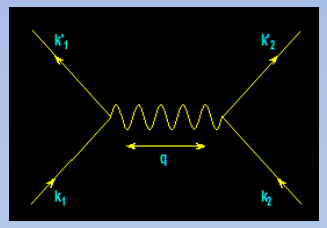
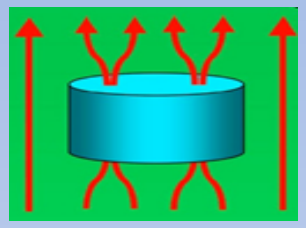
Setup

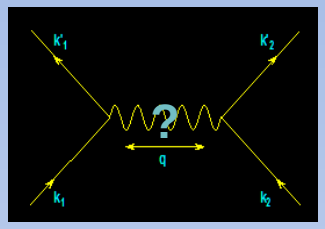
From Electrons Paired



To Electric Power Delivered



…And… Back Again



-- A Personal Journey in Applied Physics --
-- IBM, EPRI, and Beyond --

Paul M. Grant

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”
- 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)*

Paul Michael Grant

Physicist and Science Writer

Principal, W2AGZ Technologies

Senior Life Fellow, American Physical Society

PMG on YouTube!

Career Work Product

W2AGZ Site Stuff

View Video Intro

W2AGZ & The Media

About Paul Grant

Resume

Vitae

Publications

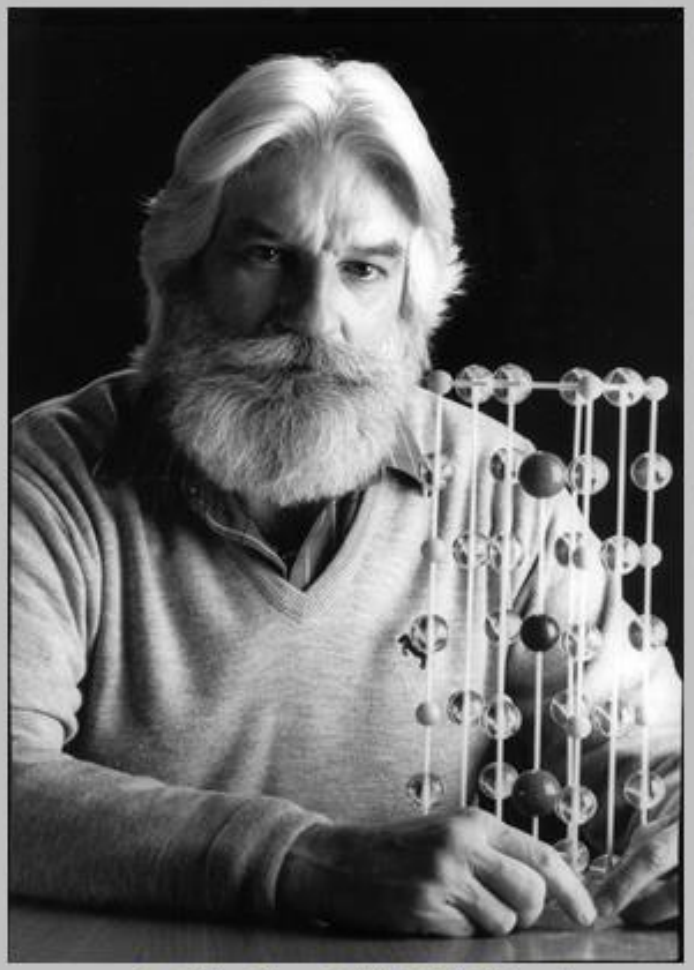
Presentations

The SuperGrid

BackDoors

TrapDoors

SuperBlog



What's New?

Go To W2AGZ

What is W2AGZ?

Chauncey's Page

Site Notes

Contact Me

SuperWiki

SuperLinks

SuperTunes

Read the Story Behind This Picture!

What are PhDs doing with their degrees?

Data courtesy of Crystal Bailey, bailey@aps.org

Types of Positions Accepted by Employment Sector, Classes of 2009 & 2010.

	Postdoc %	Potentially Permanent %	Other Temporary %	Overall %
Academic*	73	23	82	58
Private sector	1	57	9	19
Government	22	16	6	19
Other	4	4	3	4
N	740	365	89	1,194

Data only include U.S.-educated physics PhDs who remained in the U.S. after earning their degrees.

*Includes university affiliated research institutes.

http://www.aip.org/statistics

The largest percentage of Physics PhDs found initial employment in Postdoctoral and other temporary positions…

…but a significant number of graduates went straight into potentially permanent employment in the private sector.

PhD Employment in the Private Sector

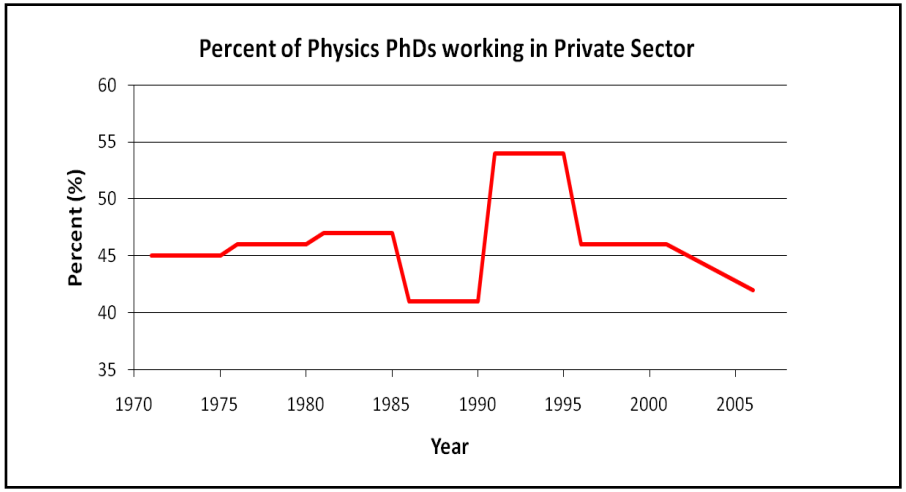
Recall that the majority (57%) of graduates who initially went into permanent employment positions were in the private sector.

According to the NSF Survey of Doctoral Recipients, in 2010 the private sector was the largest single employment base of Physics PhDs: about 47% (the next highest was 4 year colleges, at 38%).

This was also true in 2001, when the private sector employed 46% of Physics PhDs[1]…

…and was also true in 1993, when the private sector again employed 46% of Physics PhDs[2].

In fact, the same data has shown consistent support for Physics PhDs in the private sector since 1971.



[1]NSF Survey of Doctoral Recipients, 2001
[2]NSF Integrated Survey Data, 1993

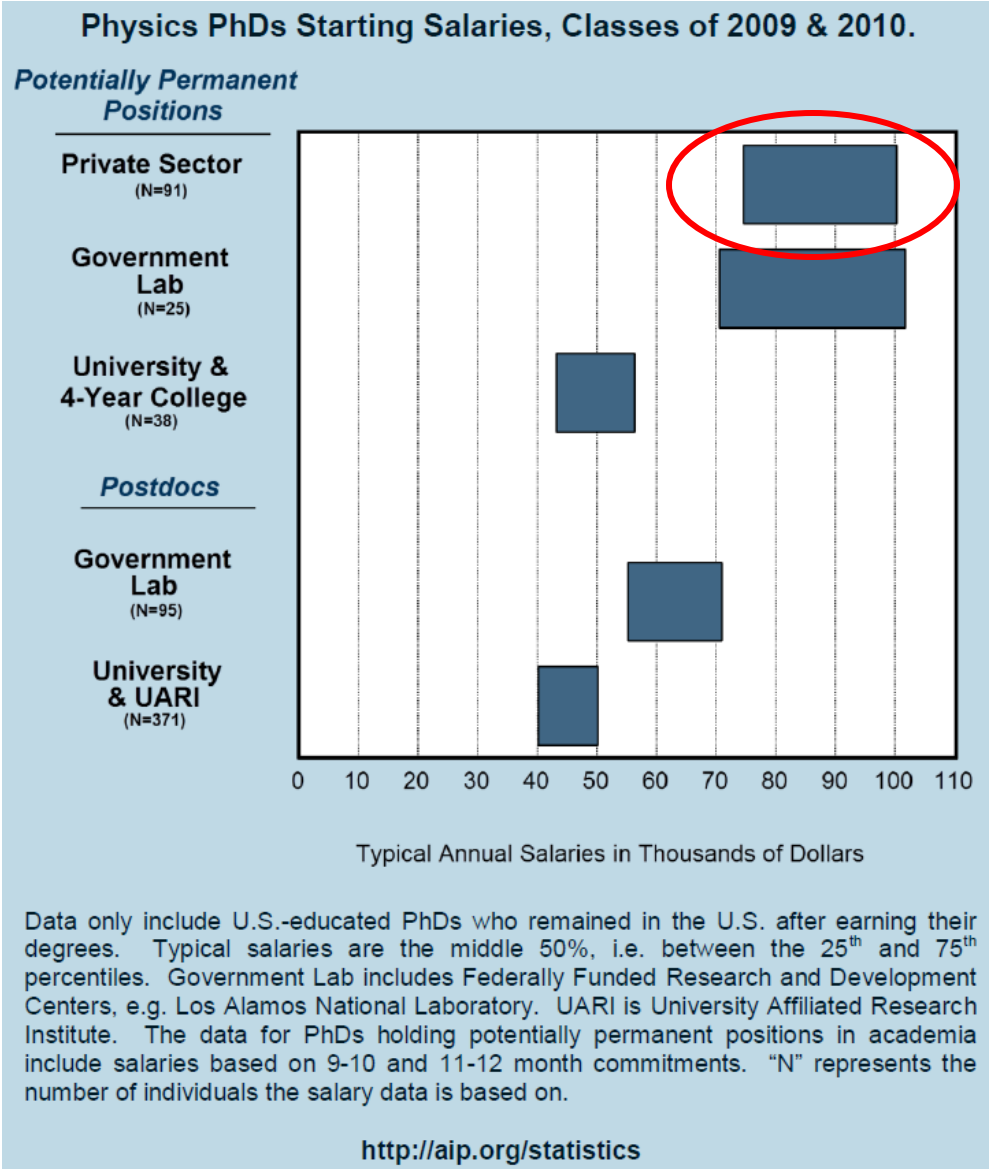
Industry has been the largest employment base for Physics PhDs for decades.

Not only does the private sector provide the largest number of jobs for physics PhDs, it also provides the highest-paying jobs, with a starting salary of $90K

By comparison, average typical starting salaries at Universities and 4-year colleges is around $50K…

…and a University postdoc position typically offers between $40K and $50K.

So, the private sector also offers well-paying employment to Physics PhDs.

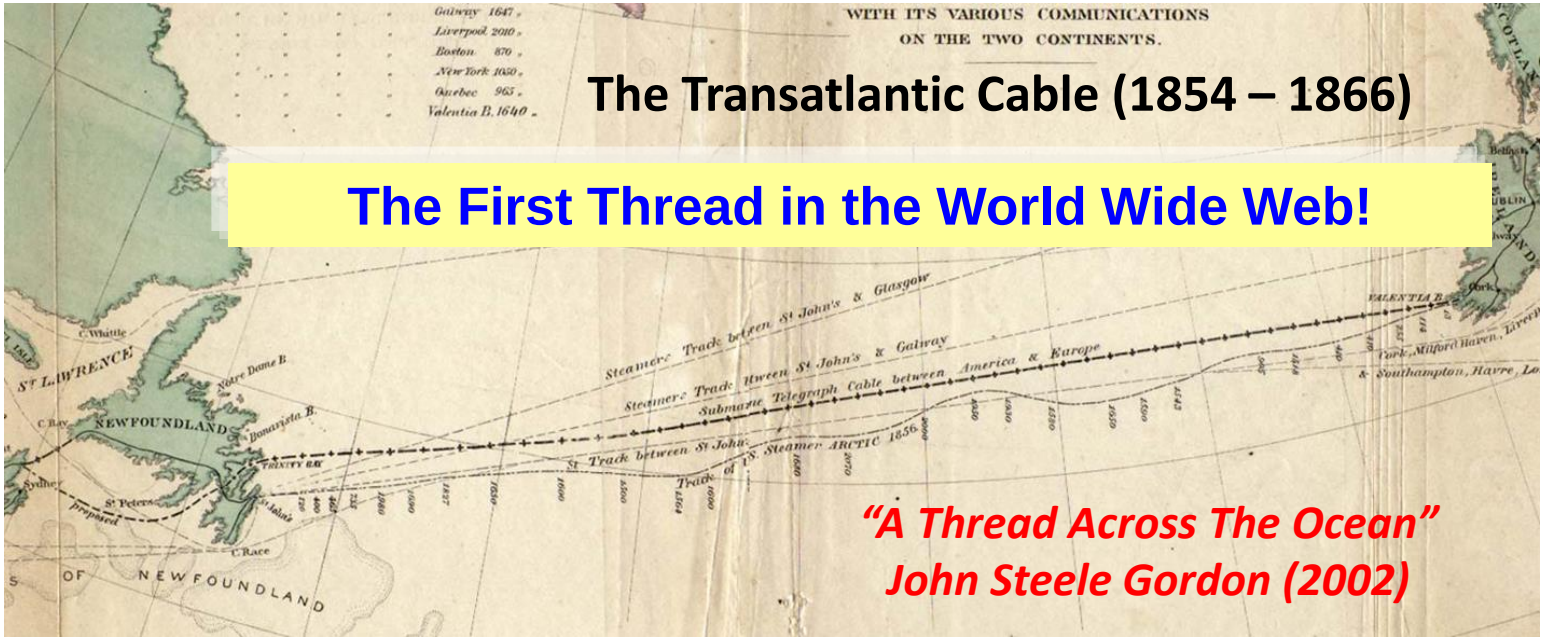


Three Famous Applied Physicists

Joseph Henry

Michael Faraday

William Thomson



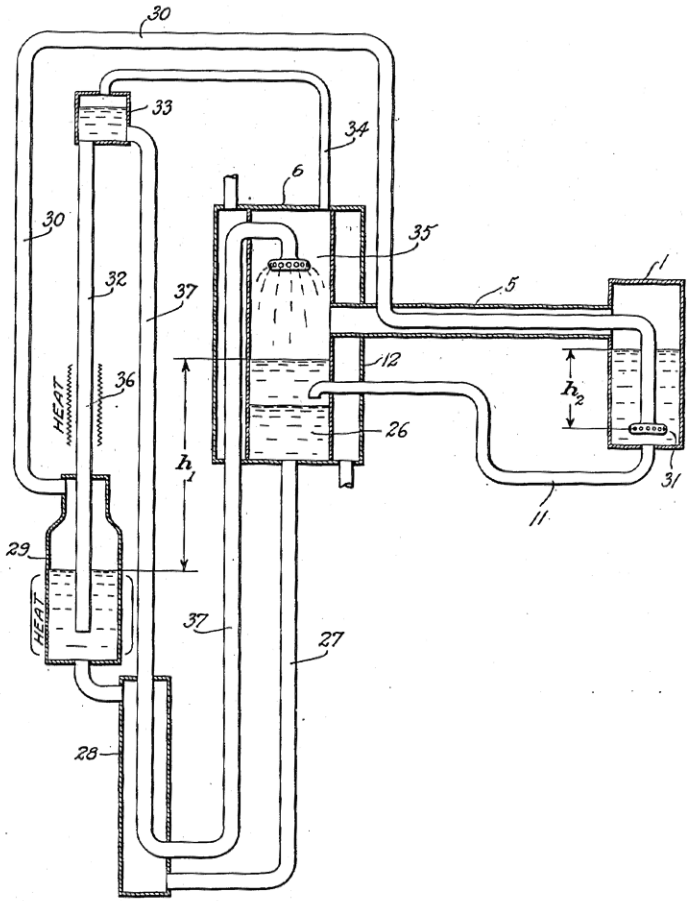
Two Other Famous Applied Physicists

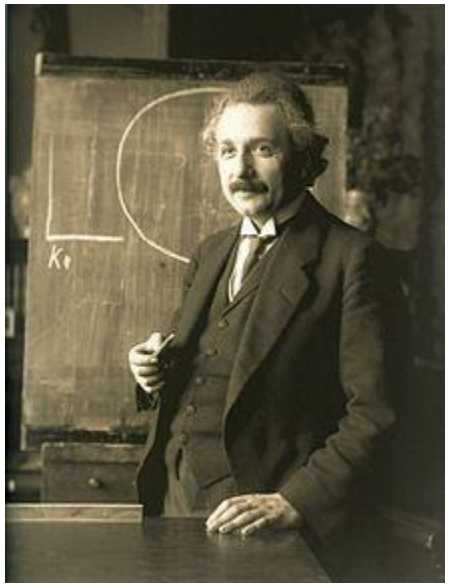
Patented Nov. 11, 1930 1,781,541

ALBERT EINSTEIN, OF BERLIN, AND LEO SZILARD, OF BERLIN-WILMERSDORF, GERMANY, ASSIGNORS TO ELECTROLUX SERVEL CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

A Simple Household Refrigerator!

Leo Szilard



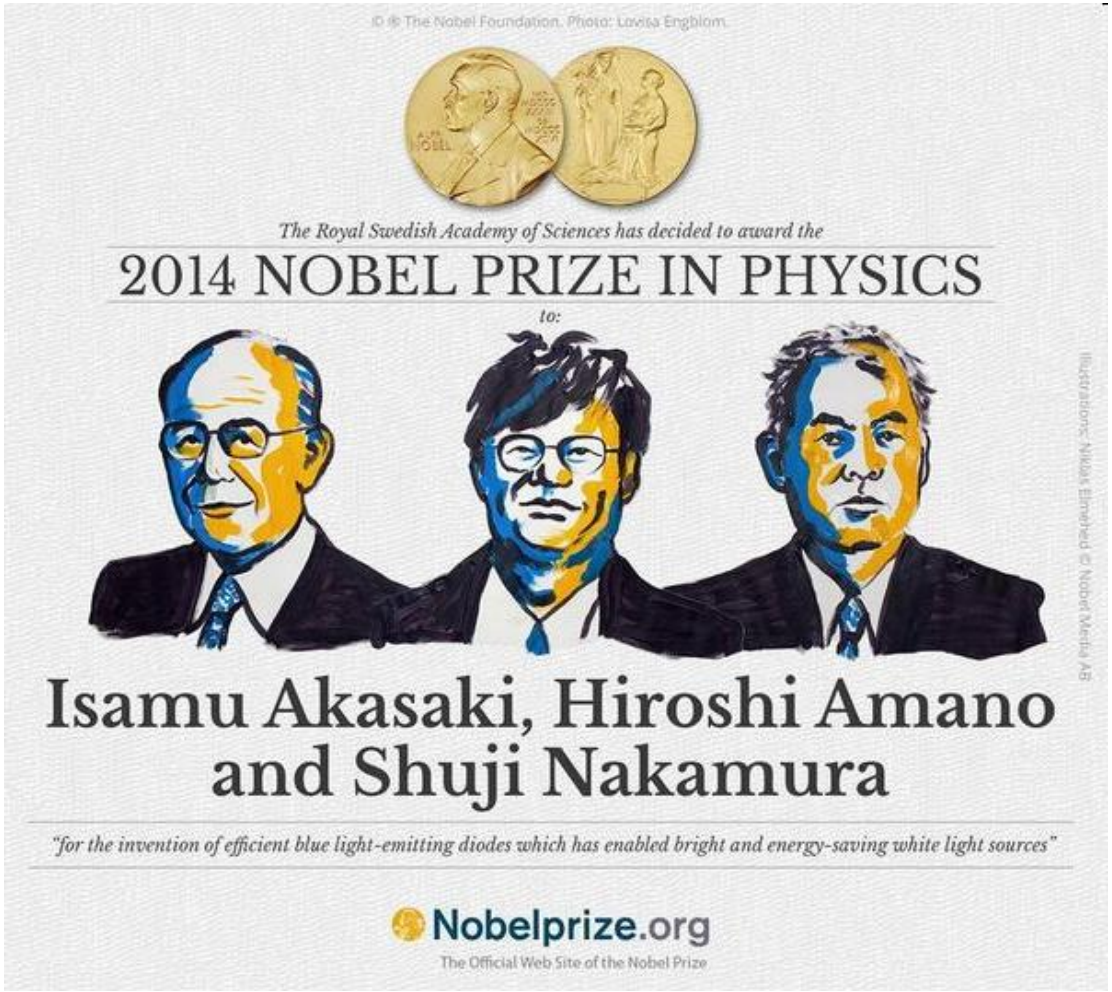


...and Finally One More...

Richard P. Feynman...The Spiritual Father of Nanotechnology (1959)

"There's Plenty of Room at the Bottom!"

But Wait…Last Week!



Invention of the "Blue Light" GaN Light Emitting Diode (LED)

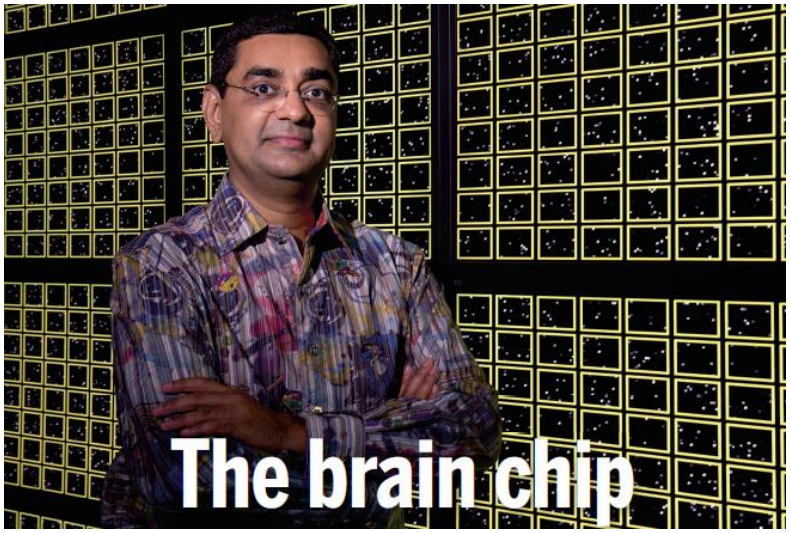
And Then a Day Later!

Congratulations
Professor W. E. Moerner!
Chemistry Nobel Laureate, 2014

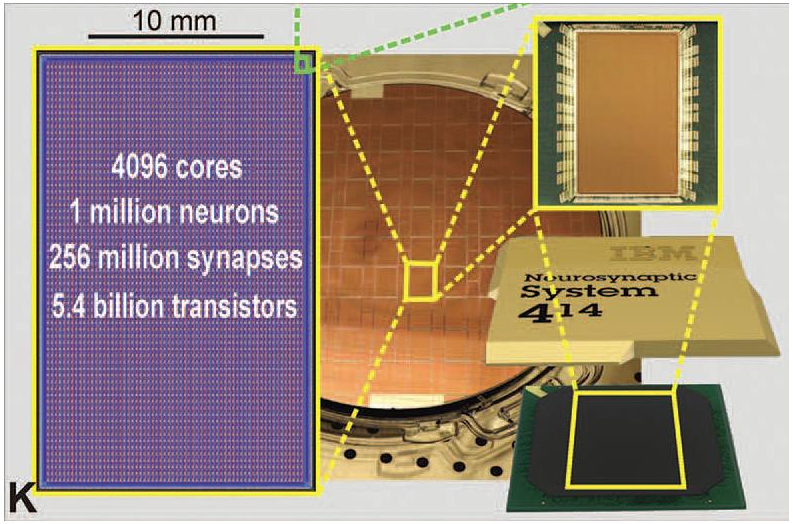
"for the development of super-resolved fluorescence microscopy"

The principle breakthroughs occurred during "WE's" career at the IBM Almaden Research Center spanning 1981-1995 as an industrial physicist!

And Next the Future...



Dharmendra Modha
IBM Almaden Research Center



"The TrueNorth Chip"

Microprocessors modeled on networks of nerve cells promise blazing speed at incredibly low power

Science, August 2014

But what happens when Moore's Law meets the Landauer Limit? The end of von Neumann computers?

A challenge awaiting the generation of physicists sitting before me!

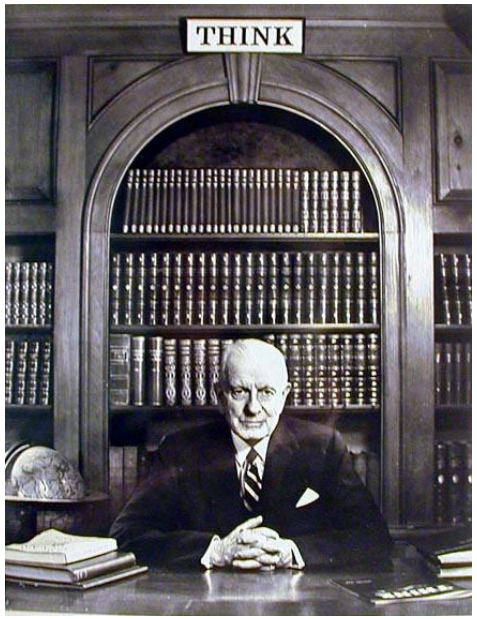
IBM

Following In His Shoes

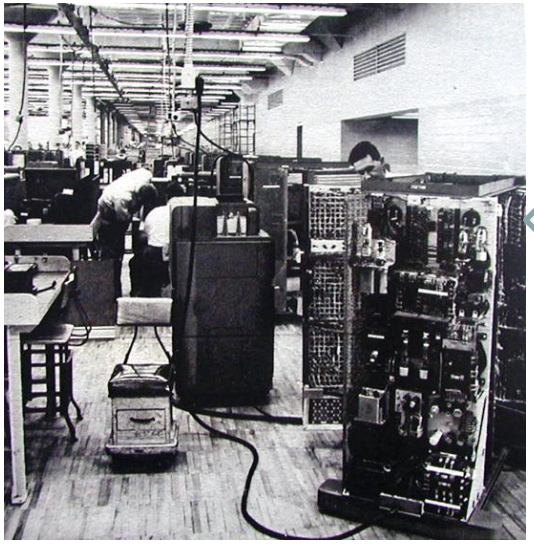
Paul Archibald Grant, W2AGZ

- Teenage Ham Radio Prodigy, 1922
- Auto Assembly Line Worker, 1923-30
- County Motorcycle Cop, 1930-33
- Owner, Home Radio Installation Business, 1934-37
- Tool & Die Machinist, 1938-42
- Radar Specialist 1st Class, US Navy, South Pacific, 1943-45
- Electronic Technician, Purchasing Agent, IBM, 1947-74
- Founder, Catskill Mountain Volunteer Ski Patrol, 1948

IBM – 100 Years



1952

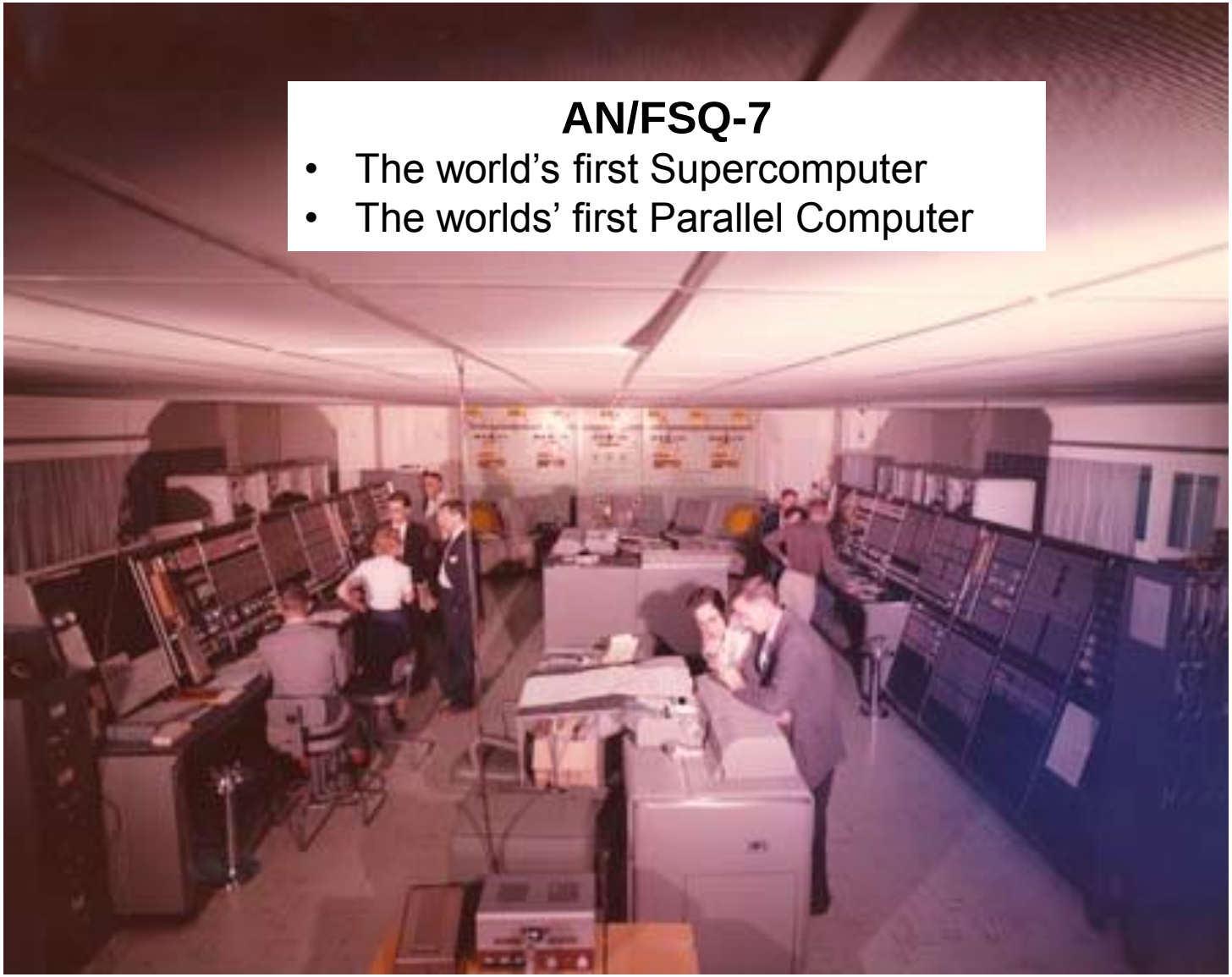


604 (1948)

Grant-Whalen
IBM Family
-Poughkeepsie-

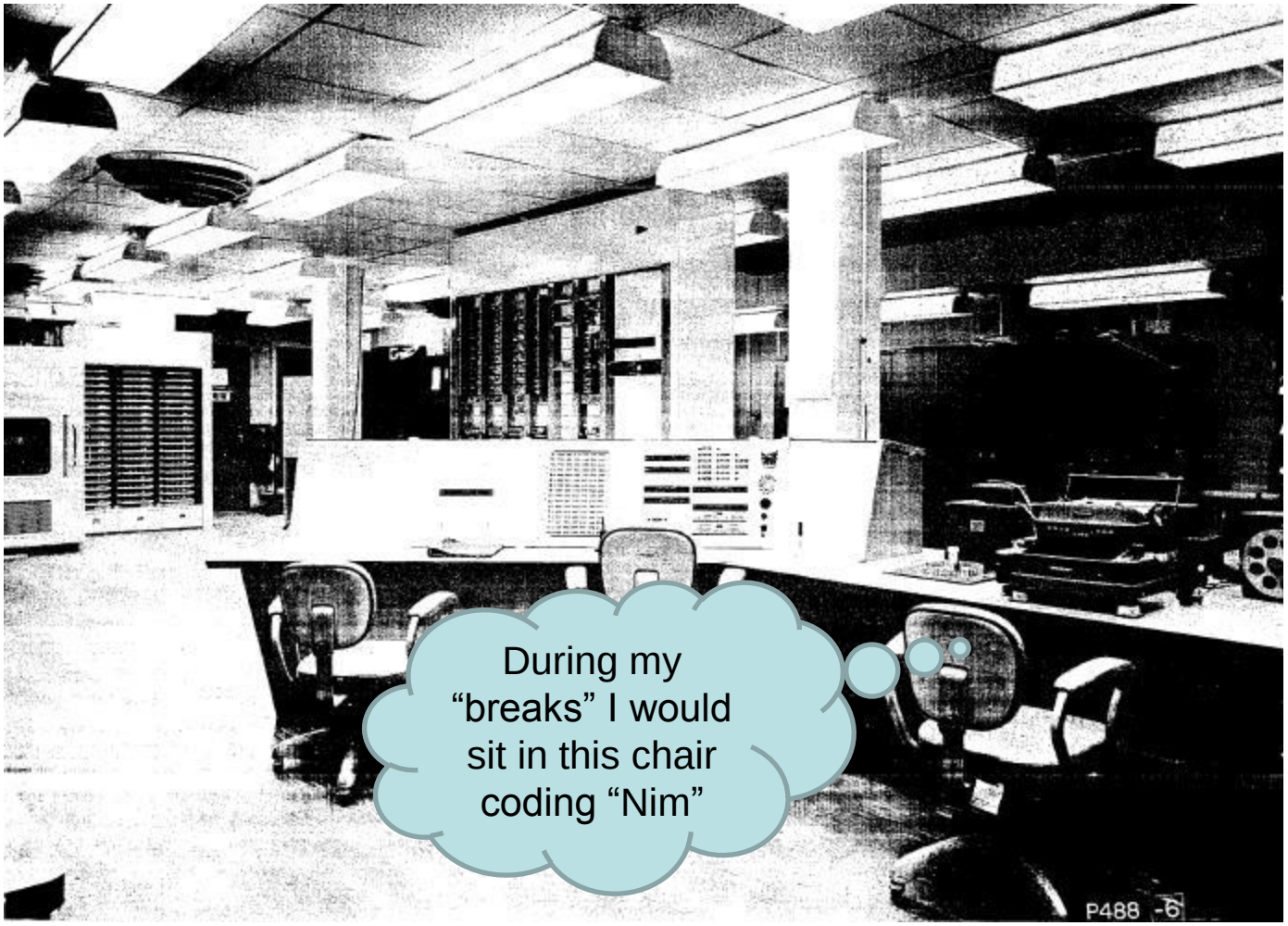
701 (1952)

1953
Project Sage – IBM/MIT



1954

TX-0: The First Transistor Computer



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

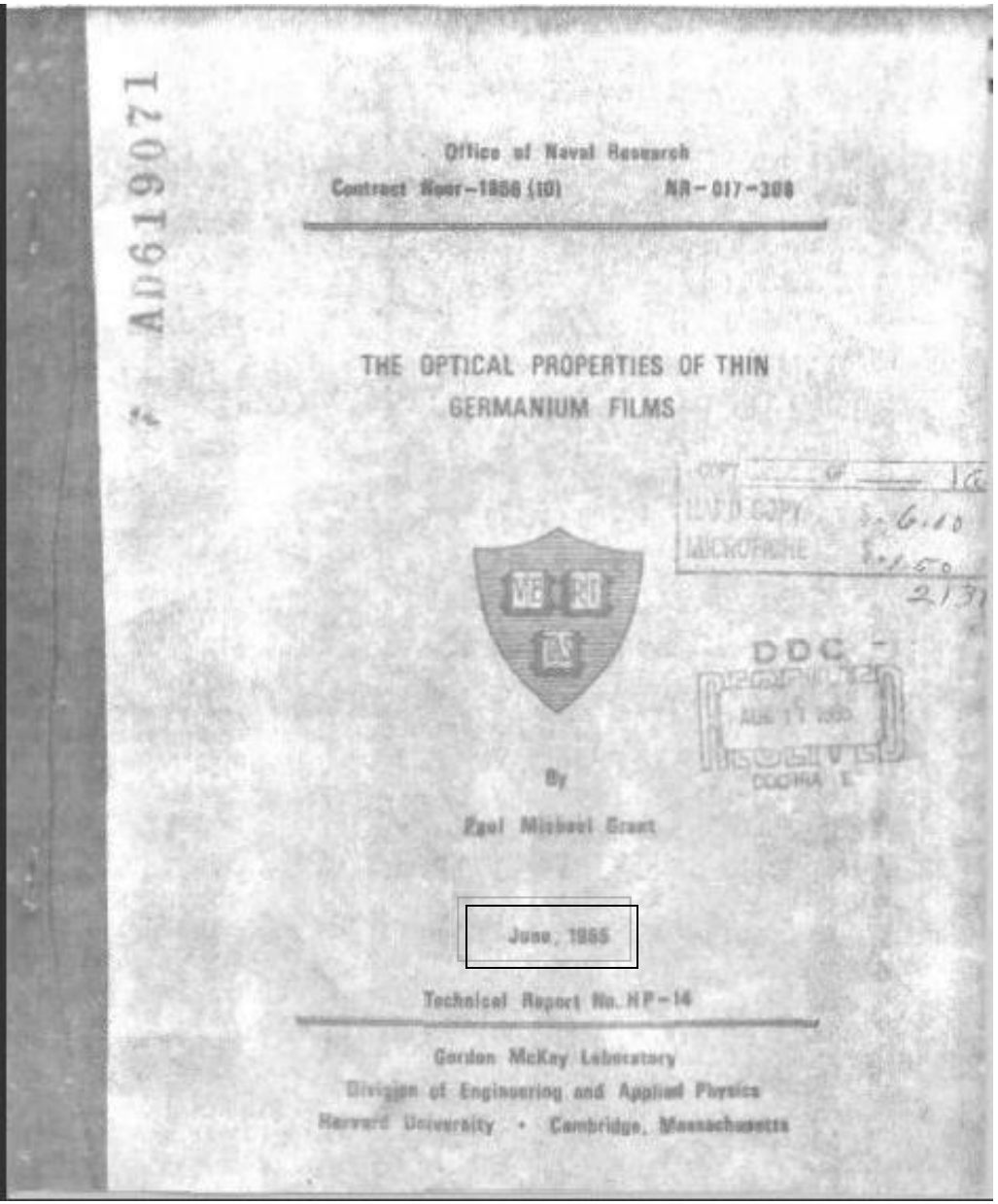
George W. Reed 26 Jan '60

Department Chairman

Paul M. Grant

The Very First Clarkson Internship Scholar?

PhD Thesis



1965:

Back from Harvard, Out to IBM San Jose,

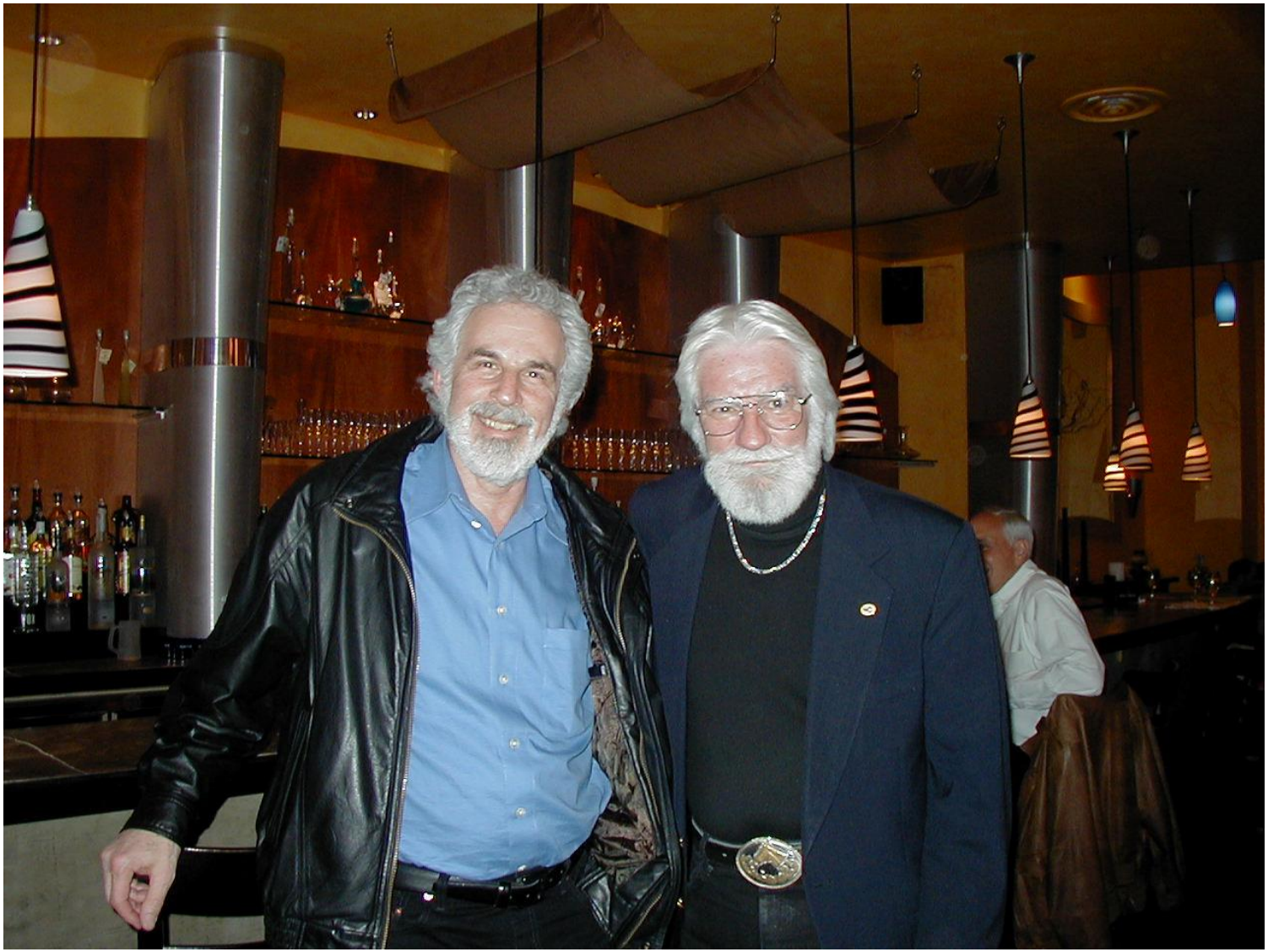
- Optical Properties of Europium Chalcogenides
- Optical Properties of Chromium Trihalides
- Laboratory Automation and Data Acquisition (Labview)
- SJRL Director's Staff: Materials Research Overview

Now It's

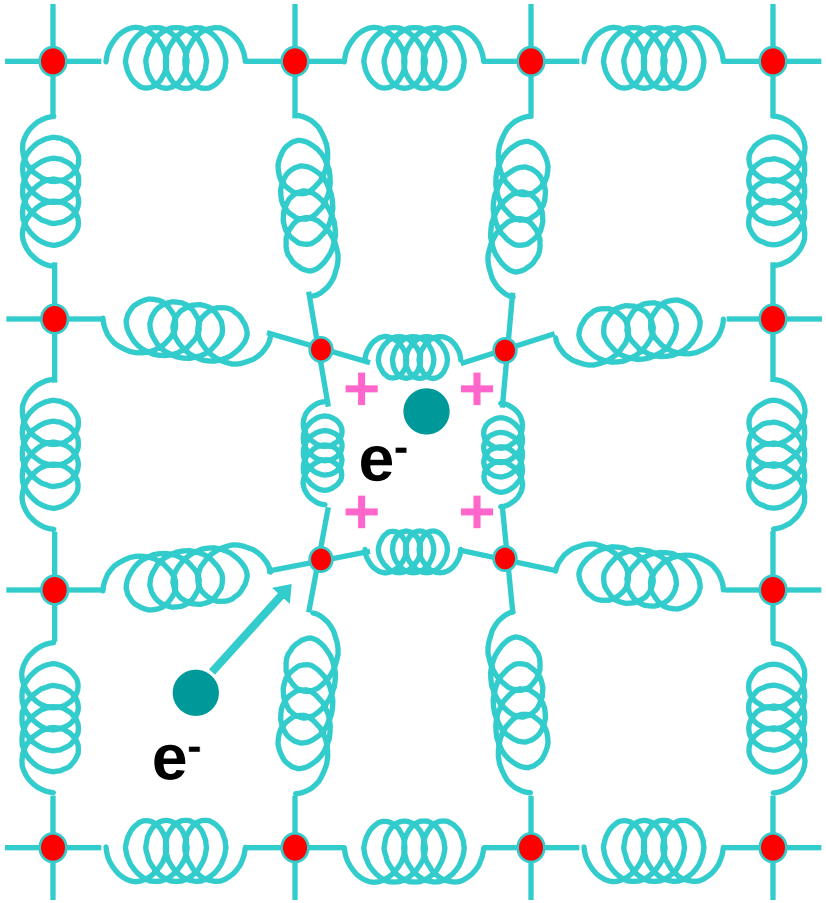
1973!

G^2 !

THE BORSCHT BELT BOYS



Physics of Superconductivity



Electrons Pair Off!

BCS Equation

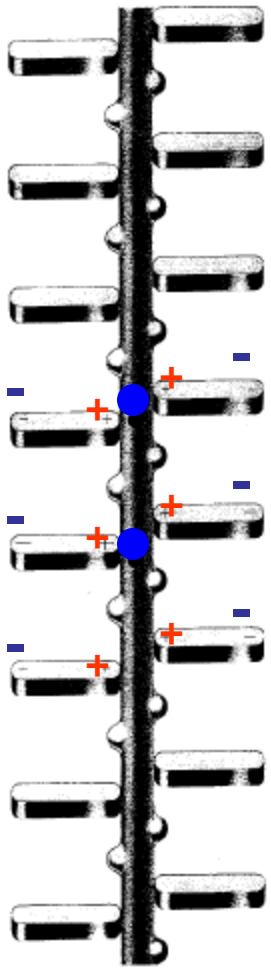
$$T_C = 1.14\,\theta_D \exp(-1/\lambda)$$

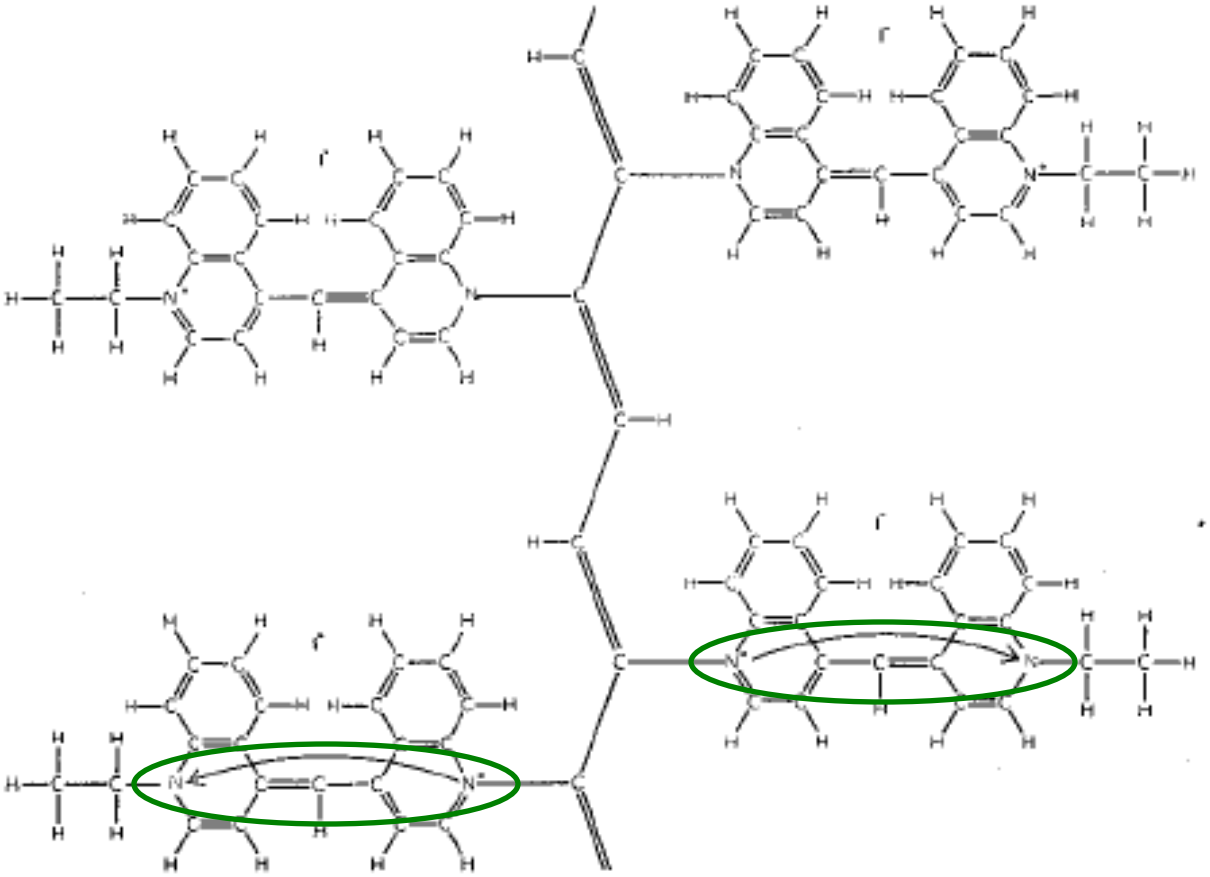
$$\theta_D = 275\,\mathrm{K},$$

$$\lambda = 0.28,$$

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

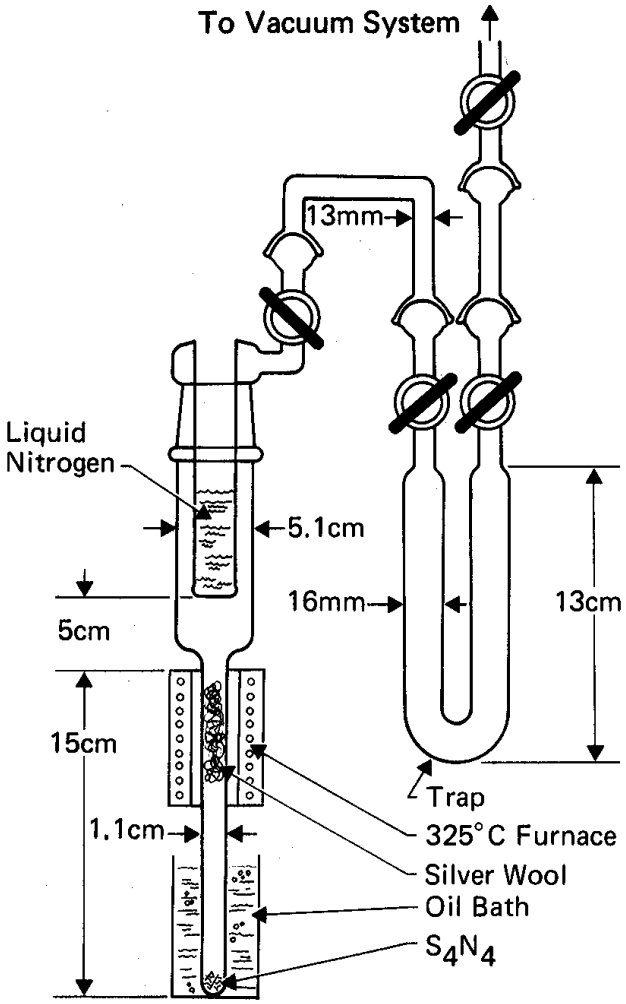
Little, 1963



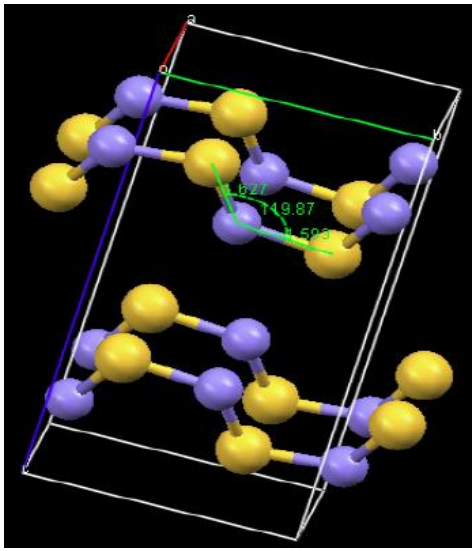


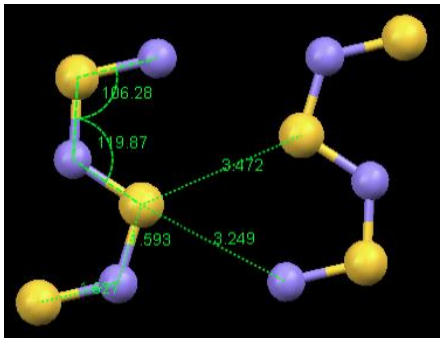
Diethyl-cyanine iodide

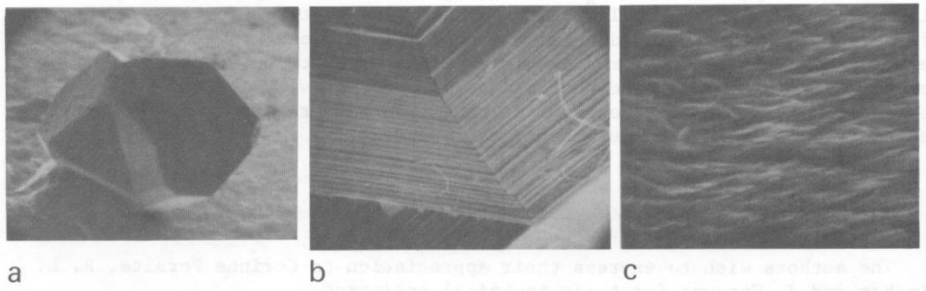
Polysulfur Nitride, (SN_x)



F. B. Burt (1910)
M. Boudeulle (1974)
G. B. Street (1974)







Conference on Organic Conductors and Semiconductors, Siófok, Hungary 1976

ELECTRONIC STRUCTURE AND OPTICAL PROPERTIES OF POLYSULFUR NITRIDE, $(SN)_x$

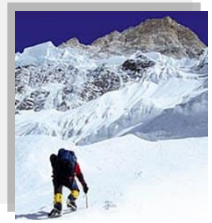
P.M. GRANT, W.E. RUDGE and I.B. ORTENBURGER

IBM Research Laboratory San Jose, California 95193, USA

Two-Band Semimetal

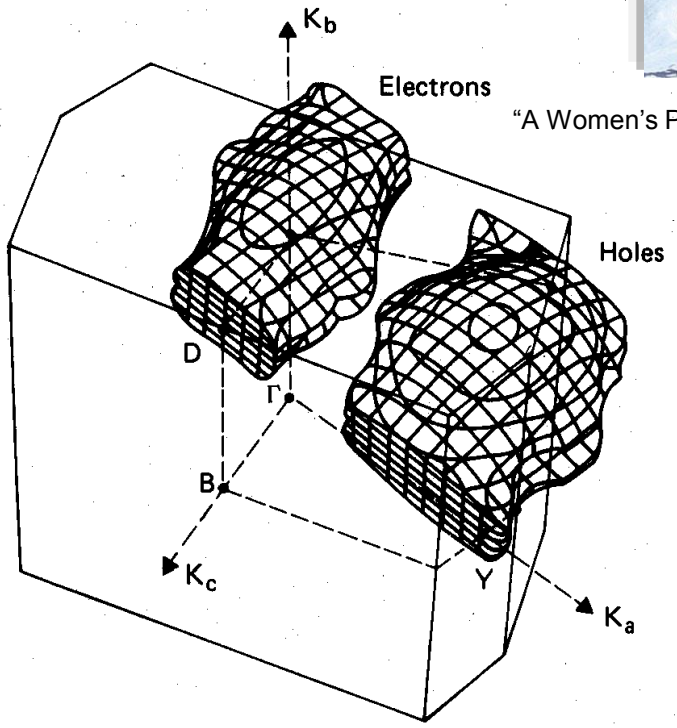
MgB_2 ?
Fe-Pnictides ?

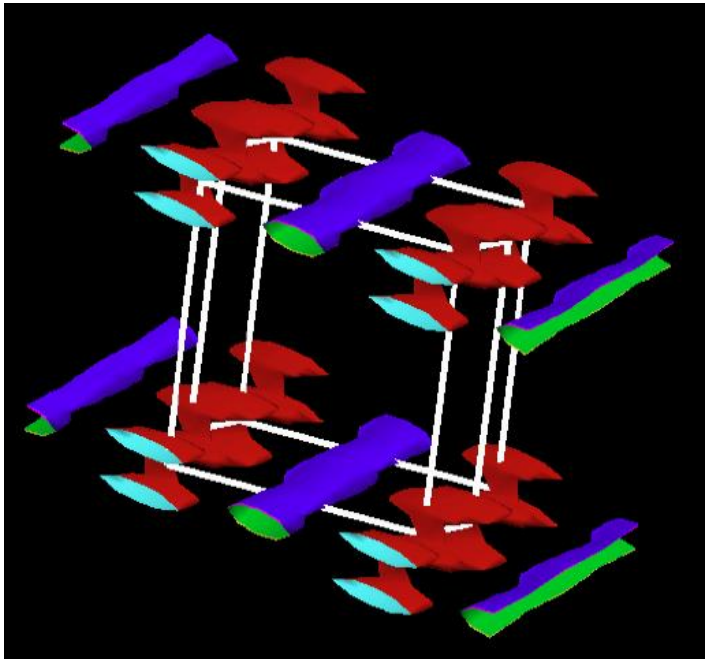
OPW, 1975-6



"A Women's Place is on Top"

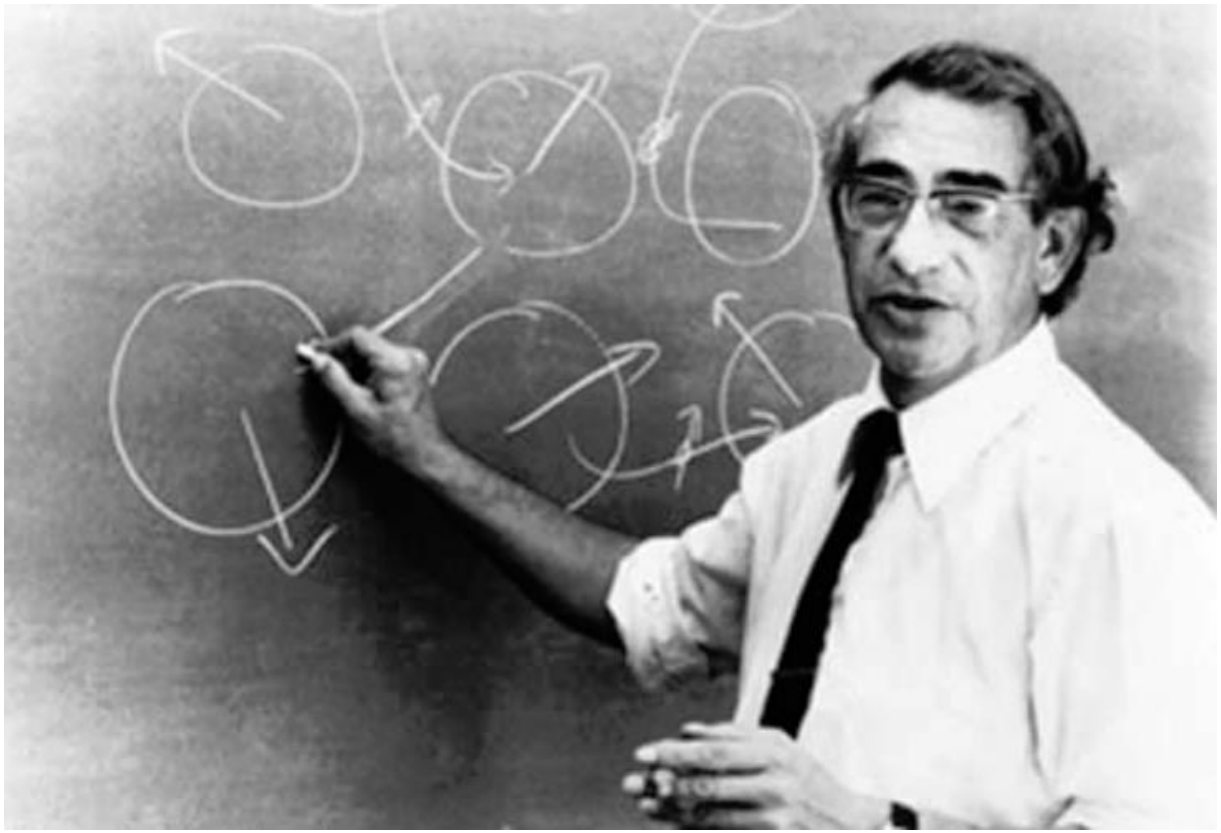
Quantum-Espresso, 2009






D10
D12

John Hubbard (1931-1980)



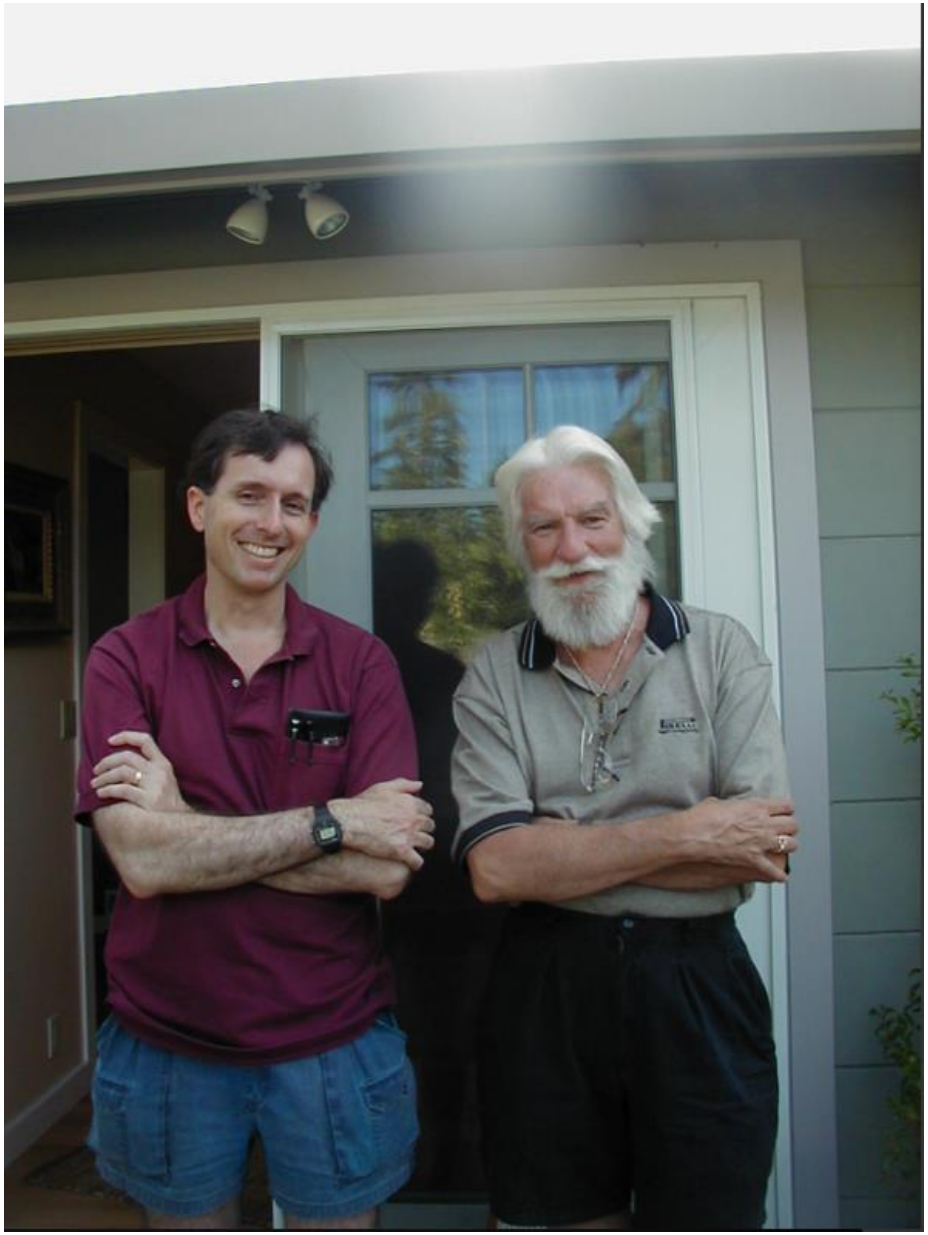
Famous for the basic theory of strongly correlated electron systems, e.g., NiO

In 1977, collaborated with P. M. Grant on the exact and unique solution of the non-linear extended Helmholtz equation elucidating the “current focusing” phenomenon underlying “resistive ribbon” printing (*IBM Confidential*)

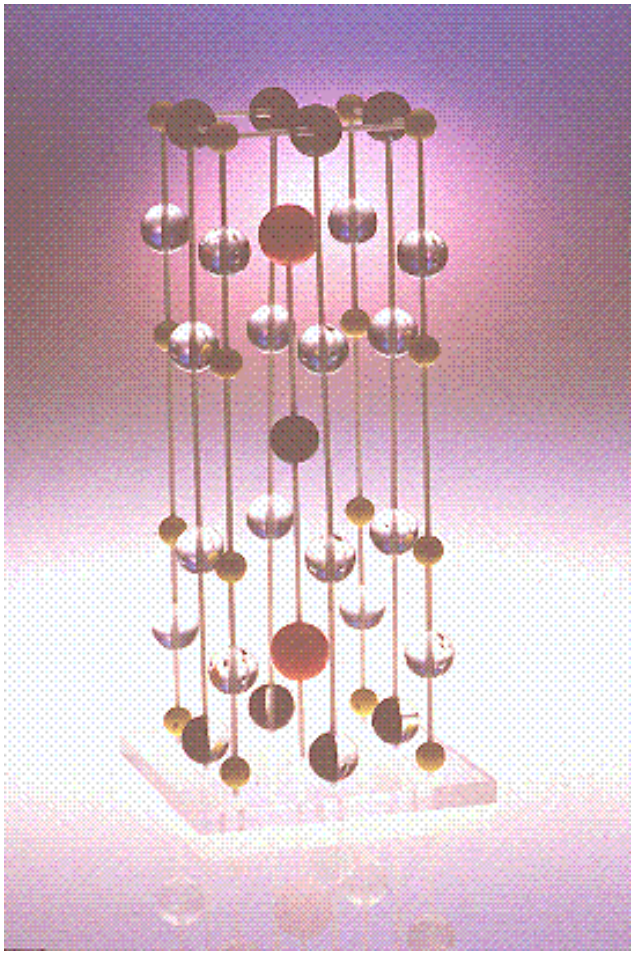
1986 – 87

High Temperature Superconductivity Discovered at IBM

The Almaden 1-2-3 Story: 1986-89



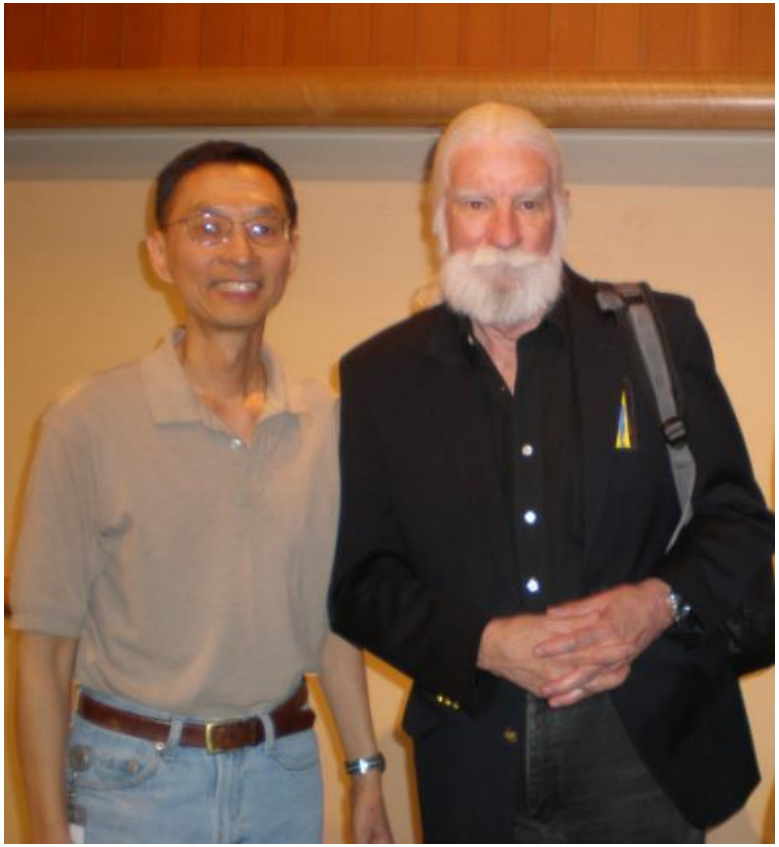
2 March 1987
"1-2-3"



Physicists' Night Out!

Band of Brothers (and a Sister!)

http://www.w2agz.com/The%20Picture%20Story.htm



The Levitators

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.

"The Great Communicator"
June, 1987

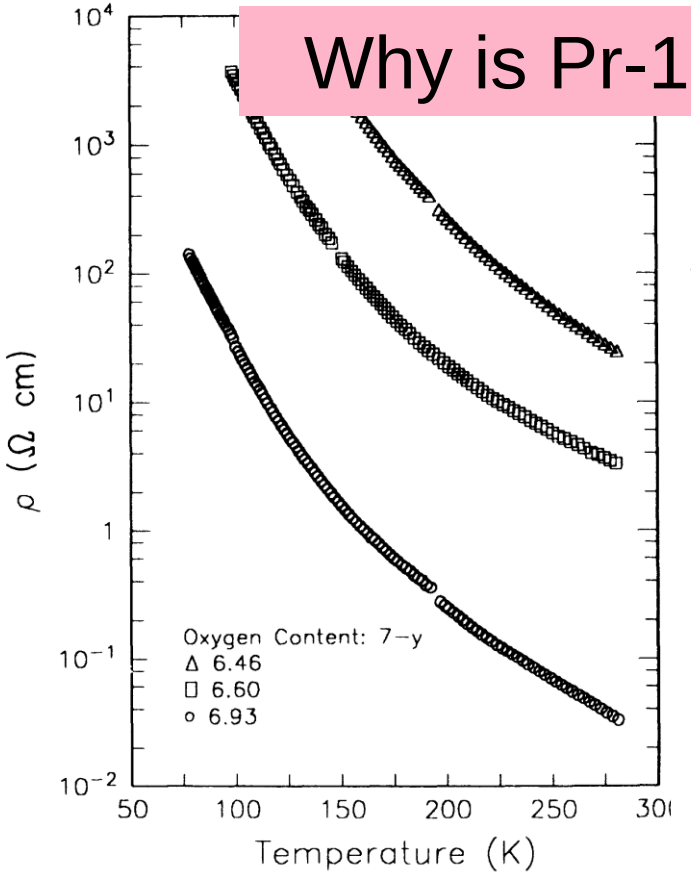
- Heidi Grant's 8th grade science project April, 1987 (New Scientist)
- Distributed to members of US Congress (at their request)
- 35,000 copies distributed to high schools worldwide by ICTP-Trieste

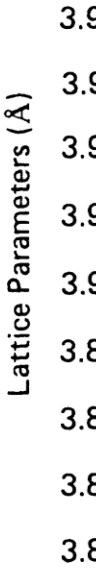
The Prasec

Role of oxygen in $PrBa_2Cu_3O_7$

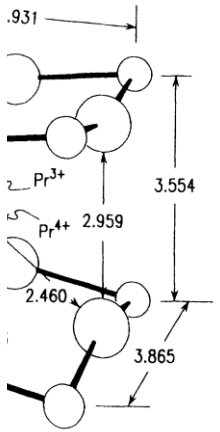
M. E. López-Morales,*
Instituto de Investigaciones en M

Why is Pr-123





It takes two to Tango



ITSC?

Selected Patents & Patent Publications

- Thin Film Magnetoresistance Sensor (*Clarkson Senior Thesis, 1959*)
- Interactive Graphics Program (*1970*)
- Isostructural Organic Junctions (*1977*)
- Method & Means for Calculation of Hypergeometric Functions on Parallel Processors (*1980*)
- Additives for Carbon-Loaded Polymers (*1984*)
- Preparation & Processing of High Temperature Superconductors (*1987*)
- Preparation of Electron High Temperature Superconductors (*1991*)

Selected PRLs

- Non-direct Processes and Optical Properties of Metals (*1967*)
- Temperature Dependence of the Near-Infrared Optical Properties of TCNQ (*1973*)
- Low-Temperature Specific Heat of (SN)x (*1974*)
- *Optical Properties of Polymeric (SN)x (*1975*)
- *OPW Band Structure of (SN)x (*1975*)
- *XPS Determination of the Valence Band Structure of (SN)x (*1975*)
- Properties of Brominated (SN)x (*1977*)
- Broken-Symmetry Band Structure of (TMTSF)2-X (*1983*)
- Evidence for Superconductivity in La2CuO4 (*1987*)

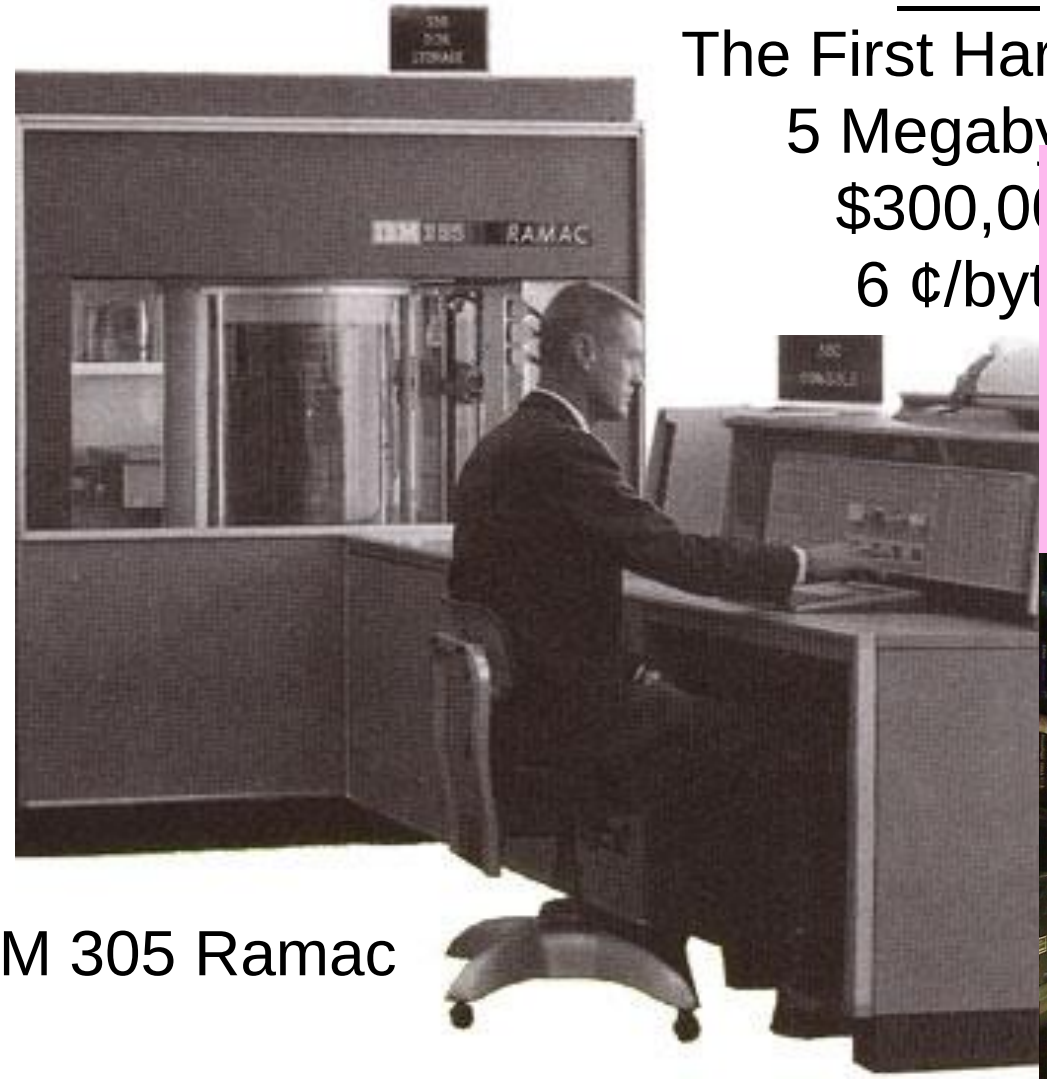
**** All in one month!***

EPRI

Next In Her Shoes

- Mary Ann Whalen Grant
  - CYO BB Champ, 1921
  - NYS Bowling Champ, 1939
  - Women's Baseball, '33-'47
  - Outstanding Skier & Golfer
  - Central Hudson Gas & Electric, 1923-1958
    - From teenage stenographer
    - To Admin of the CEO

From this:...faster, smaller, cooler…and cheaper!



1956

The First Hard Drive

5 Megabytes

$300,0

6 ¢/byt

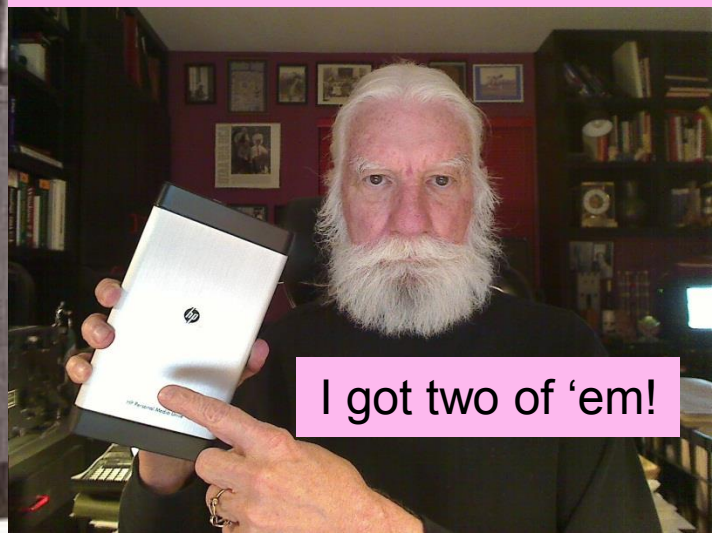
2011 (+55)

HP Personal Media

2 Terabytes

$100

5 nano-¢/byte



Devin Joan Grant
"Famous-to-be" 12-year-old
Grandaughter
of Paul Michael Grant

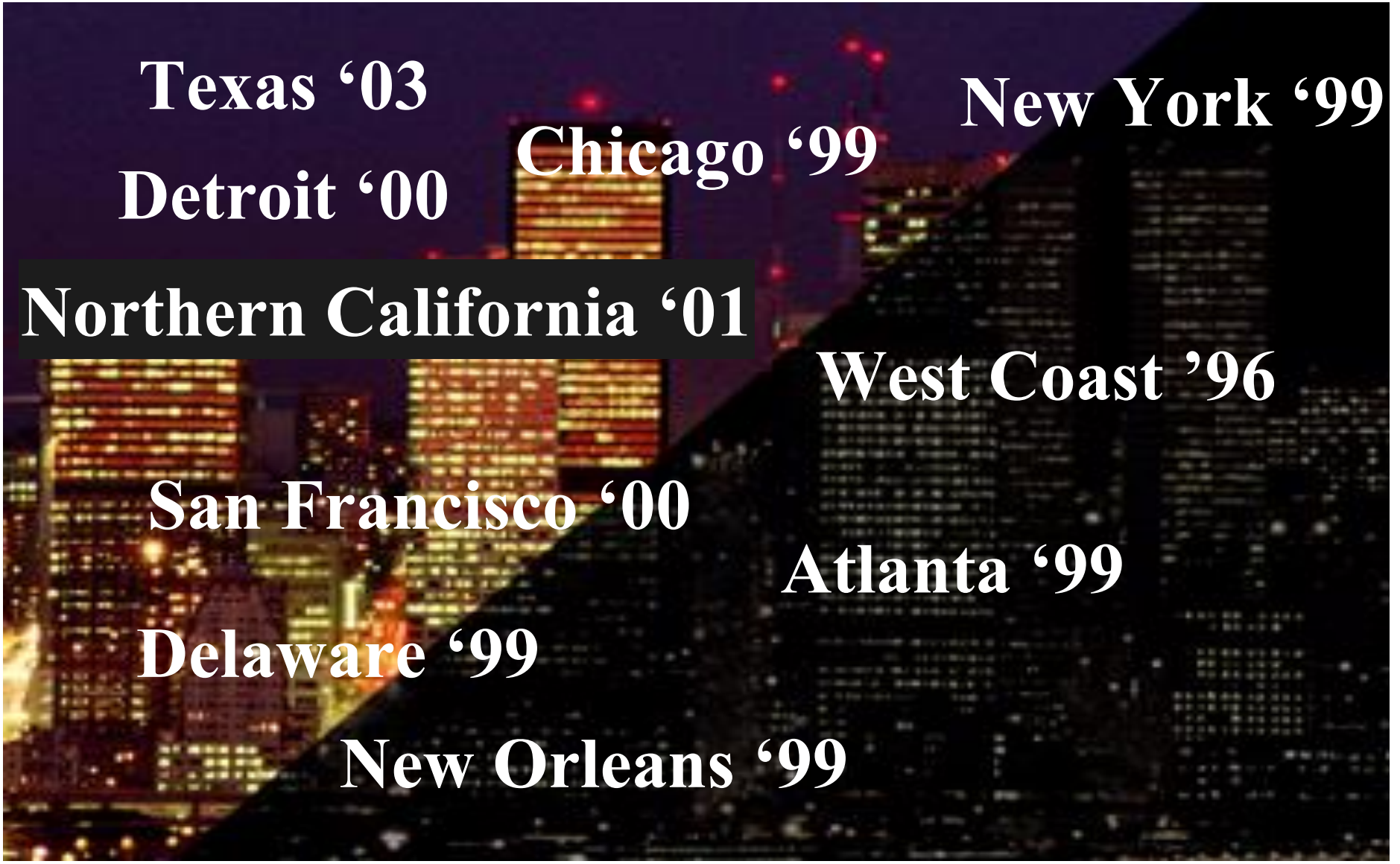
"Harvard" Entrance Exam:

1) **How many 1950 IBM punched cards does it take to...**
2) **Fill up a 32 gig "idiot"Phone?**
3) **???**
4) **A stack about 30 miles high!**

Talk about room at the bottom!
Thanks, Dick F. !

To this…

…and this…


Texas ‘03
New York ‘99
Chicago ‘99
Detroit ‘00
Northern California ‘01
West Coast ’96
San Francisco ‘00
Atlanta ‘99
Delaware ‘99
New Orleans ‘99

…and this!

PUC orders PG&E to let customers opt out of SmartMeter program

The PUC order is a stunning turnabout on a technology that many consider a key to managing energy use in the future. Utilities around the country have installed the electronic meters -- which can be monitored and adjusted wirelessly -- with little incident. But in Northern California, angry residents have expressed concerns that the meters can lead to overbilling and cause health problems, and PG&E has struggled to counter the bad publicity.

Bob Park!
Where are you when we need you!

…and…Finally This!

AP/Kyodo News

Blast at Japan nuke plant; thousands missing

Spraying water to cool stressed reactor…Sure. Duh! It's a gas/petrol storage port!

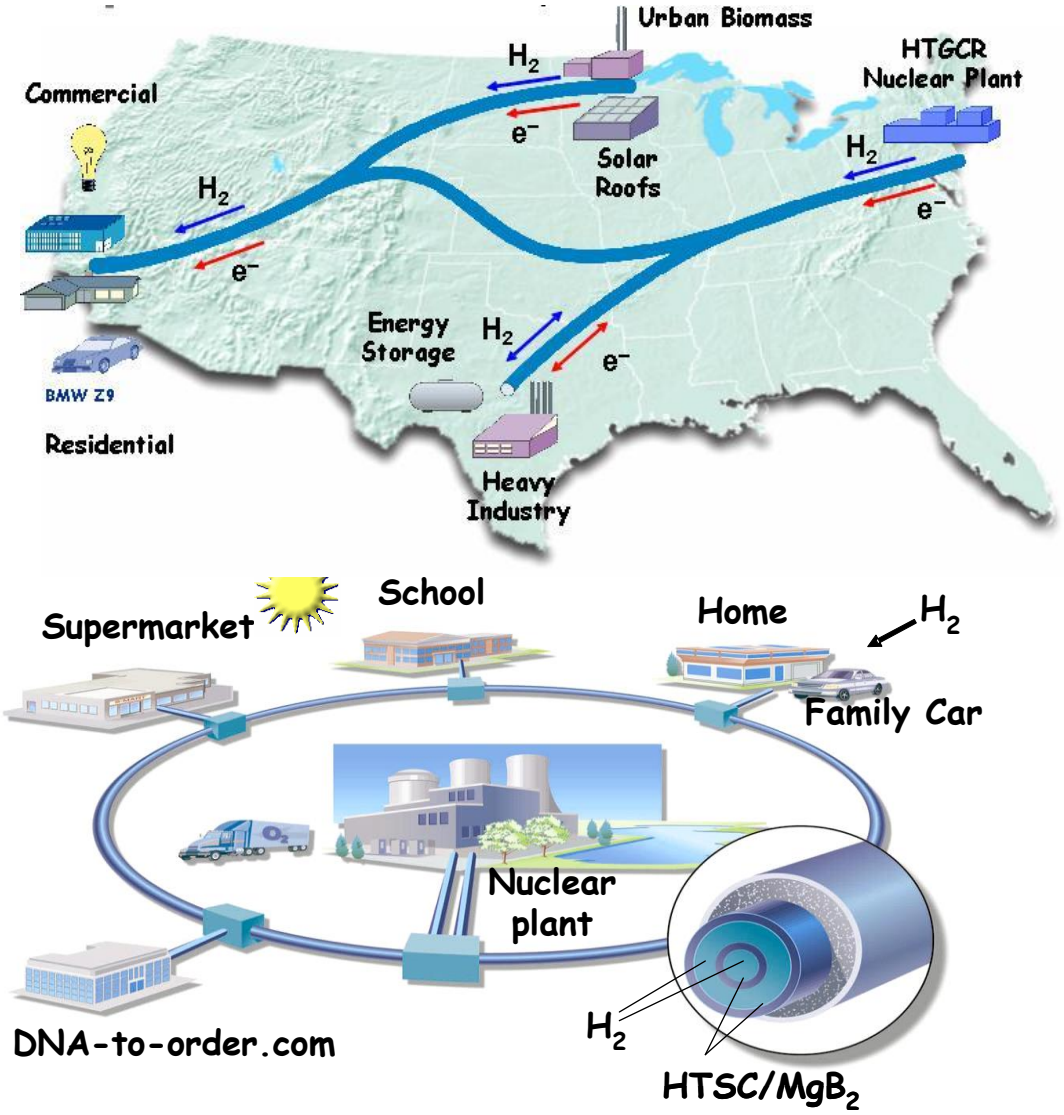
Pirell

The Energy Enterprise…

- When I retired from IBM and went to EPRI, I underwent a traumatic revelation from a culture where:
  - If you made something:
    - Smaller, cheaper, & which ran faster and cooler,
    - You WON in the marketplace!
  - To one where science and technology is at best only 50% of the equation, the rest dominated by politics and societal perception (e.g., policies and legislation motivated by uncertainties underlying the physics of the climate).

My Virtual Grandfather (@ 94)

SuperCities & SuperGrids



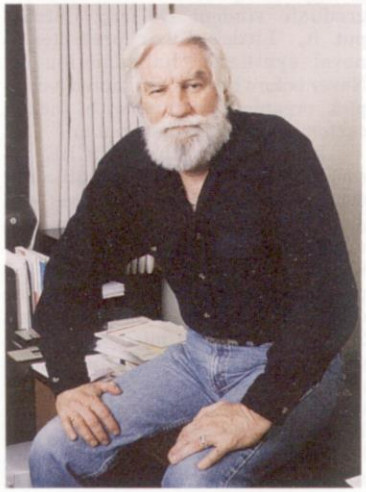
- Nuclear Power can generate both electricity and hydrogen – "Hydricity"
- Hydricity can be distributed in underground pipelines like natural gas
- The infrastructure can take the form of a **SuperGrid**
- …or a **SuperCity**

Scientific American
July, 2006

The Future?

Physics Today, November 1998

PHYSICS TOMORROW: ESSAY CONTEST WINNER



RESEARCHERS FIND EXTRAORDINARILY HIGH TEMPERATURE SUPERCONDUCTIVITY IN BIO-INSPIRED NANOPOLYMER

Paul M. Grant

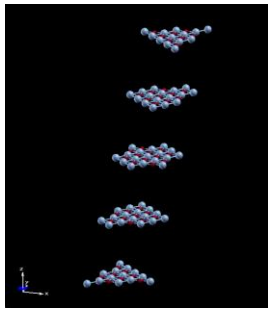
May 2028

700 K !

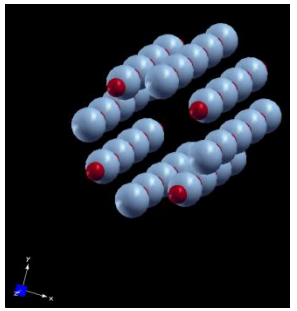
May, **2028**

W2AGZ & Beyond

A DFT (LDA+U) Study of the Electronic Properties of Square-Planar Coordinated Copper Monoxide Structures



(does the secret to high-Tc lie within?)



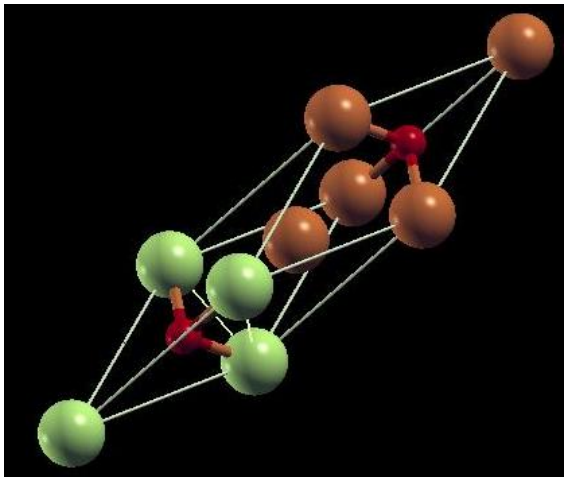
...Back to the Future...

My IBM Day Job of the 60s and 70s… Electronic Structure Calculations

What's New?

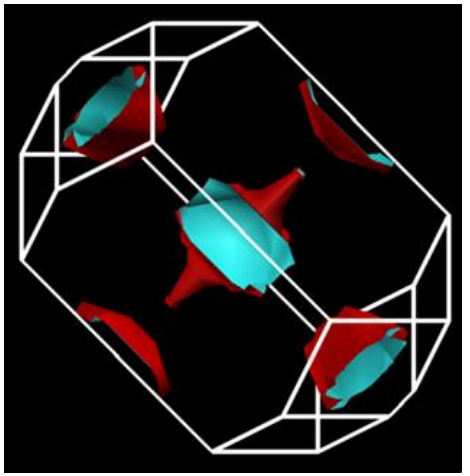
- Really cheap gaming hardware with extended cpu, core and RAM hardware
- Free high end Linux platforms
- Free high performance DFT software

A DFT Study of Tetragonal Rocksalt Proxy Copper Monochalcogenide Structures: -- Implications for Possible High-Tc Superconductivity --



Paul M. Grant
W2AGZ Technologies

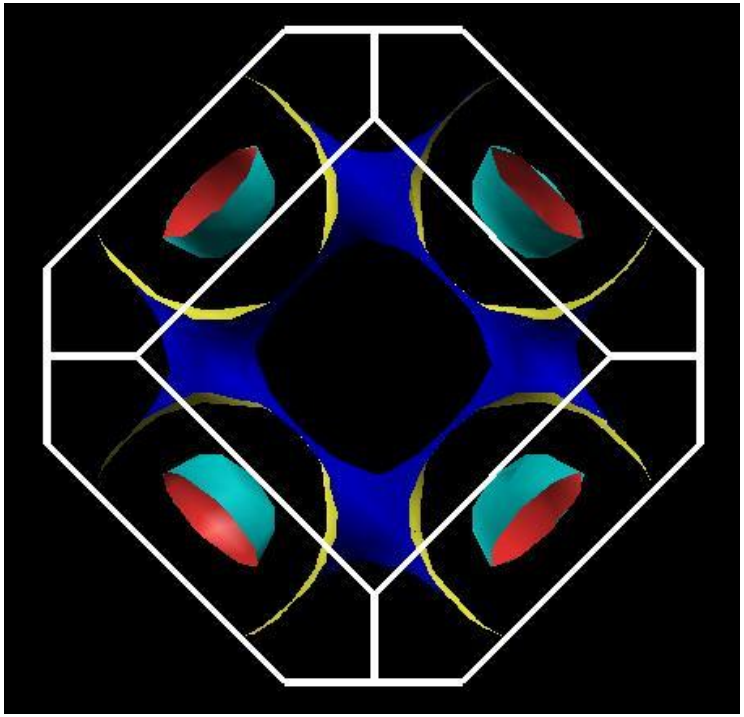
Robert H. Hammond
Stanford University



Be Sure to Stay Tuned!
Calculations Underway

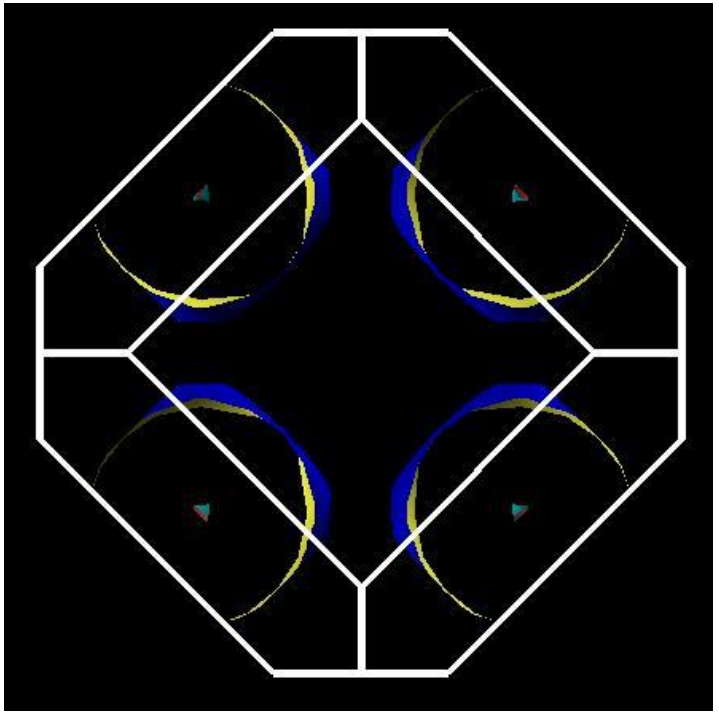
Here's Where We Are So Far

q = 0.15 |e|/CuO (holes)



≈ 43 °K

q = -0.15 |e|/CuO (electrons)



≈ 25 °K

Apply DFT to obtain $g^{\mathbf{q}_\nu,mn}_{\mathbf{k}+\mathbf{q},\mathbf{k}}$ between electrons and phonons, followed by application of the Eliashberg-McMillan-Allen-Dynes formalism to find Tc:

Opportunities to Exploit the Keystone XL Pipeline ROW for the Dual Transport of Chemical and Electrical Energy

Smart Grid

Fraternal Twins

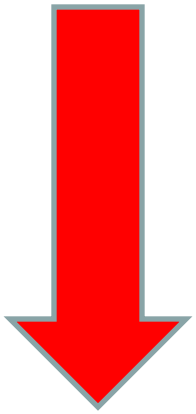
2013 P. M. Grant's Editorial in Smart Grid News

Selected Popular Articles (IBM, EPRI, W2AGZ)

- Do-it-yourself Superconductors (*New Scientist, 1987*)
- HTSC: Four Years Since Bednorz & Mueller (*Advanced Materials, 1990*)
- Another December Revolution? (*Nature, 1994*)
- Researchers Find Extraordinarily High-Tc in Bio-Inspired Nanopolymer (*Physics Today, 1998 (or 2028?)*)
- Is a Bell Tolling for Bell Labs? (*Nature, 2002*)
- Hydrogen Lifts Off – With a Heavy Load (*Nature, 2003*)
- A Worthy Hero for Boys and Men (*San Jose Mercury News, 1999*)

The Take-Home...

Wisdom gained (*so far*!) from a lifetime career in Industrial and Applied Physics...



“You can’t always get what you want…”

“…you get what you need!”