its particular electrical properties, can be called the state of *superconductivity*

Gilles Holst, H. Kamerlingh-Onnes (1911)



Physics of Superconductivity (1957 – 2006)



Electrons Pair Off!

BCS Equation

$$T_C = 1.14\,\theta_D \exp(-1/\lambda)$$

$$\theta_D = 275\,\mathrm{K},$$

$$\lambda = 0.28,$$

$$\therefore T_C = \underline{9.5\,\mathrm{K}}\ \ (\mathrm{Niobium})$$

It takes two to Tango

conductor

Semiconductor

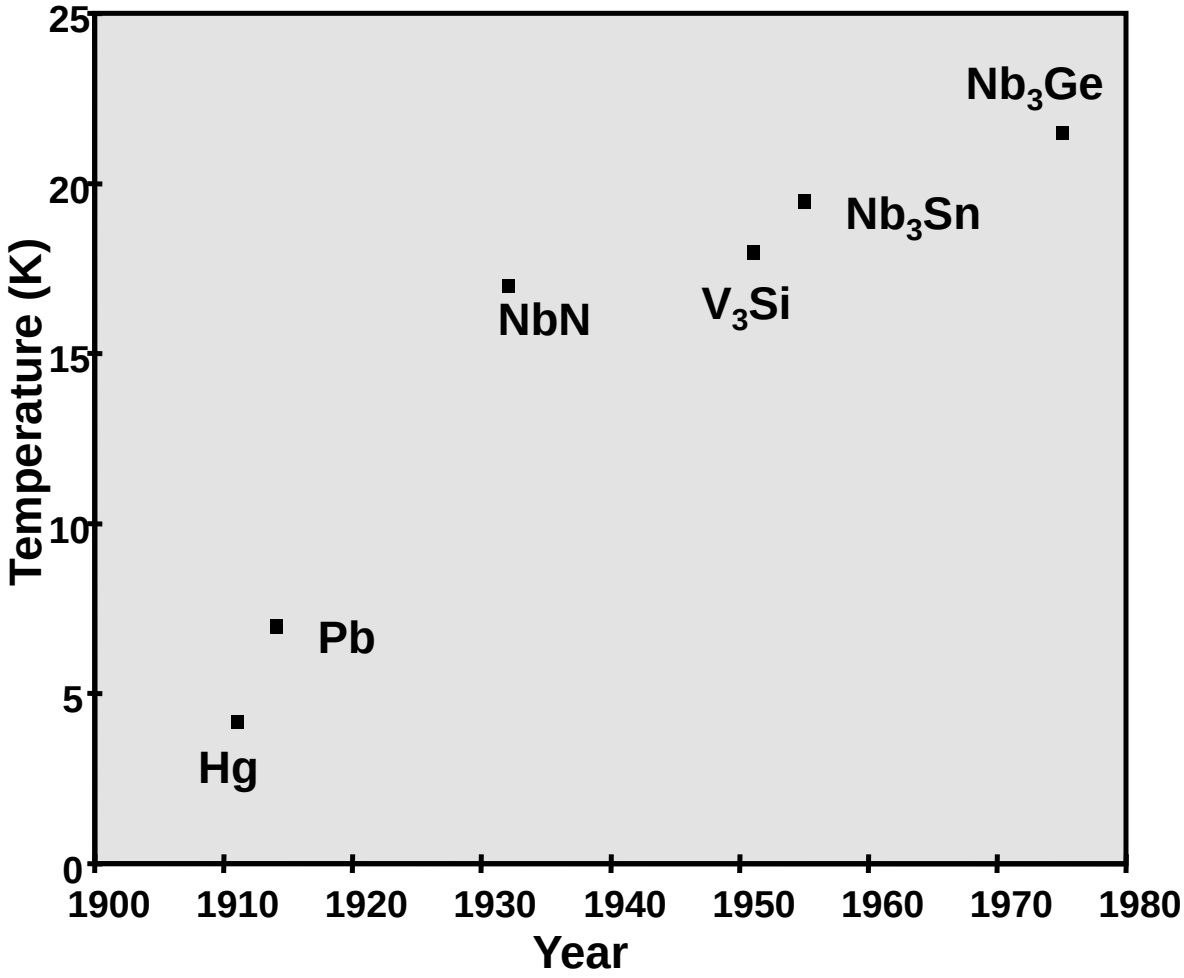
SUPERCONDUCTOR

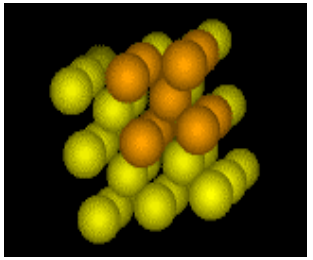
Important Numbers in Superconductivity

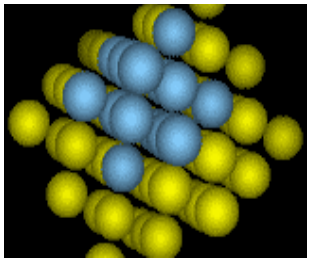
Transition Temperature, T_c	Way below 300 K
Critical Current Density, J_c	10^{-2} - 10^{6} A/cm^2
Critical Magnetic Field, H_c	10^{-4} - 10 T
London Penetration Depth, λ	10 - >1000 Å
Pippard Coherence Length, ξ	10 - >1000 Å
G-L Parameter, $\kappa = \lambda/\xi$	0.01 - 100

NB! All these numbers depend on each other. E.g., $H_c \sim \lambda\, \xi$

T_C vs. Year: 1911 - 1980







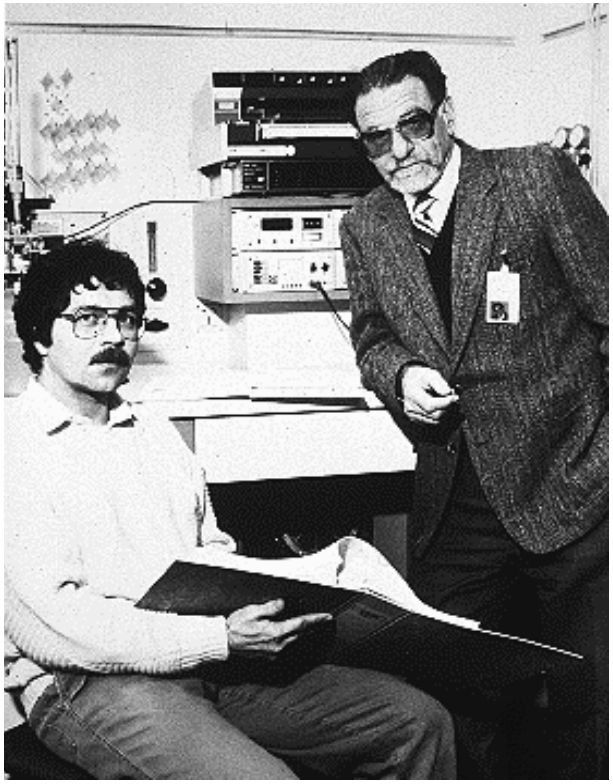
Cubic Metals

MRI & “Big Physics”

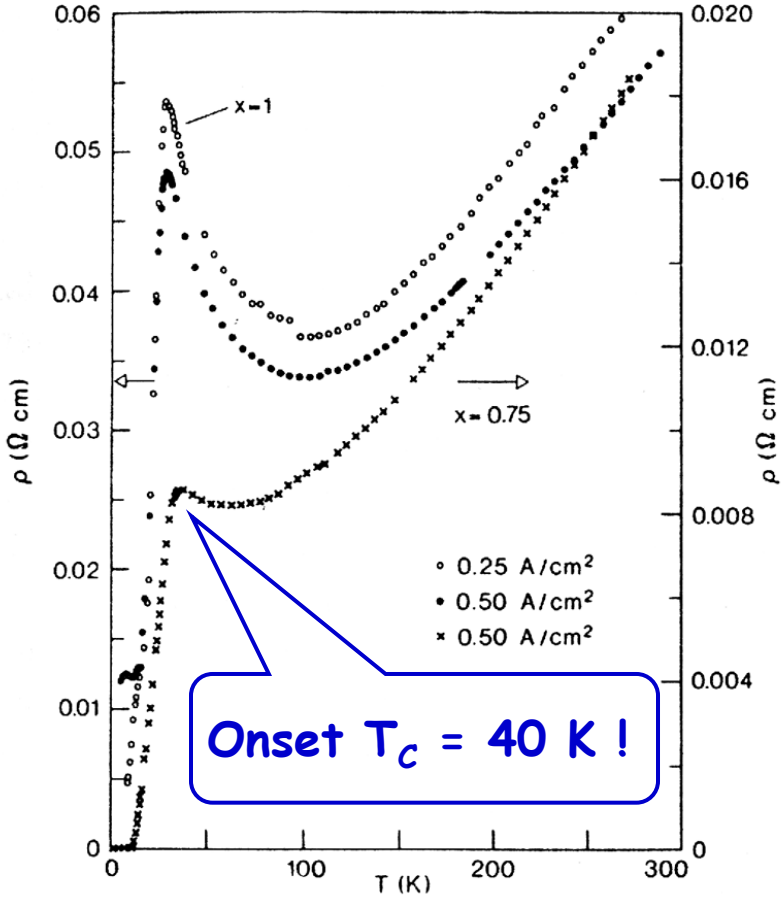
Magnetic Resonance Imaging
Philips

Tevatron
Fermi National Laboratory

1986
Another Big Surprise!



Bednorz and Mueller
IBM Zuerich, 1986



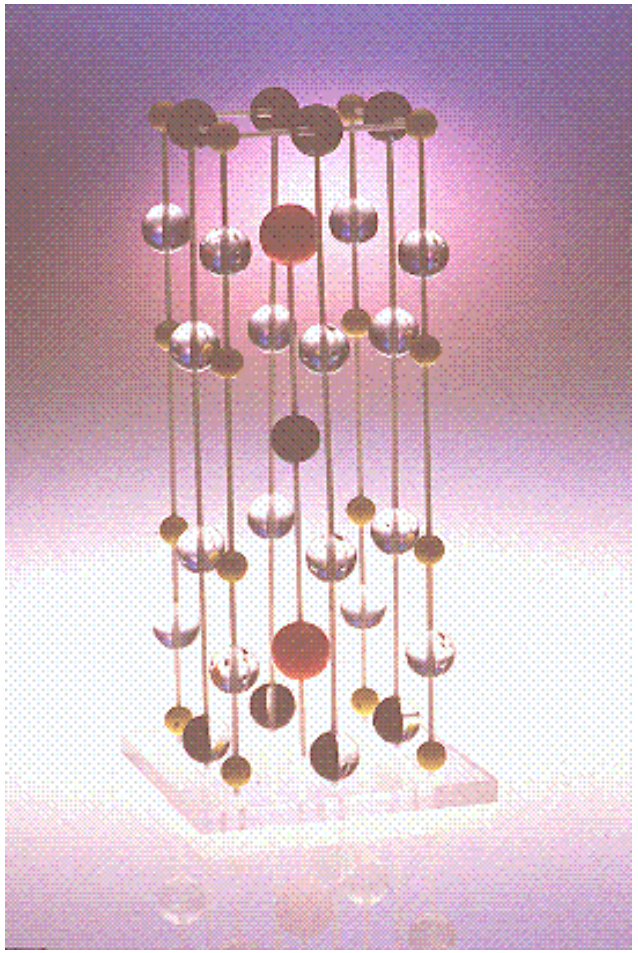
1987
“The Prize!”

Associated Press

J. Georg Bednorz, left, and K. Alex Müller after learning they had won the Nobel Prize in physics.

2 Get Nobel for Unlocking Superconductor Secret

March 3, 1987
“123” Discovered



1991 IBM International Patent on High Temperature Superconductivity

(12) UK Patent (19) GB (11) 2 201 955 (13) B

(54) Title of Invention

Electrically superconducting compositions and processes for their preparation

(51) INT CL⁴: C04B 35/00

(21) Application No
8801770.2

(22) Date of filing
15.01.1988

(30) Priority Data

(31) 24653

(32) 11.03.1987

(33) US

(43) Application published
14.09.1988

(45) Patent published
18.09.1991

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(56) Documents cited
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WO88/05604 A1
WO88/05029 A1
Nature, 30 April 1987, Vol 326, pages 856-857 (RAO et al)
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(58) Field of search

As for published application
2201955 A viz:
UK CL C1J
INT CL C04B
updated as appropriate

Woodstock of Physics NYC, 1987

Physicists' Night Out!

Woodstock of physics revisited

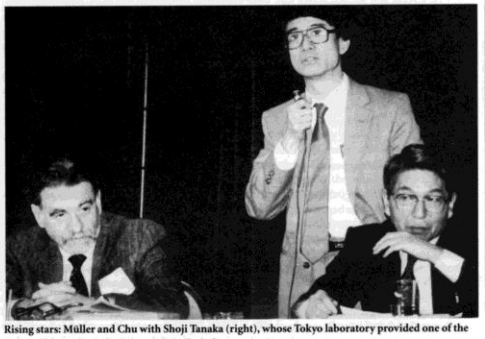
Ten years have passed since the now famous American Physical Society meeting that heard the first breathless accounts of high-temperature superconductivity. Now, in calmer times, practical applications are emerging.

Paul M. Grant

Snap quiz: who can tell me the winner of the 1987 Super Bowl? Not most physicists, I suspect, for whom it was certainly eclipsed by two events of far greater consequence that shared the early months of that year. One, the discovery of Supernova 1987A, perhaps portended the other: the announcement of superconductivity above liquid-nitrogen temperature on planet Earth — a dream fulfilled for many condensed-matter physicists like myself, whose careers had orbited around this elusive star.

The successful sighting[1] fell to W. K. Wu and C. W. (Paul) Chu and their teams of students and postdocs at the Universities of Alabama and Houston, following only five months after the publication in autumn 1986 by Georg Bednorz and Alex Müller[2] at IBM Zürich of their discovery of superconductivity in a previously unexplored class of compounds, the layered copper-oxide perovskites.

The 'inside' story of the hectic interval between the first week in January 1987 — when an announcement of the confirmation of Bednorz and Müller's discovery first brought 'high-temperature superconductivity' to wide public attention — and the week of the American Physical Society's March meeting, remains to be told. Suffice it to say that this period, and the last three months of 1986, were replete with incredulity, credulity, excitement, secrecy and a sense of immediacy in competition with one's peers, all of which resulted in, frankly, a substantial amount of intrigue and suspicion. All who participated surely came to understand, if they had not done so before, that physics is not only a science but, perhaps more significantly, an intensely human pursuit — something they do not teach you in graduate school.



Rising stars: Müller and Chu with Shoji Tanaka (right), whose Tokyo laboratory provided one of the first confirmations of Bednorz and Müller's discovery.

The programme of the March meeting, held each year in a different US city, is 'cast in concrete' early the preceding December; thereafter, an absolute policy of no alterations prevails. By the deadline of 5 December 1986, for the 1987 meeting at the Hilton hotel in New York City, only one abstract had been accepted on the new materials: "Specific heat of Ba–La–Cu–O superconductors" by Rick Greene and his collaborators at IBM Yorktown. But the explosion of results that appeared in the new year prompted the meeting's organizers to take an unprecedented step. Brian Maple of the University of California, San Diego, was asked to put together a special post-deadline evening session devoted entirely to the discovery.

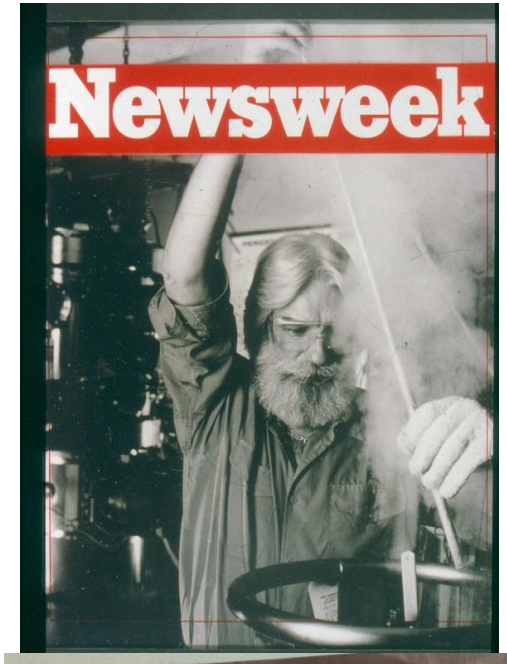
All those wishing to report results would be granted five minutes each, in order of the arrival of their request to take part — and did the requests rain in, reaching a downpour in the two weeks before the meeting, as confirmations of the Wu–Chu measurements were made. All in all, 51 presentations were to be given throughout the evening and early morning of Wednesday and Thursday, 18 and 19 March. That memorable and riotous session was to become our "Woodstock of physics", so named in honour of the village only 50 miles north where, in an obscure farmer's muddy field in 1969, the rock concert occurred that defined a generation of youth the world over.

Fever pitch: the room filled to overflowing with physicists eager for news of superconductivity.

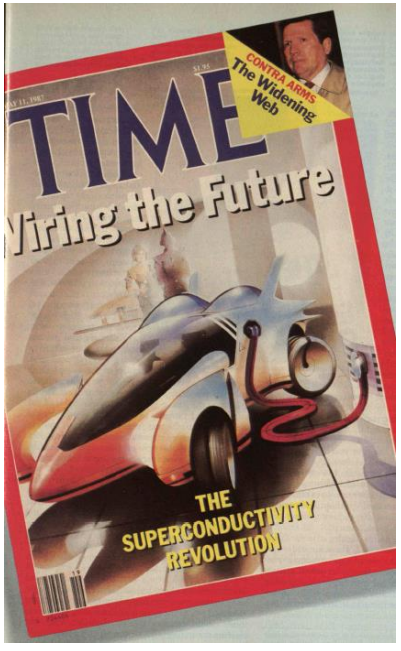
Opening act

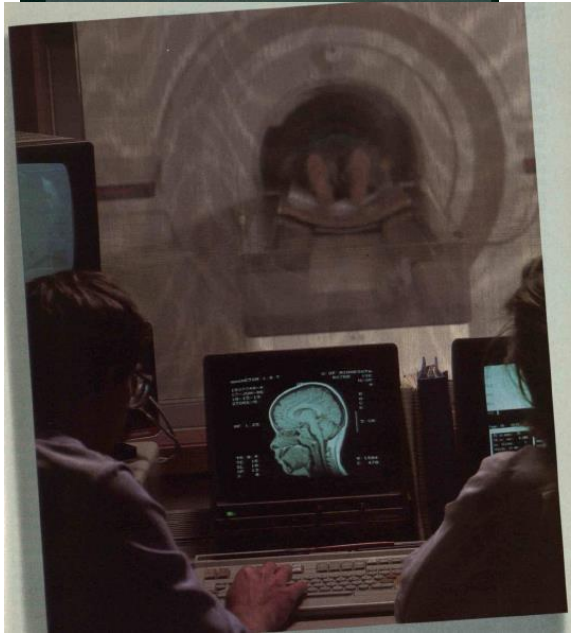
A few personal observations and anecdotes may help to convey the colour of that week in midtown Manhattan. Excitement was running high even before Wednesday night. On Monday, the opening day, the press were already beginning to catch some of us to be interviewed. That noon my colleague Ed Engler and I went to lunch at a nearby Brew 'n' Burger and found Alex Müller sitting by himself in a corner booth, attempting to escape the turmoil at the Hilton. At the time he was not yet widely recognizable to those attending the meeting or to the press — a situation that would soon change.

"The Hype"

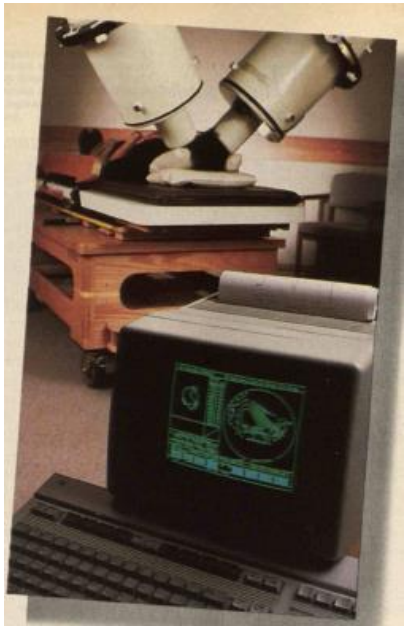

Newsweek


WHAT IS MORE EXCITING THAN
High Tc — Physics Art!
PAM DAVIS
STEVE KIVELSON
DAN ROKHSAR and
SHAHAB ETEMAD
LIMELIGHT
FOR DANCING
AT NEW YORK'S MOST FASHIONABLE NIGHTCLUB
THURSDAY, MARCH 19, 1987
DOORS OPEN 10:00 PM SHARP
DANCING ALL NIGHT


TIME
Wiring the Future
CONTRA ARMS
The Widening Web
THE SUPERCONDUCTIVITY REVOLUTION



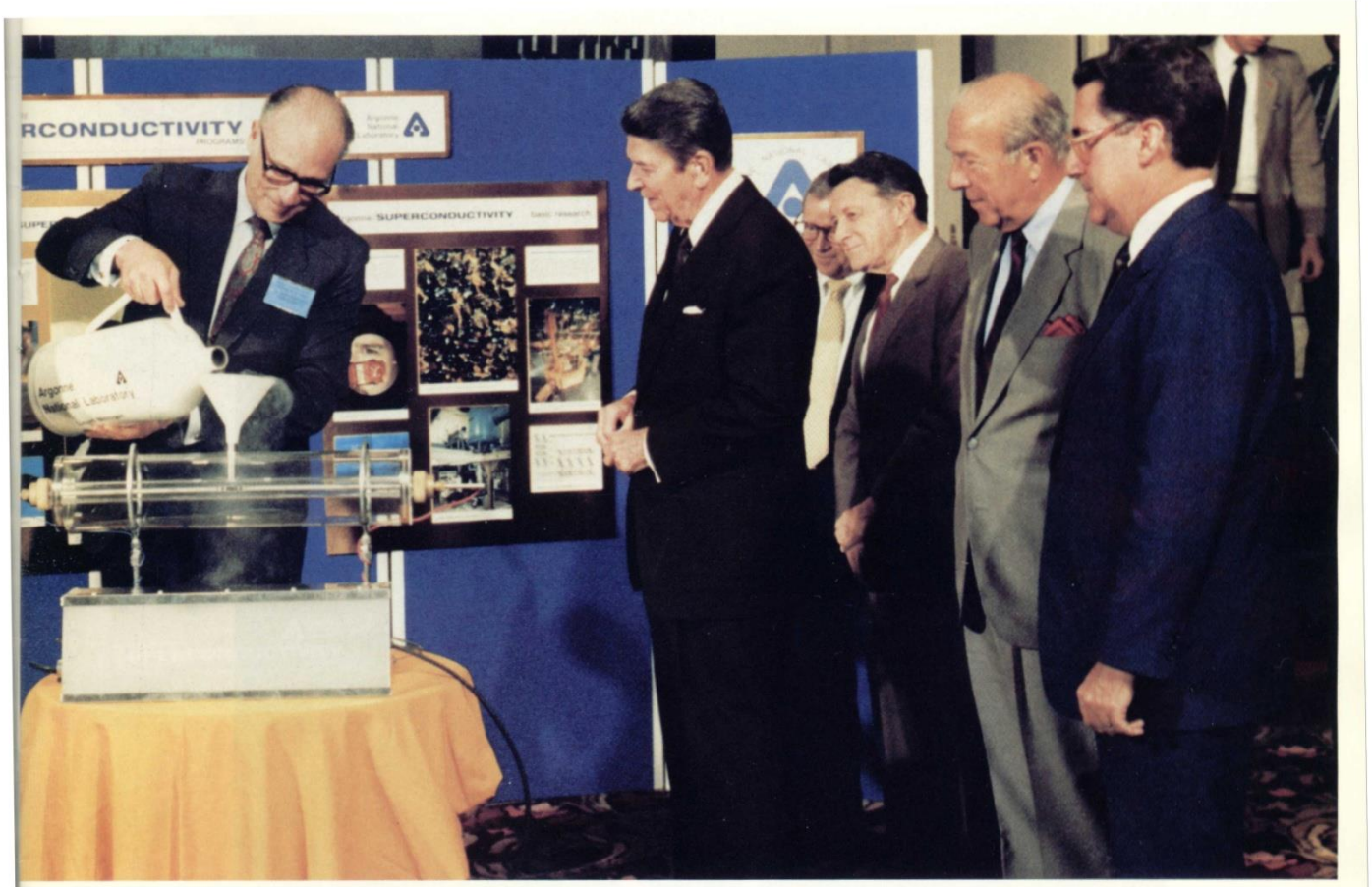

HSST



HTSC Symposium, MRS Spring Meeting, Anaheim, 23-24 April 1987

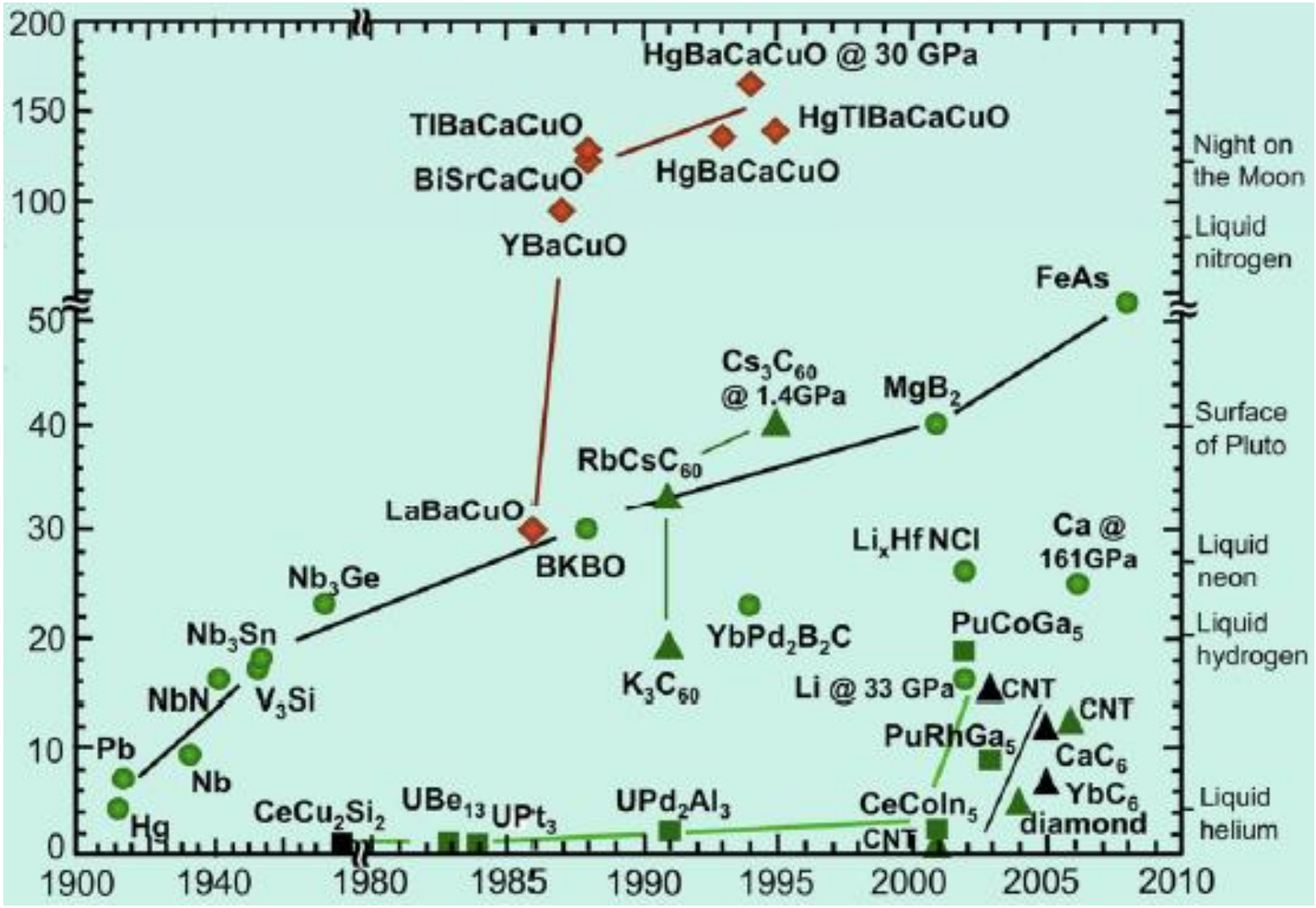
"The Altamont of Materials"

“The Great Communicator”



Alan Schriesheim, Director of Argonne National Laboratory, demonstrates superconductivity to the President, Chief of Staff Howard Baker, Secretary of Defense Caspar Weinberger, Secretary of State George Shultz and Secretary Herrington.

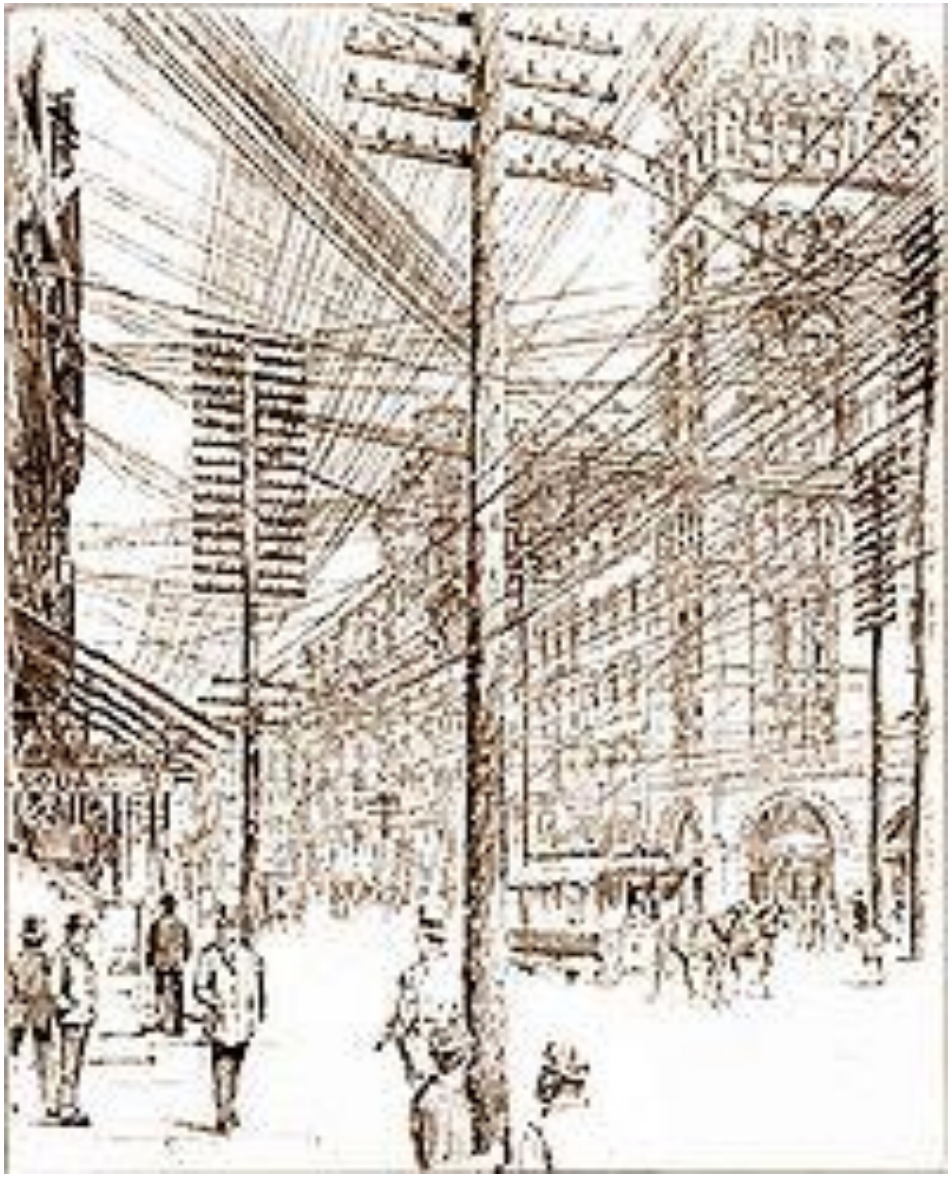
Today


Tc (K)
Year
HgBaCaCuO @ 30 GPa
TlBaCaCuO
HgTlBaCaCuO
BiSrCaCuO
HgBaCaCuO
YBaCuO
FeAs
Cs_3C_{60} @ 1.4GPa
MgB_2
$RbCsC_{60}$
LaBaCuO
BKBO
Li_xHfNCl
Ca @ 161GPa
Nb_3Ge
Nb_3Sn
$YbPd_2B_2C$
$PuCoGa_5$
K_3C_{60}
Li @ 33 GPa
CNT
CNT
NbN
V_3Si
$PuRhGa_5$
CaC_6
Pb
Nb
YbC_6
$CeCu_2Si_2$
UBe_{13}
UPt_3
UPd_2Al_3
$CeCoIn_5$
diamond
CNT
Hg
Night on the Moon
Liquid nitrogen
Surface of Pluto
Liquid neon
Liquid hydrogen
Liquid helium
200
150
100
50
40
30
20
10
0
1900
1940
1980
1985
1990
1995
2000
2005
2010

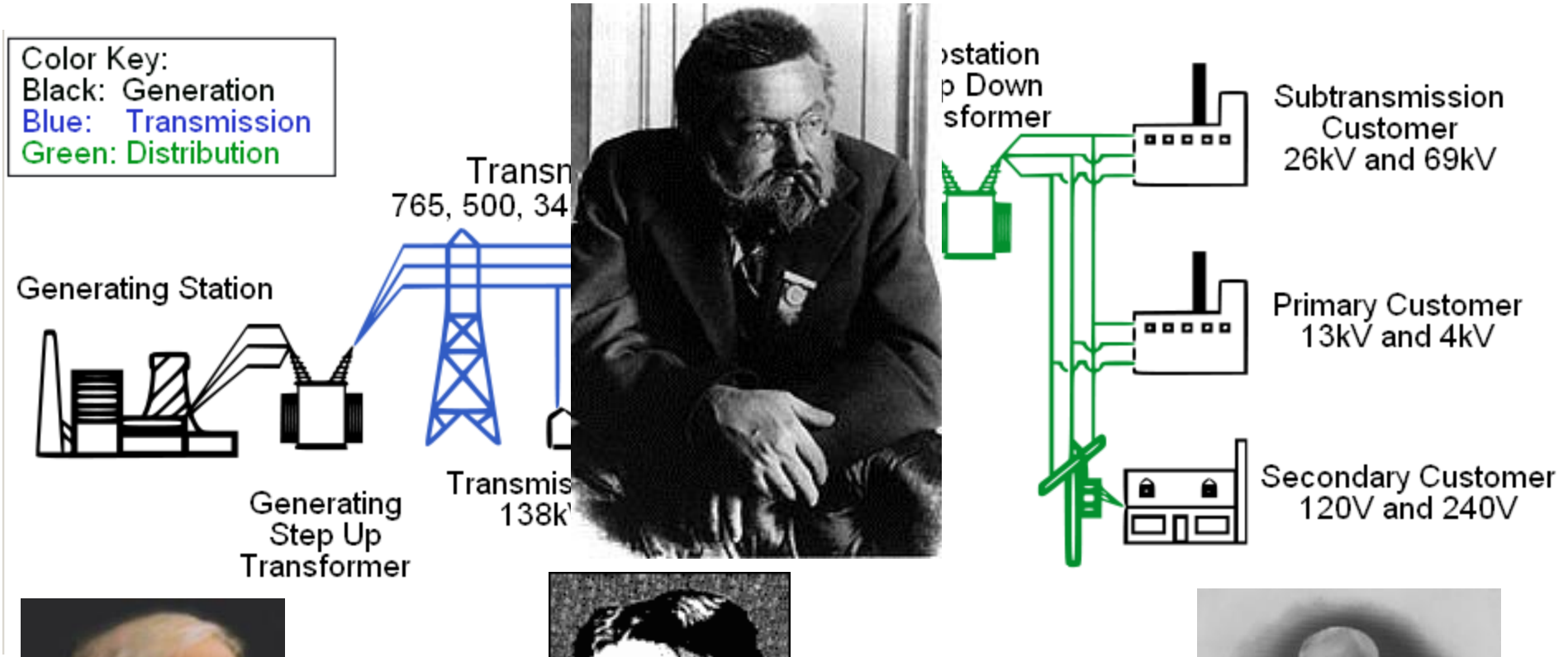
PMG@EPRI: 1993-2005

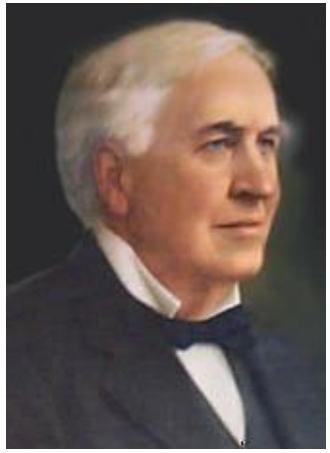
My Virtual Grandfather (@ 94)

NYC circa 1890s



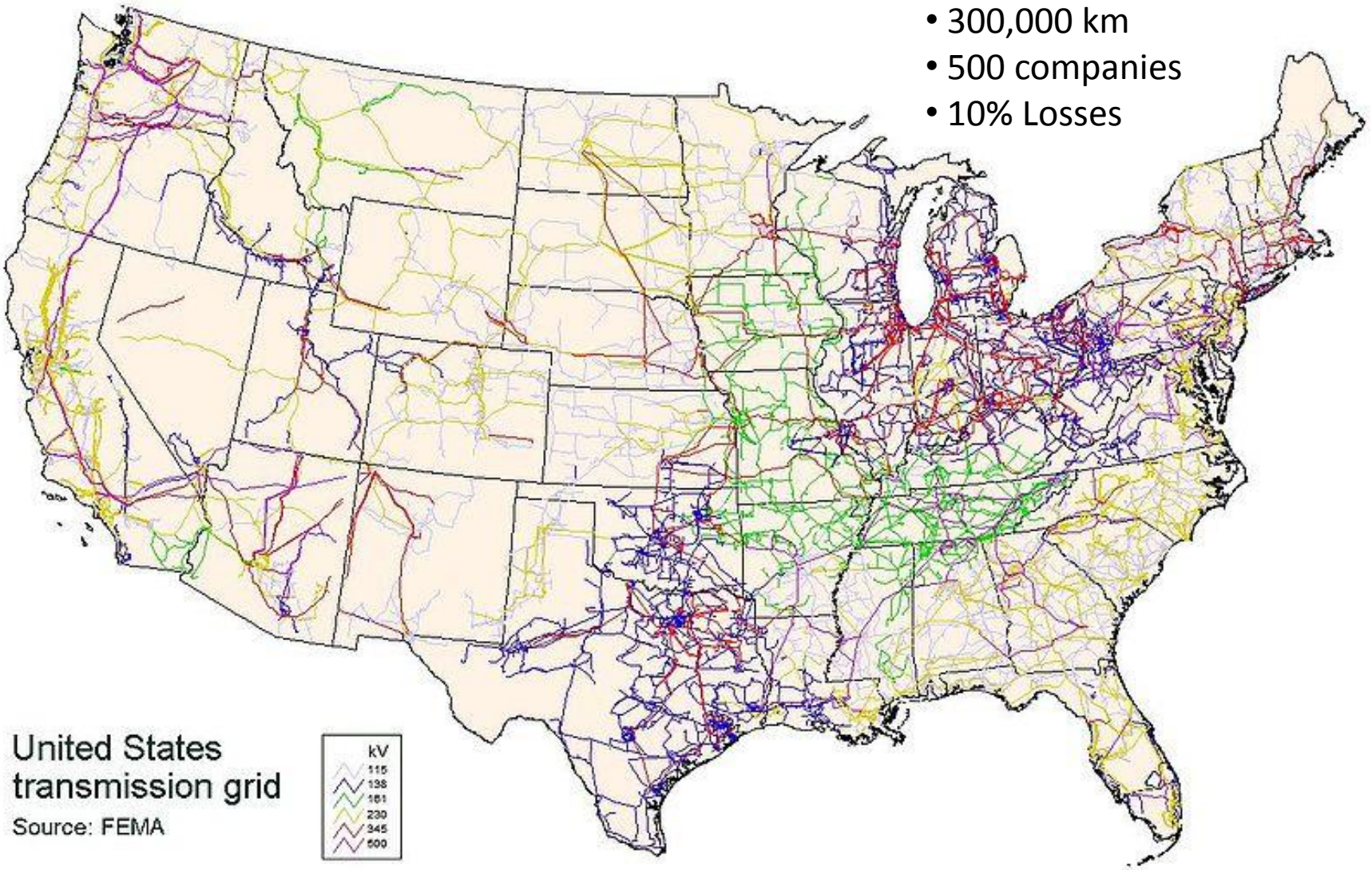
The US Electrical System





The US Transmission Grid(s)

- 300,000 km
- 500 companies
- 10% Losses



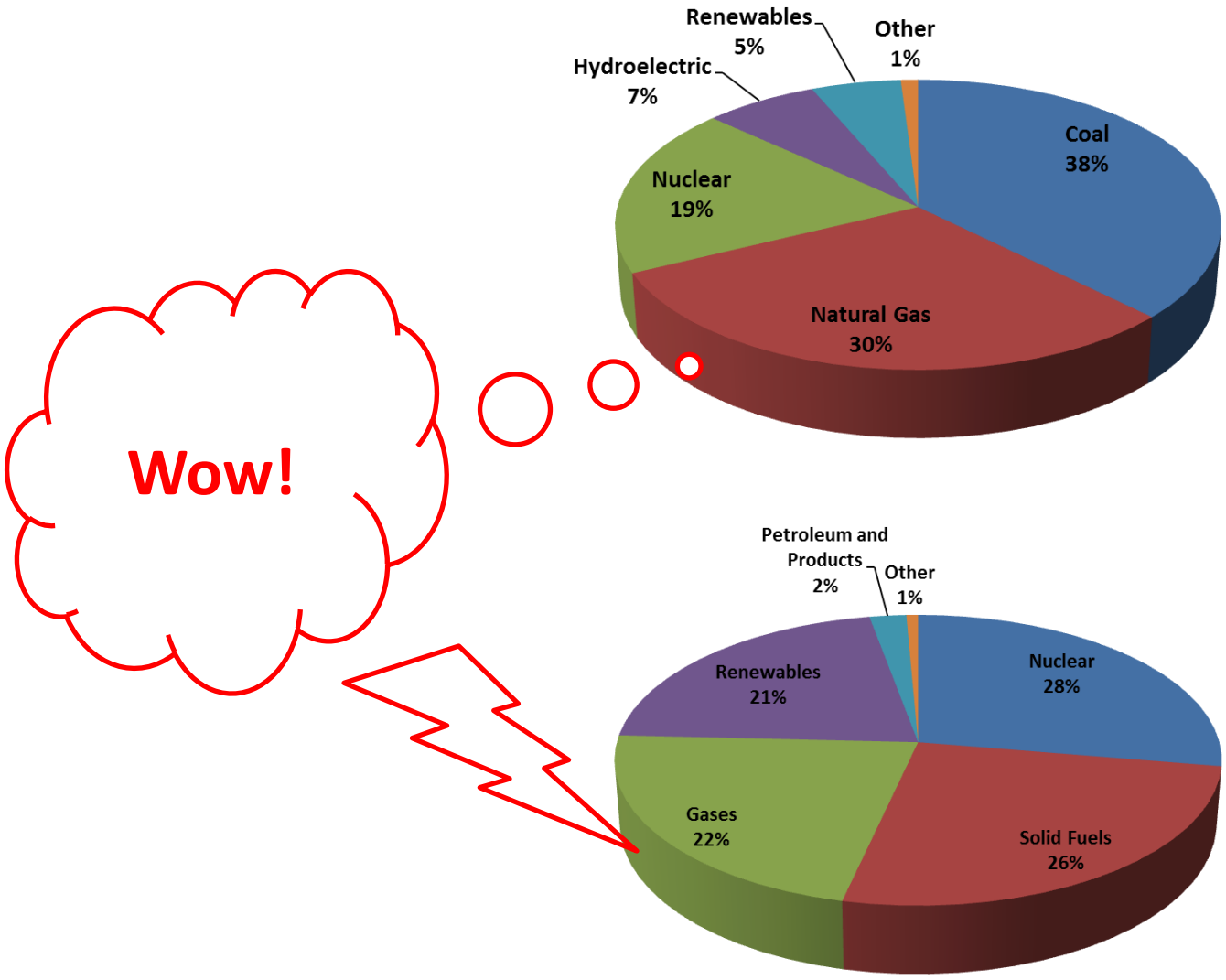
Pirelli-EPRI-AMSC-Detroit Edison

1996 - 2001

Pirelli

“Dual Use” of Energy Transport Corridors

Electricity Generation by Primary Fuel Source (2011-12)

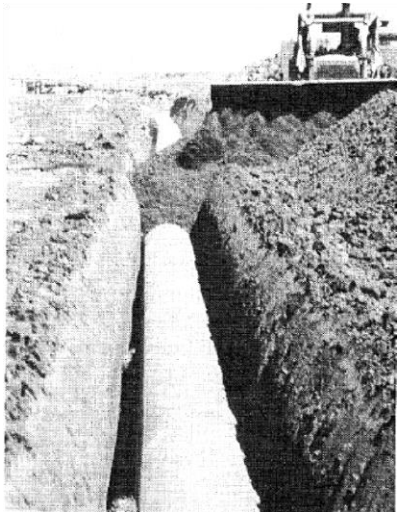


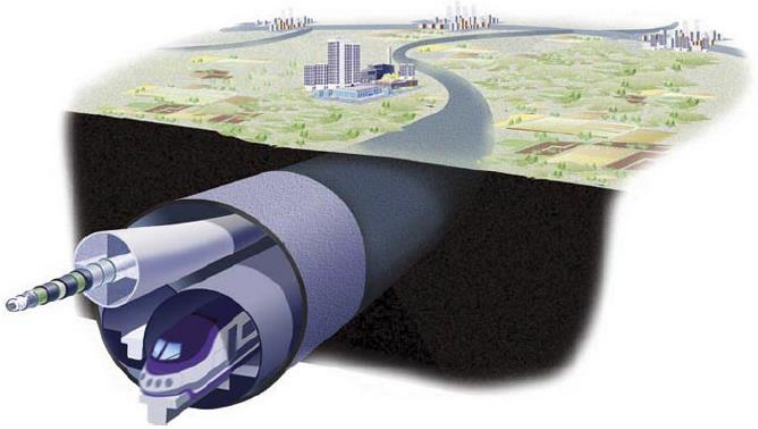
USA

Europe

The “Dual Use” Concept Embodied

- Almost all NG used for electricity generation is “combusted” at a “local” delivery point using modern, efficient, combined cycle gas turbine (CCGT) technology.
- Why not “combust” that gas portion so-used at the “well-head” instead and deliver the “electrons” over a low-loss HTSC dc cable? As well as reducing volume...and...frictional loss due to NG transported by pipeline.
- ...and...consider “recycling” well-head generated CO_2 emissions into alcohols...and “pipe” those down the same ROW!





The ROW Dual Use concept has been documented in several peer reviewed journals as well as member magazines of the APS, IOP, IEEE, and Nature...contact the author/speaker for a linkable anthology.

2100: The World Runs Out of CH_4

- The Dual Use ROWs Remain
- Replace the CCGTs with 1-2 GW Nukes
- Use Half the Power to Electrolyze (Frack) Nearby H_2O Reserves to Release H_2 ,
- Then Liquify and Use to Refridgerate Upgraded HTSC Cables (If Necessary!)

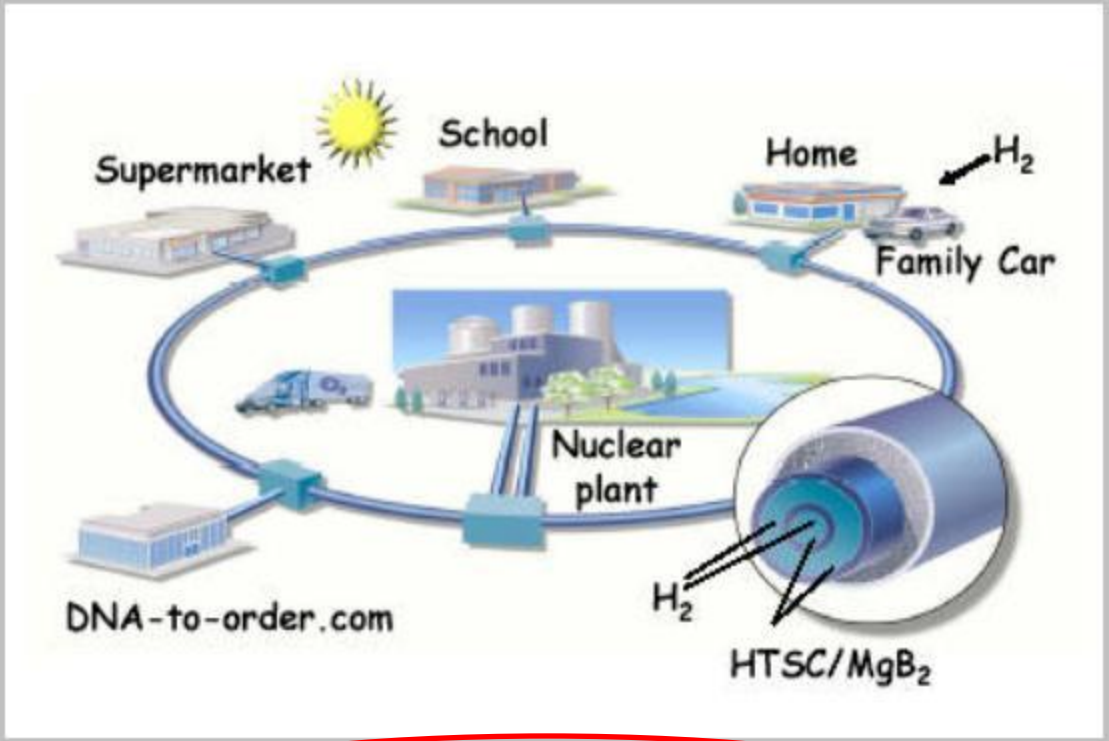
http://w2agz.com/PMG%20SuperGrid%20Home.htm

W2AGZ Technologies

The Energy SuperGrid

W2AGZ Technologies

SG Home
The Vision
Tech Stuff
SuperGrid 2
Press Coverage
Bibliography



Chauncey Starr
Paul Grant
Jesse Ausubel
Tom Overbye
Contact Me

A Symbiosis of

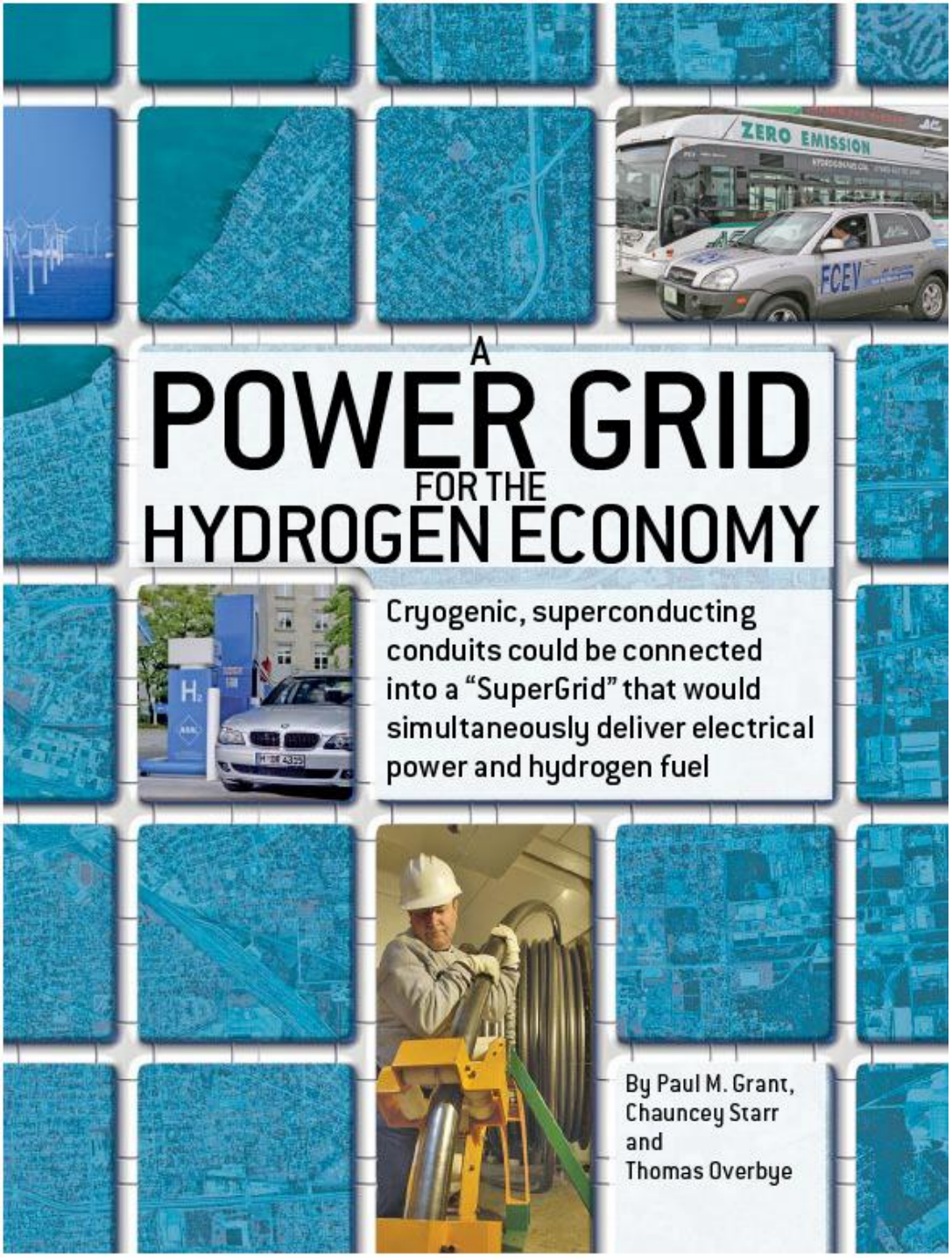
Nuclear/Hydrogen/Superconductivity/Solar/Biomass
Technologies supplying Carbon-free, Non-Intrusive Green Energy
for all Inhabitants of Planet Earth

W2AGZ Technologies

Home

Front Page

W2AGZ Technologies



On the afternoon of August 14, 2003, electricity failed to arrive in New York City, plunging the 10 million inhabitants of the Big Apple—along with 40 million other people throughout the northeastern U.S. and Ontario—into a tense night of darkness. After one power plant in

Published in

SCIENTIFIC AMERICAN

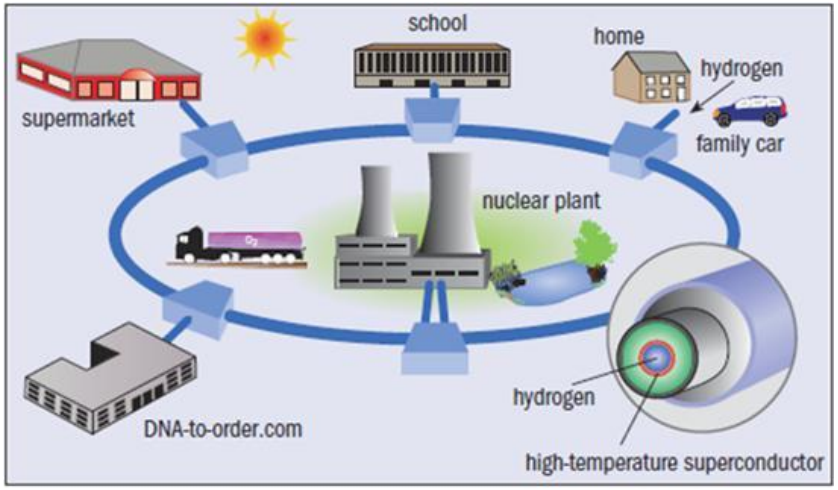
July, 2006

"System Crash"

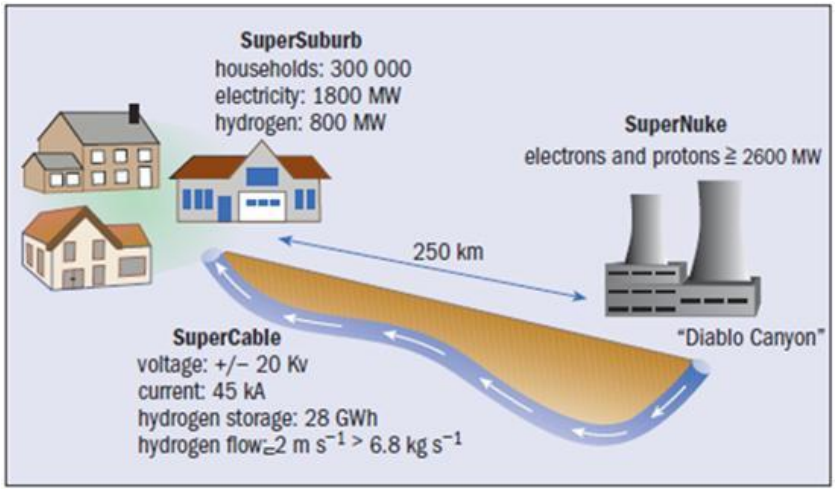
Omni Productions, Vancouver, BC

CBC Broadcast October, 2008

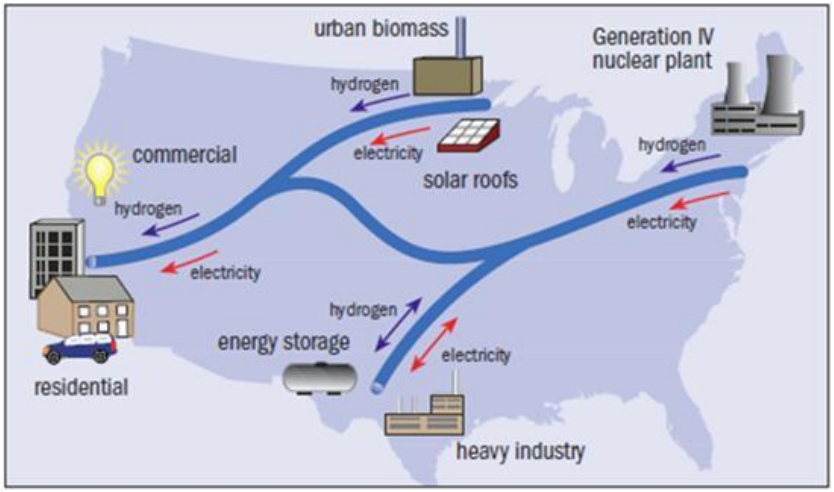
Exascale Energy for Our Great-Great GrandKids!



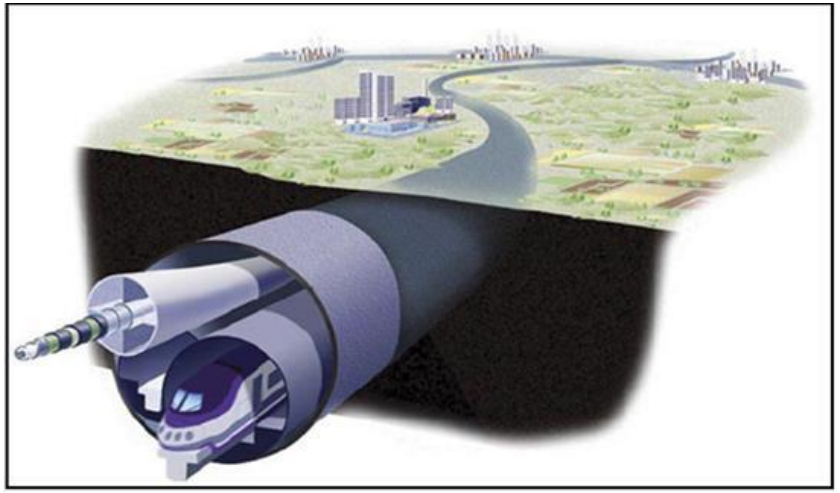
SuperCity



SuperSuburb

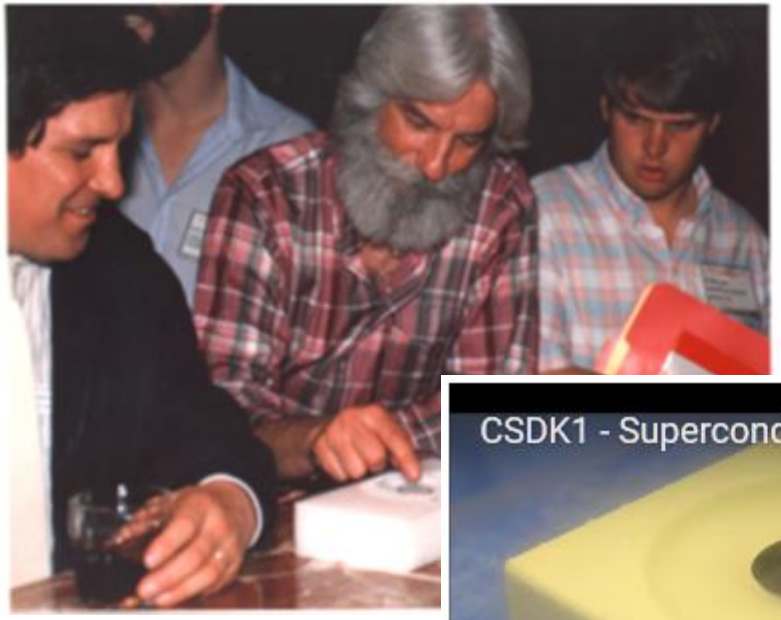


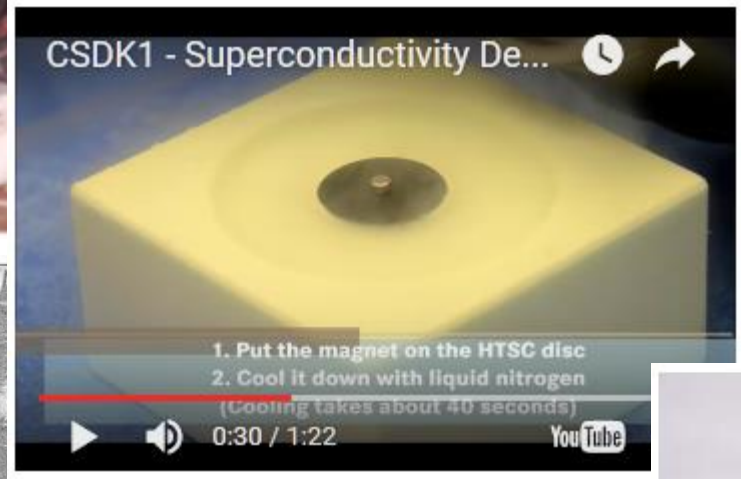
SuperGrid

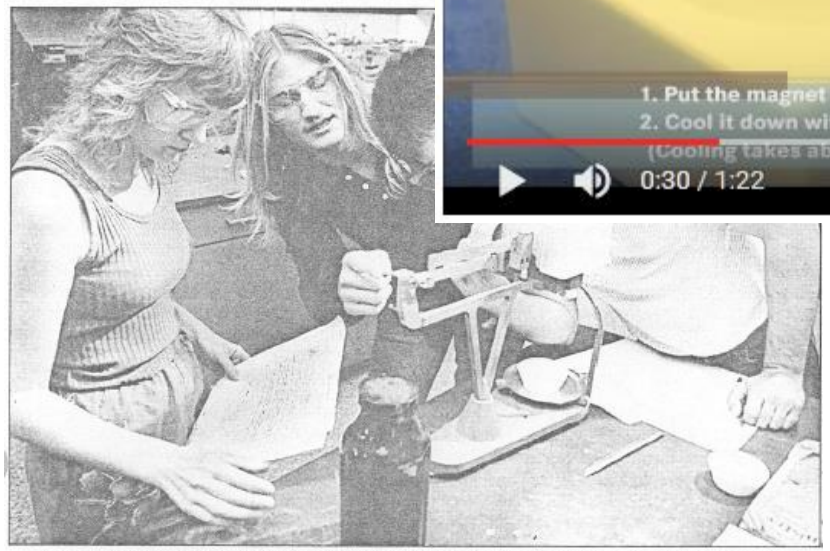


SuperTrain

"The Only Commercial Application of HTSC"







Pupils at Gilroy High School in California make their own high-temperature superconductor

Now it's graphene!

PMG@W2AGZ.COM: 2005-?

Challenges for Today's (and Future) Oakwood Physics Majors

- The Theory of Everything
- Designer DNA (aka "Life")
- Origin of HTSC
- The End of Turing-von Neuman Computing
- Climate Change

Bob Laughlin's "Theory of Everything" (that's important!)

Theory of Everything

$$\mathcal{H} = -\sum_j \frac{\hbar^2}{2m}\nabla_j^2 - \sum_\alpha \frac{\hbar^2}{2M_\alpha}\nabla_\alpha^2 - \sum_{j,\alpha}\frac{Z_\alpha e^2}{|r_j - R_\alpha|} + \sum_{j<k}\frac{e^2}{|r_j - r_k|} + \sum_{\alpha<\beta}\frac{Z_\alpha Z_\beta e^2}{|R_\alpha - R_\beta|}$$

- Hydrogen atom
- Methane molecule
- Water
- Air
- Rocks
- Concrete
- Steel
- Glass
- Plastic
- Buildings
- Cities
- Continents

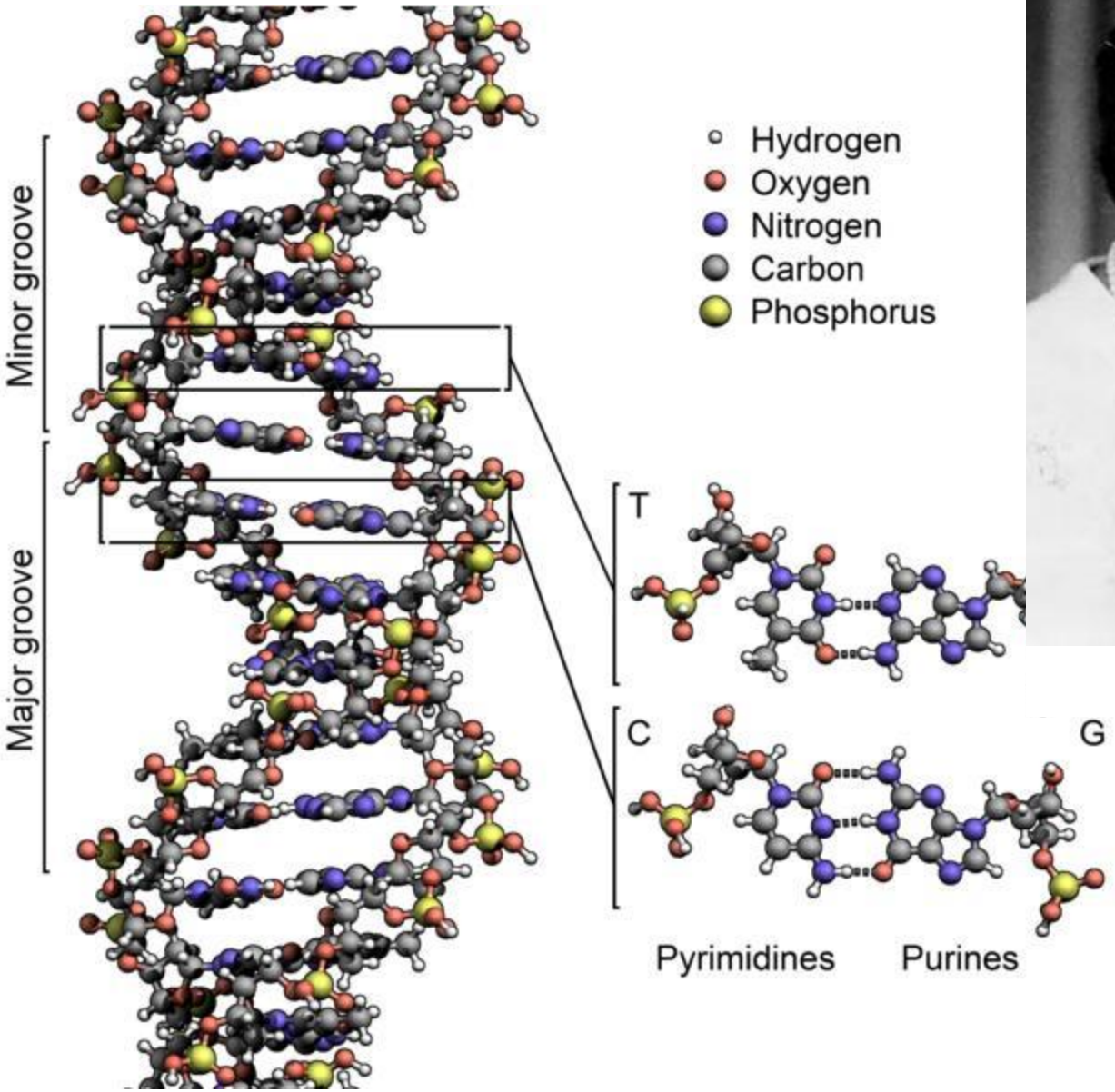
- Proteins
- DNA
- Viruses
- Bacteria
- Yeast
- Slime mold
- Butterflies
- Sharks
- Rats
- Lawyers
- Ebola virus
- Legislatures
- Civilizations

- Flowers
- Trees
- Cows
- Cheese
- Sauce Bernais
- Computers
- Television
- Cars
- Jets
- Lawnmowers
- Sewage
- Spotted Owls
- ...

- 3 -> 10^2
  - Chemistry
- 10^2 <-> 10^3
  - Thermodynamics
- 10^3 <-> 10^{10}
  - Cooperative Phenomena
- 10^{10} <-> 10^{20}
  - Emergent Behavior (Us)

- > 10^{20}
  - CLIMATE !
- **SIZE MATTERS !**

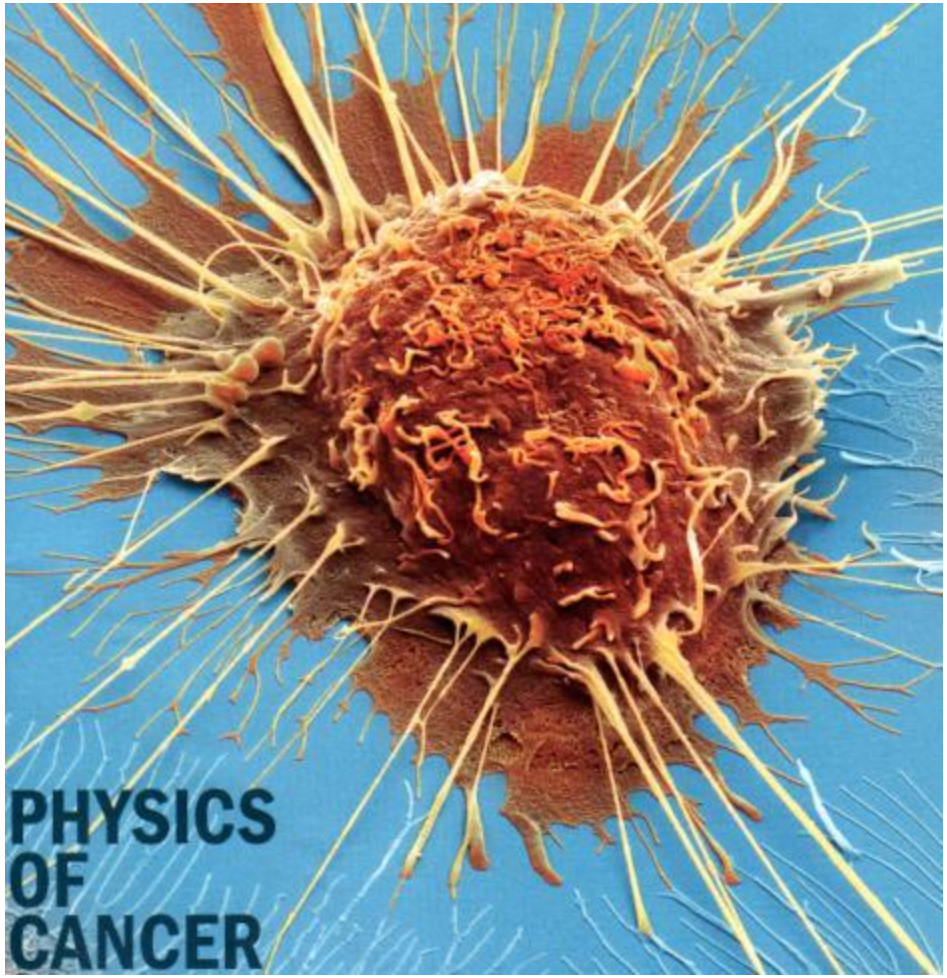
The Structure of Life

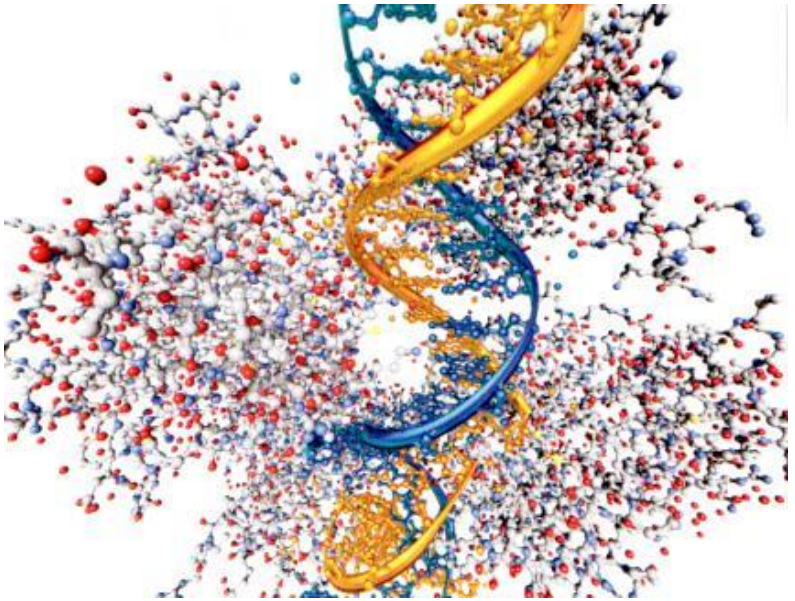


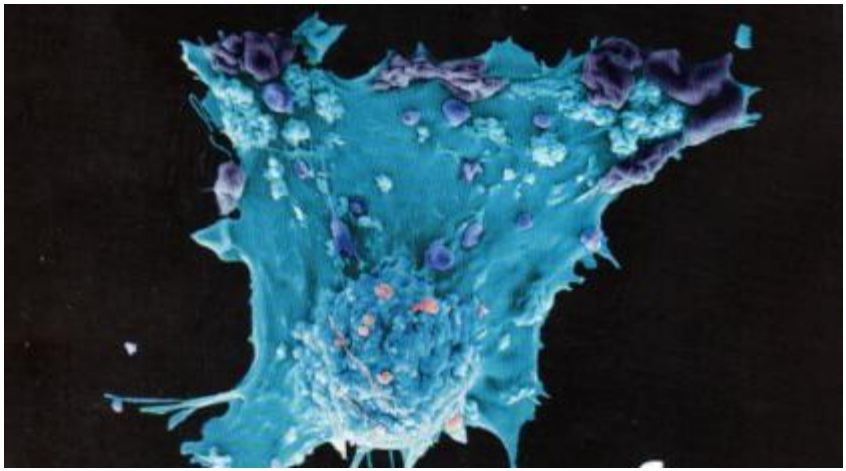
Rosalind Franklin

Physics World

Volume 26 No 7 July 2013







The HTSC Pairing Glue

“Alex says it’s phonons”

OK, OK...J-T polarons and/or bipolarons (after Chakravarty/Hoest)

Could he be right after all?

Landauer Limit

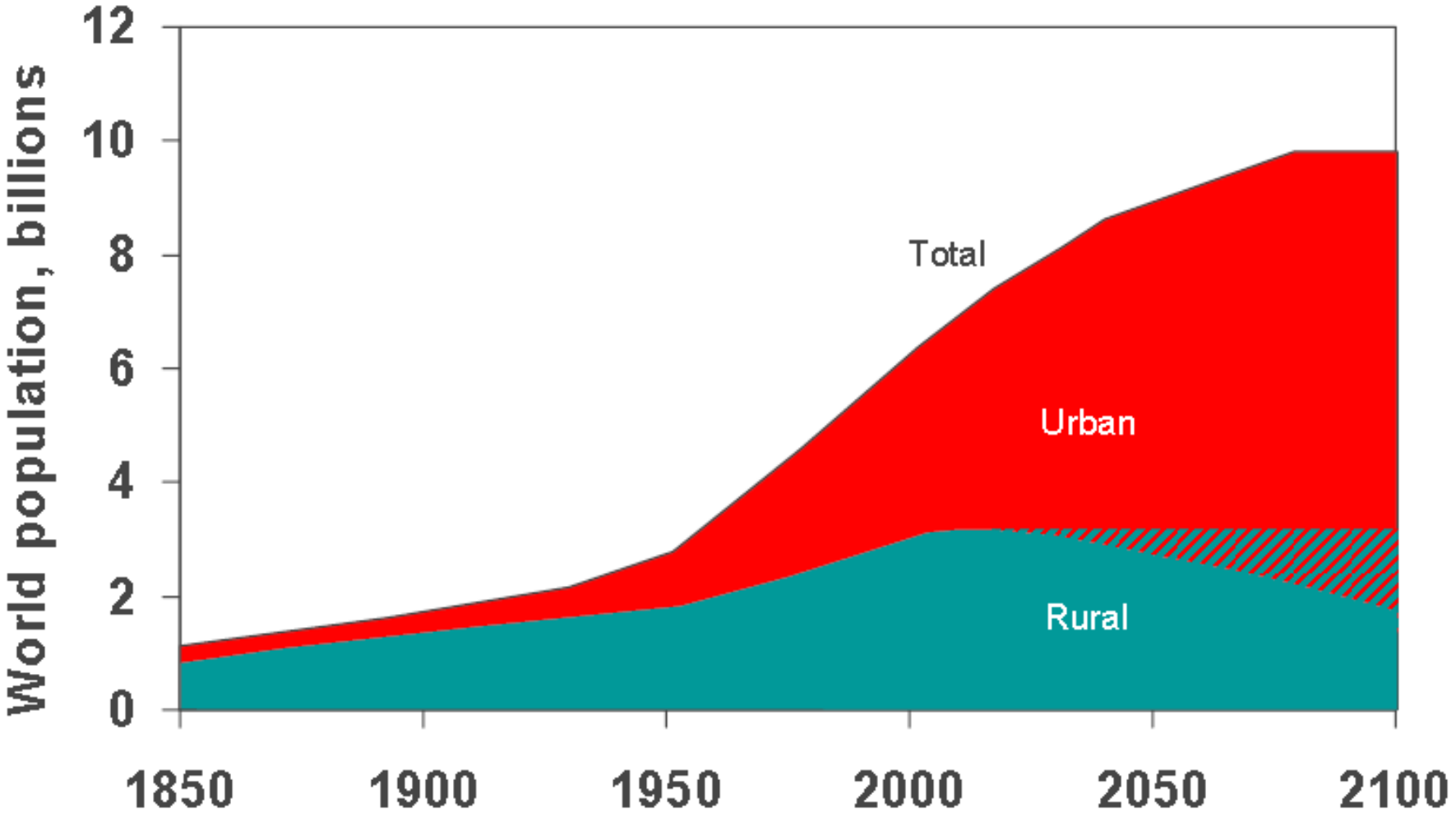
Landauer's principle asserts that there is a minimum possible amount of energy required to erase one bit of information, known as the Landauer limit:

$$kT \ln 2,$$

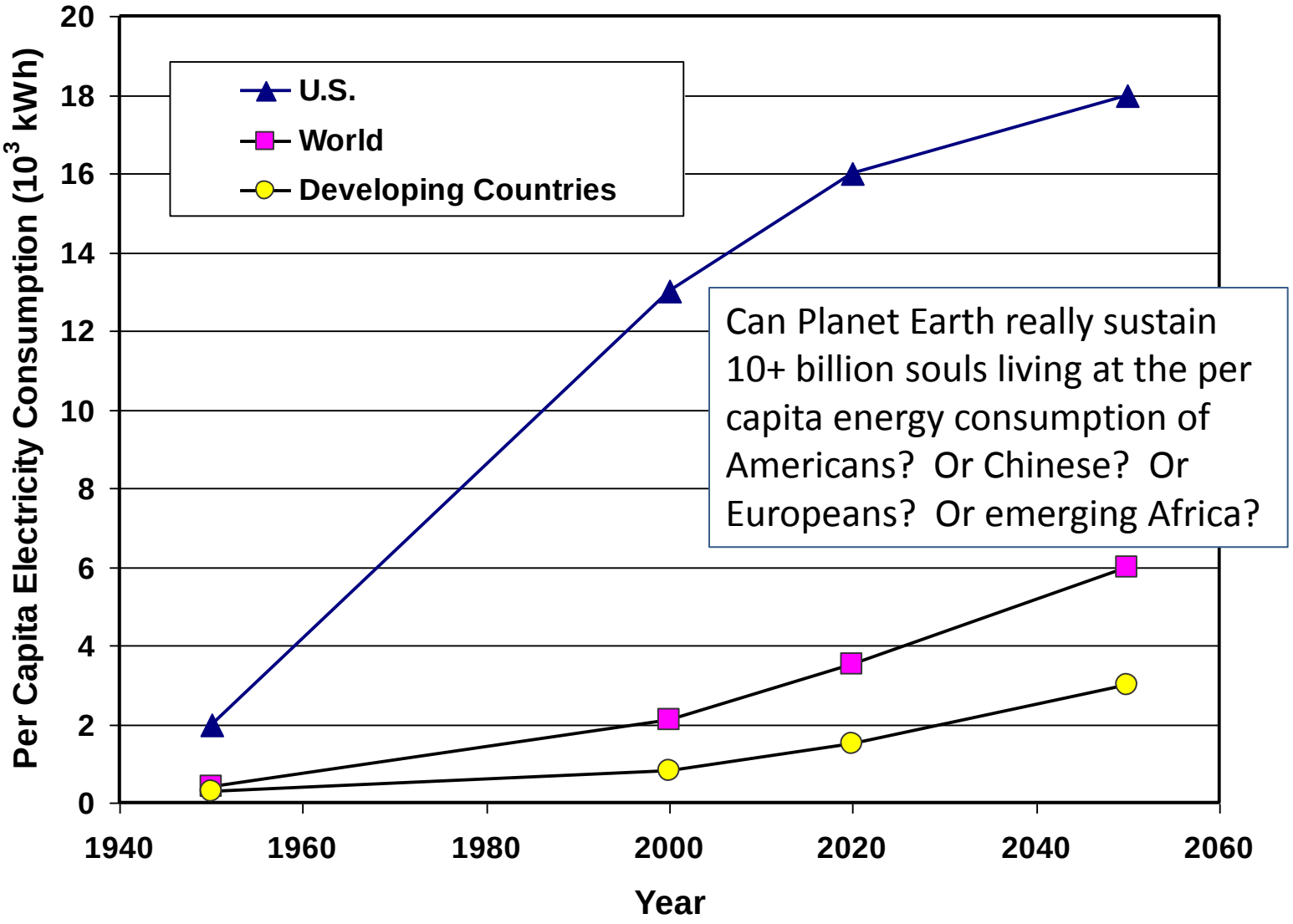
where k is the Boltzmann constant (approximately $1.38 \times 10-23$ J/K), T is the temperature of the heat sink in kelvins, and ln 2 is the natural logarithm of 2 (approximately 0.69315).

“Greenhouse Gases”

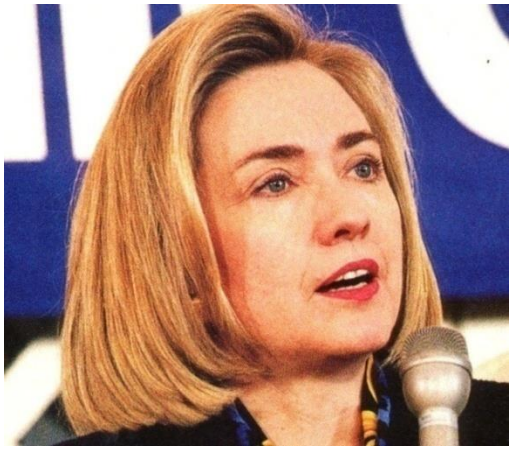
World Population: 1850 - 2100



Trends in Per Capita Electricity Consumption



Enfranchisement of Women



Where there is no vision, the people perish…

Proverbs 29:18

“You can’t always get what you want…”

“…you get what you need!”