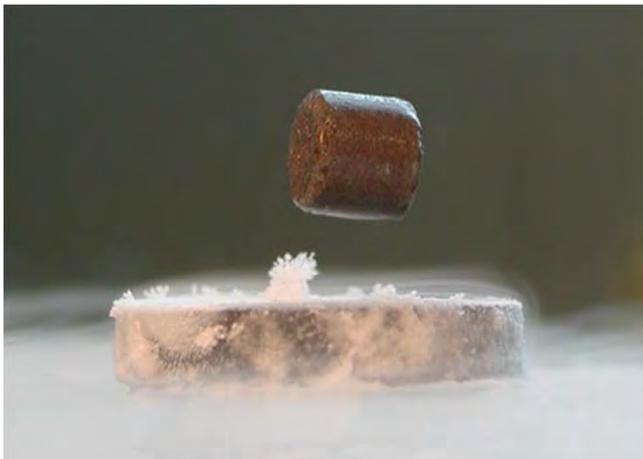


# Supraconductivité: La magie du monde quantique devant vos yeux.

André-Marie Tremblay

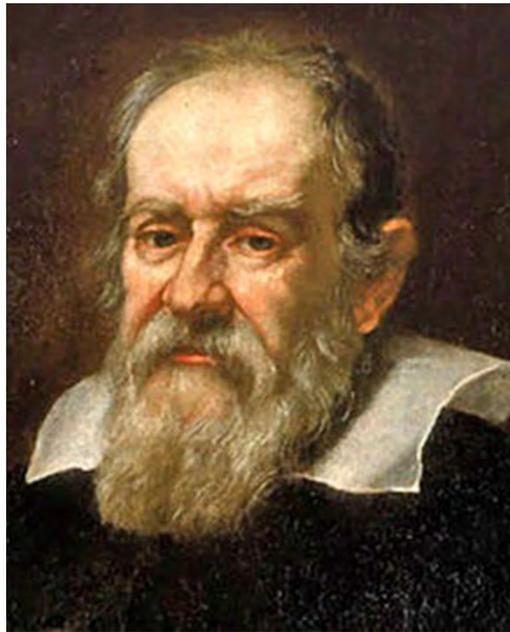


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# Galileo Galilei



1564-1642



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# Richard Feynman



1918-1988



Quelle serait la phrase qui contiendrait le plus d'information dans le moins de mots?



# Atomes - température



# La course vers la température zéro



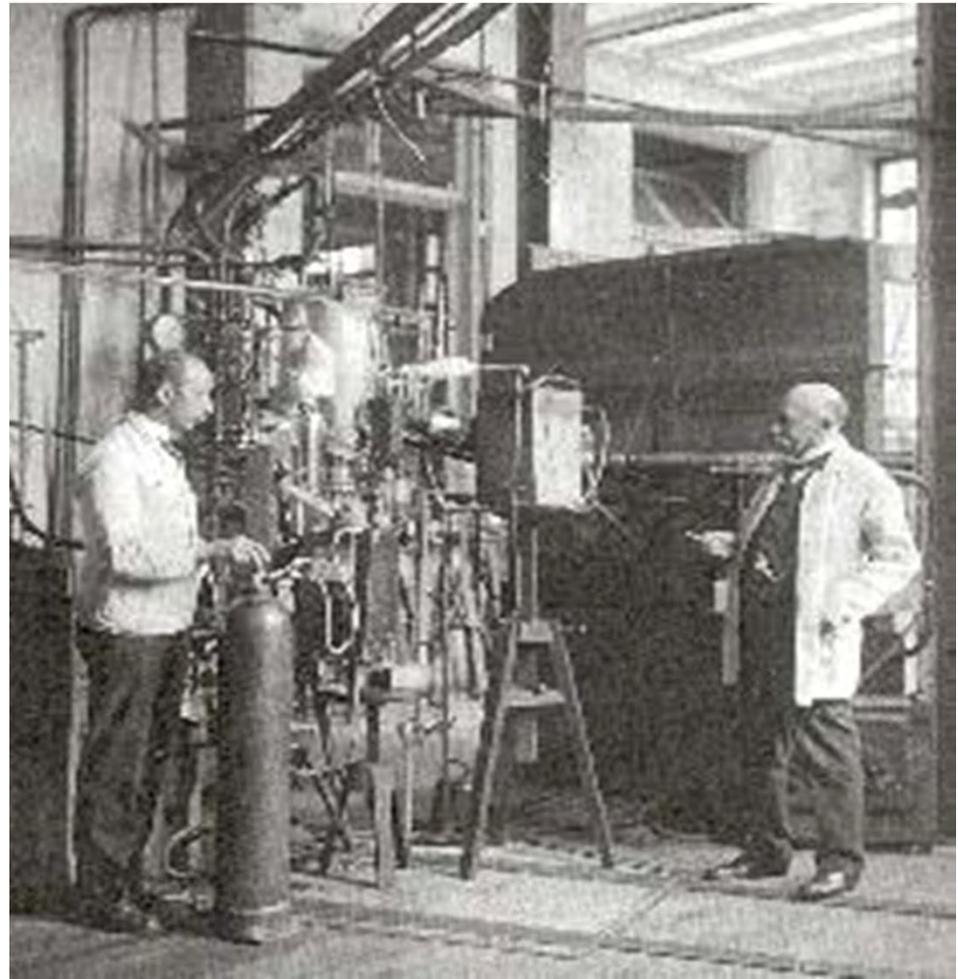
# Un pas important vers $T = 0$

- Heike Kamerlingh Onnes  
(Leiden) (1853/1926)



# Les débuts du travail d'équipe en recherche

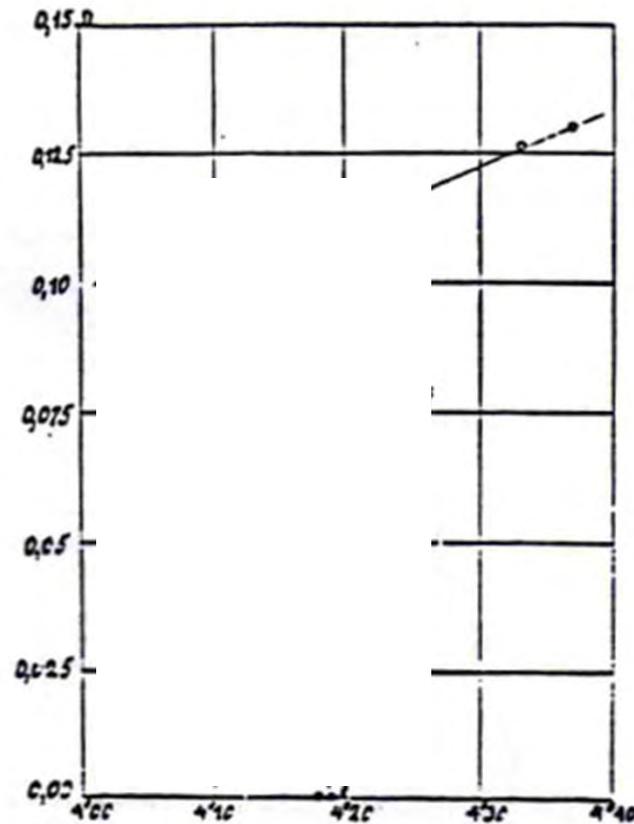
J.G.. Flim, cryogénie  
G. Dorsma: thermométrie  
G. Holst: électronique  
Souffleur de verre



# Et alors?

- Qu'arrive-t-il à la résistance électrique?

8 avril 1911



# Congrès Solvay, 1911



GOLDSCHMIDT      PLANCK  
NERNST      BRILLOUIN

RUBENS      LINDEMANN      HASENOHRL  
SOMMERFELD      M. DE BROGLIE      HOSTELET

SOLVAY      KNUDSEN      HERZEN      JEANS      RUTHERFORD  
LORENTZ      WARBURG      WIEN

PERRIN      Madame CURIE      POINCARÉ      KAMERLINGH ONNES      EINSTEIN      LANGEVIN      DE BROOKE

## Et le gagnant est...

- Heike Kamerlingh Onnes  
(Leiden) (1853/1926)



<http://www.nobel.se>

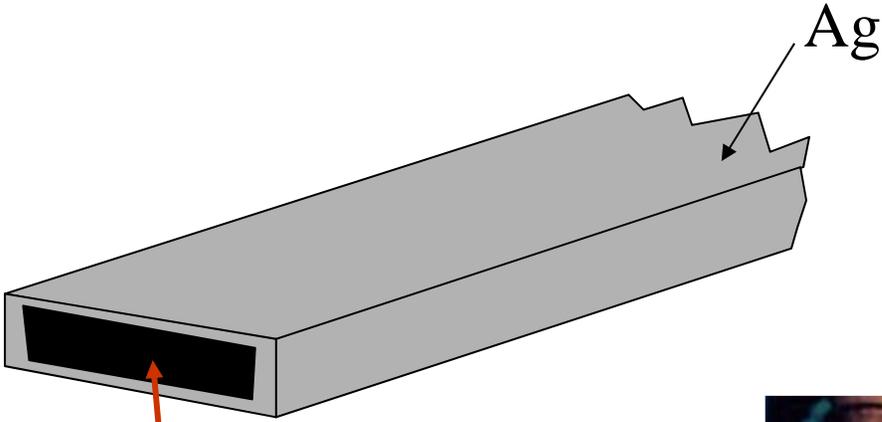
**1913: Prix Nobel de physique**

*Au Professeur H. Kamerlingh Onnes de Leiden, pour ses expériences sur les propriétés de la matière à basse température qui ont conduit, concomitamment à la production de l'hélium liquide.*

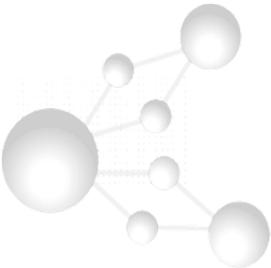
# Transmission de l'électricité



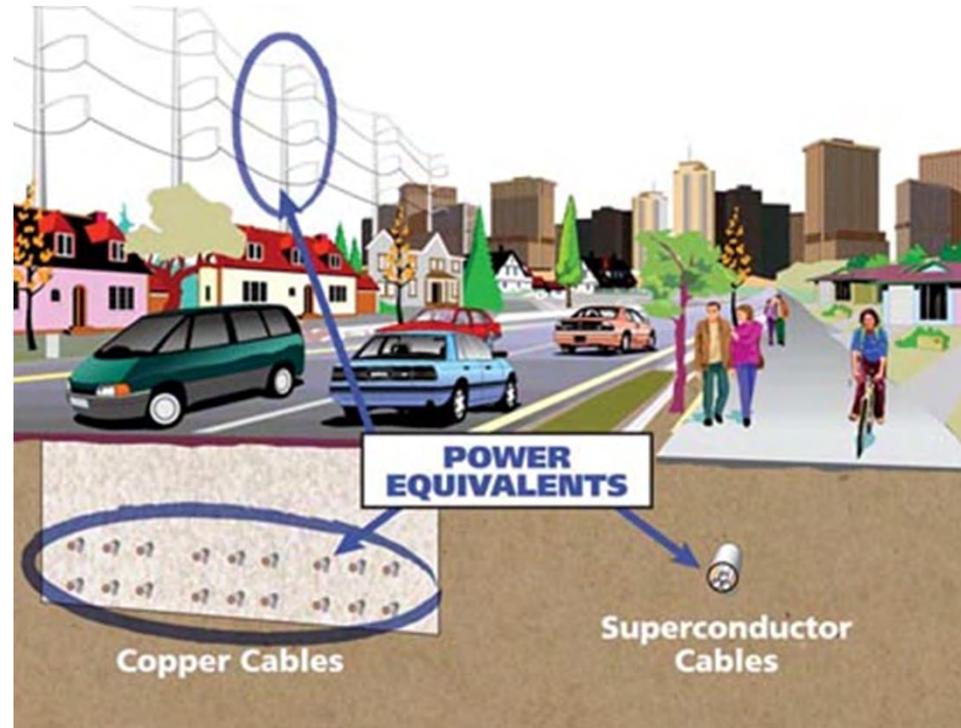
# Câbles



BiSrCaCuO



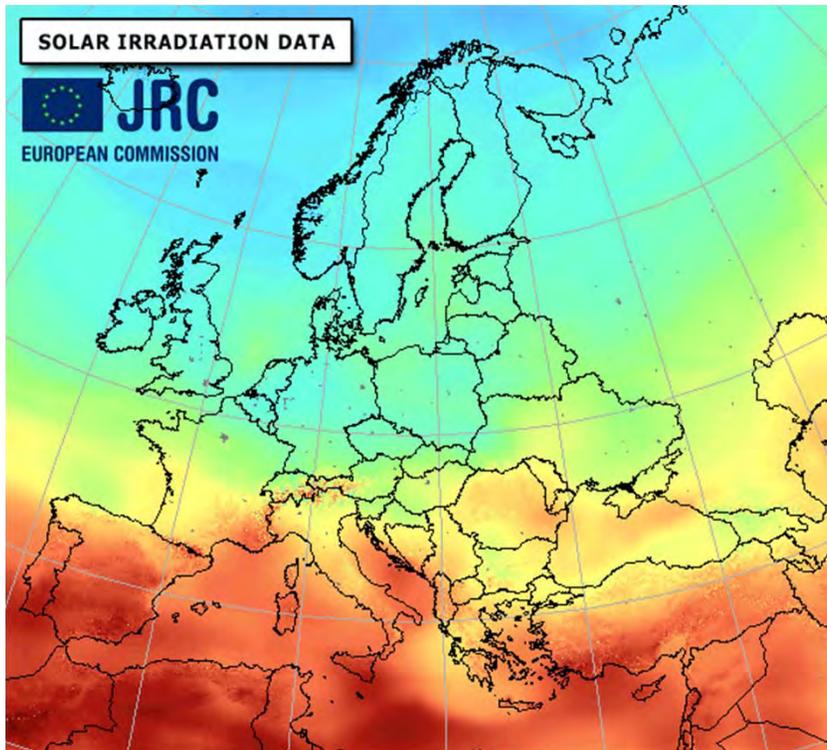
# 7 octobre 2010, American Superconductors



3,000 km de câbles pour la Corée du sud



# Production et besoin



Tourner en rond tout en faisant quelque chose d'utile



# André-Marie Ampère



1775 - 1836

# Le premier aimant supraconducteur



Martin

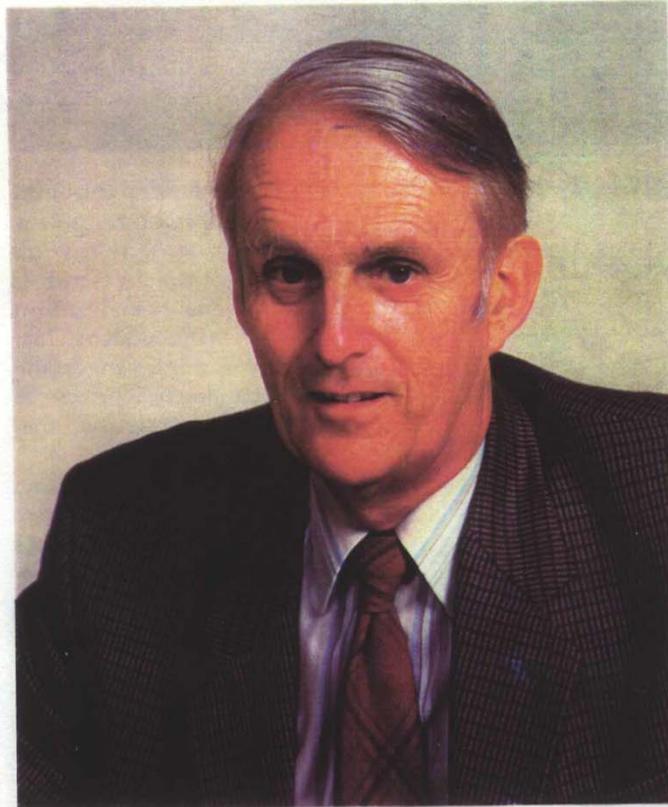
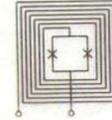
Wood, 1962



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# Supercurrents

*The Superconductivity Magazine*



Sir Martin Wood  
Founder, Oxford Instruments



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# Transport des personnes

# Maglev, aéroport de Shanghai



350 km/h (220 mph) en 2 minutes,  
Vitesse maximale 431 km/h (268 mph).  
Record 12 novembre 2006, 501 km/h (311 mph).



# Test, train à lévitation magnétique, Japan Rail



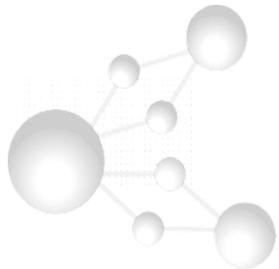
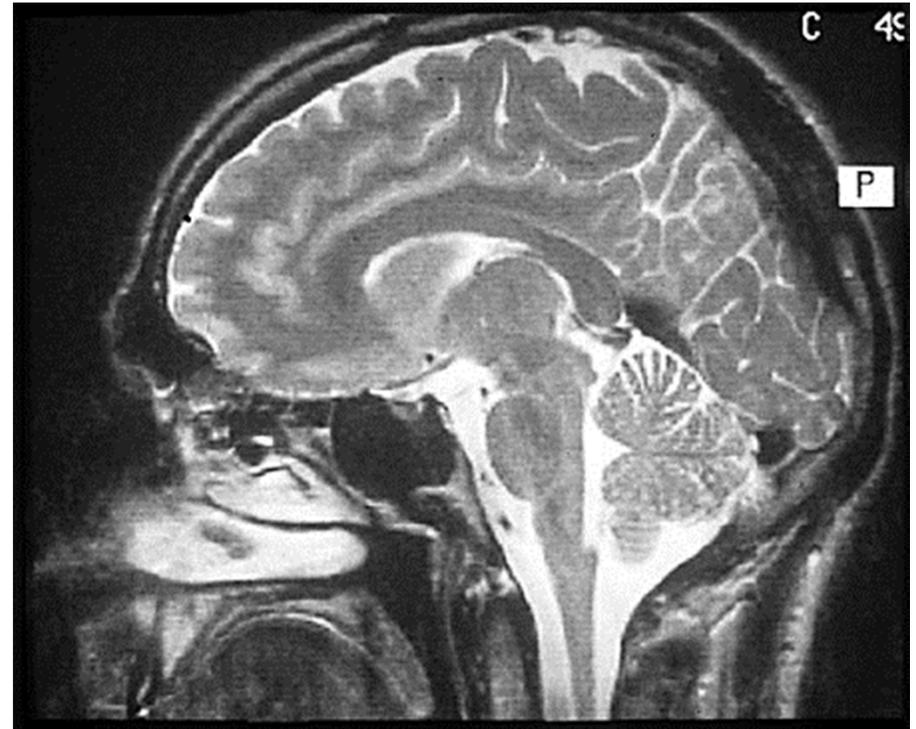
JR-MLX01 maglev train at [Yamanashi](#) test track



En médecine



# Imagerie par résonance magnétique



Et là où vous l'attendez le moins



# De retour à la lévitation

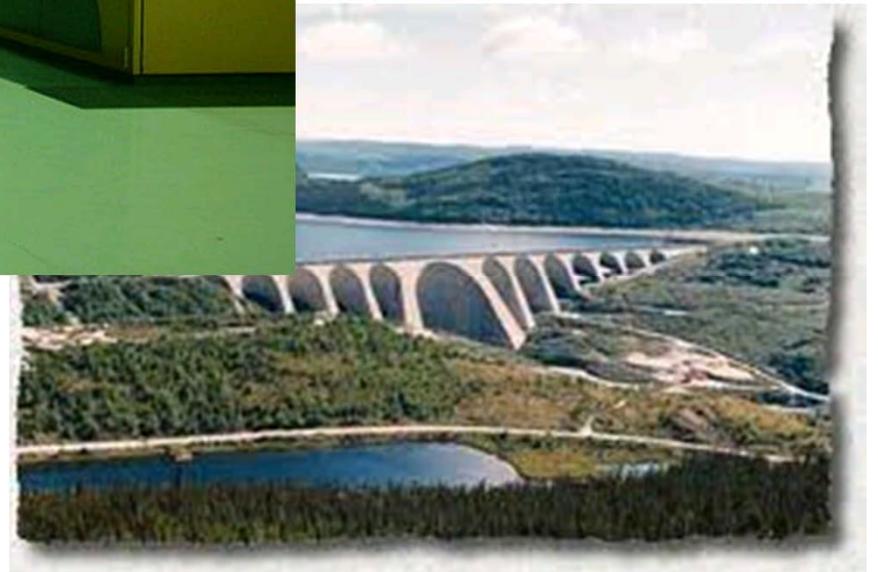


# Michael Faraday



1791-1867

# Induction

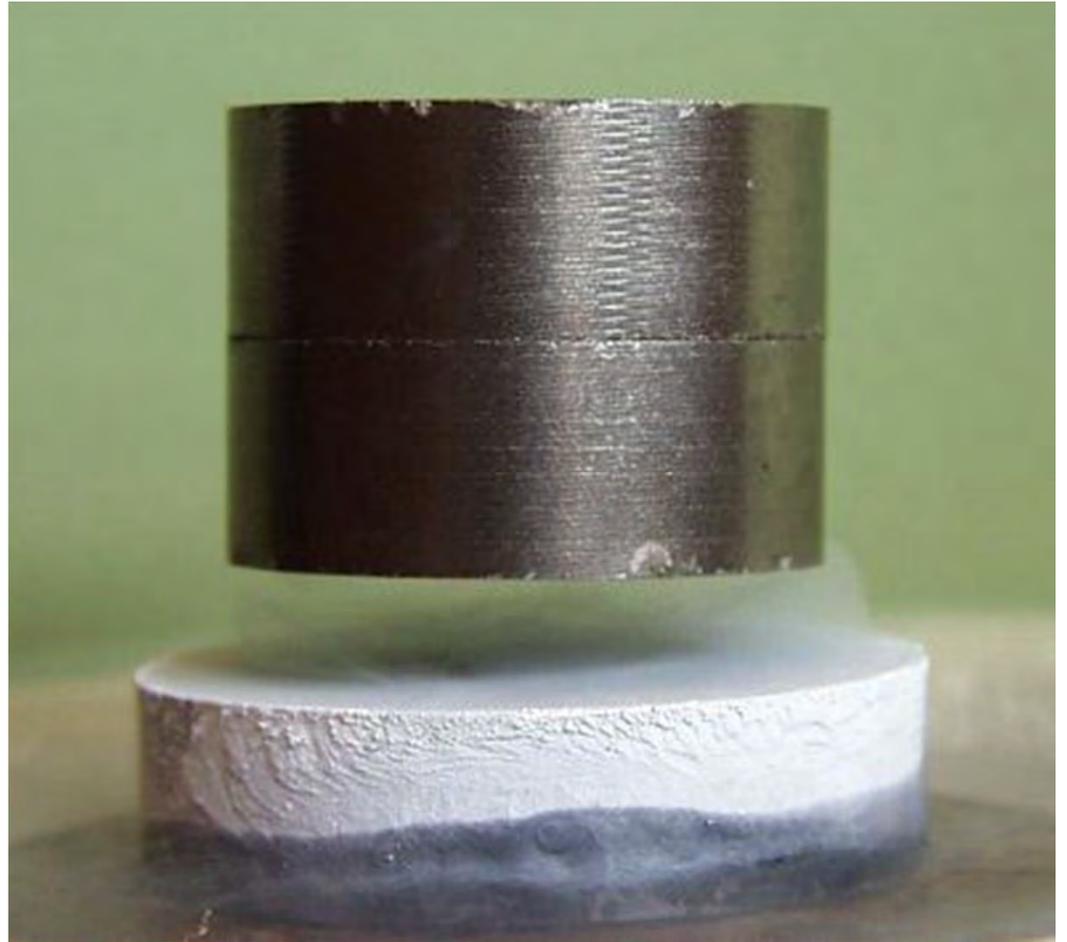




Walther Meissner  
(1882-1974)

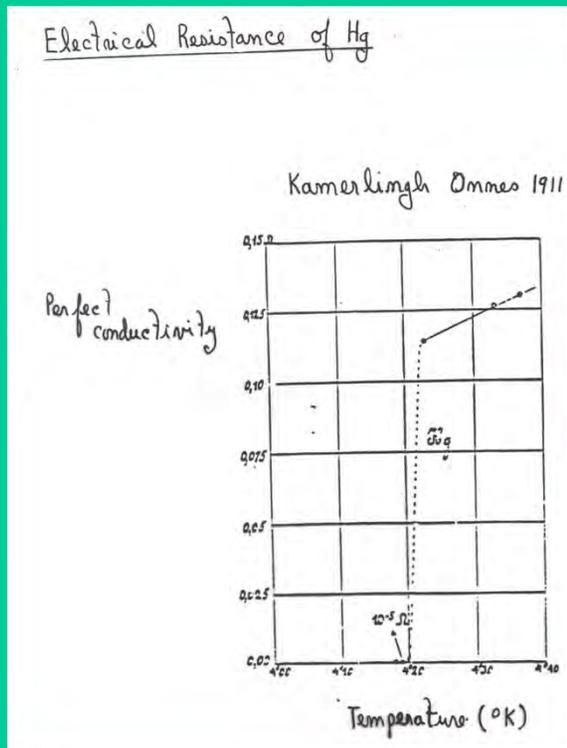


R. Ochsenfeld (1900-1992)

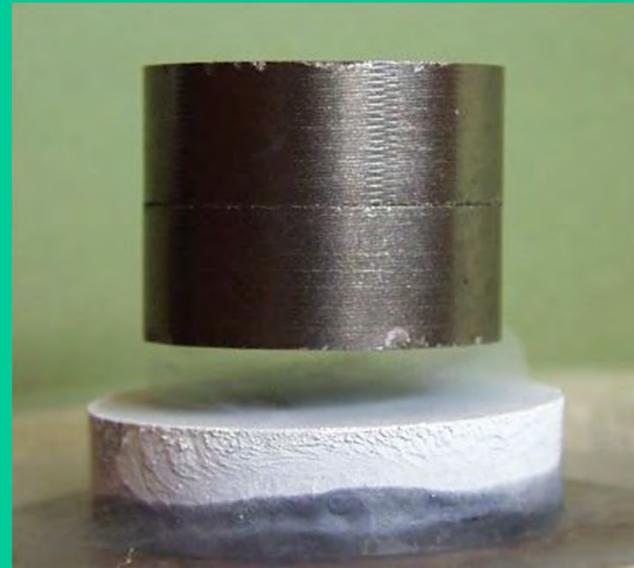


# Deux propriétés importantes

## 1. Zero resistance (if $\mathbf{B}=0$ )



## 2. Diamagnetism



# Comment explique-t-on la supraconductivité?



# Théorème de Bloch, 1930

- On peut prouver que toutes les théories de la supraconductivité sont fausses.
- Feynman: personne n'est assez brillant pour trouver la solution.

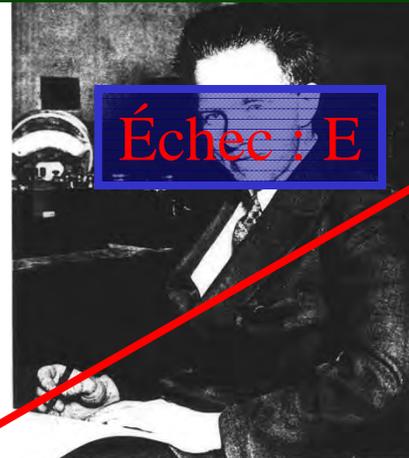


# Quelques essais infructueux



Échec : E

Feynman



Échec : E

Heisenberg

WERNER HEISENBERG (1901- ) introduced matrix mechanics, which, like the Sch

Bohr



Échec : E

NIELS BOHR (1885-1962) introduced the idea that the electron moved about the nucleus in well-defined orbits. This photograph was made in 1922, nine years after the publication of his paper

Einstein



Échec : E



# Une analogie

- Symétrie brisée
- Rigidité

# BCS 1957

## *Comportement quantique à l'échelle macroscopique*

Leon Cooper



Prix Nobel : 1972

John Bardeen\*

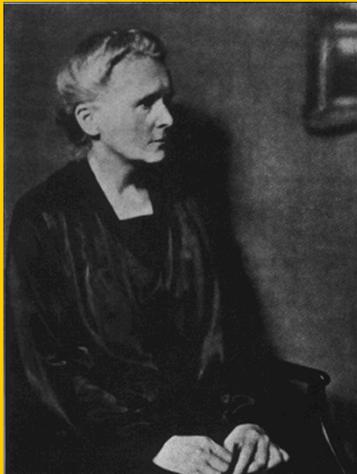
Robert Schrieffer

- John Bardeen :
- Le seul à avoir obtenu deux prix Nobel en physique!!!



## **Invention : TRANSISTOR!**

W. Shockley, J. Bardeen, W.H. Brattain



### **Marie Curie:**

1903 Physique with H.A. Becquerel

1911 Chimie (seule)



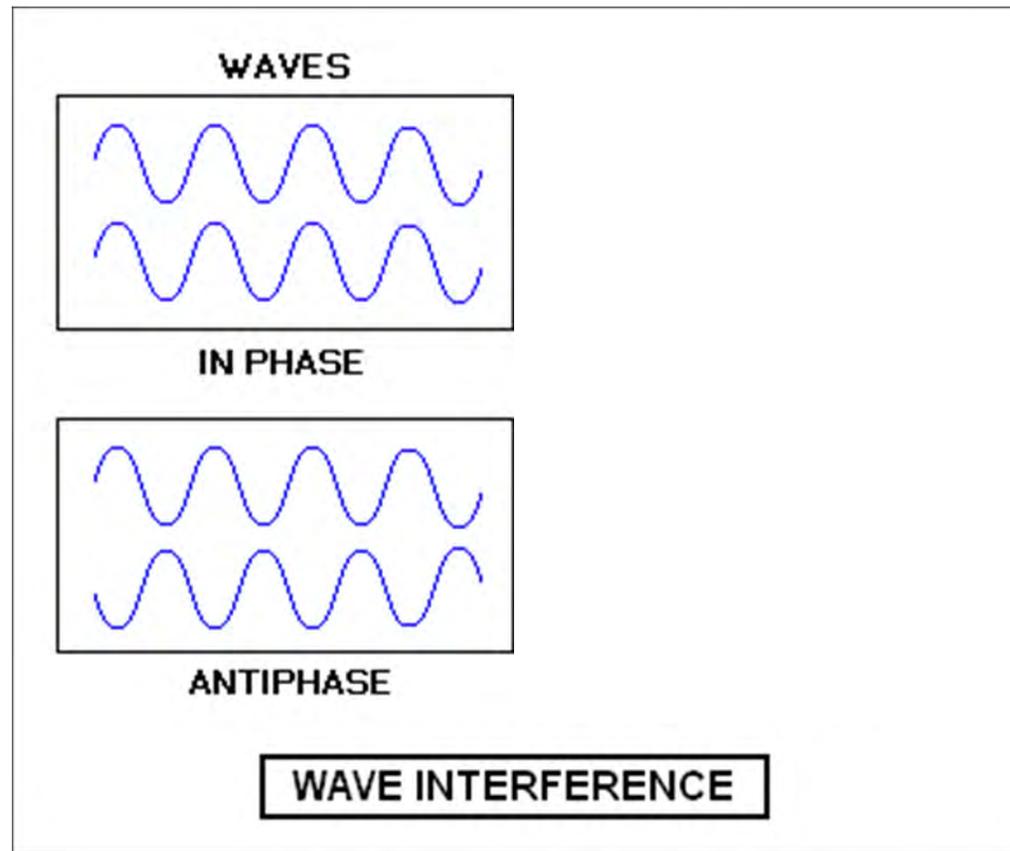
# Ce qui était connu

- La résistance s'annule
- L'effet Meissner
- Transparent aux microondes basse fréquence
- Effet isotopique

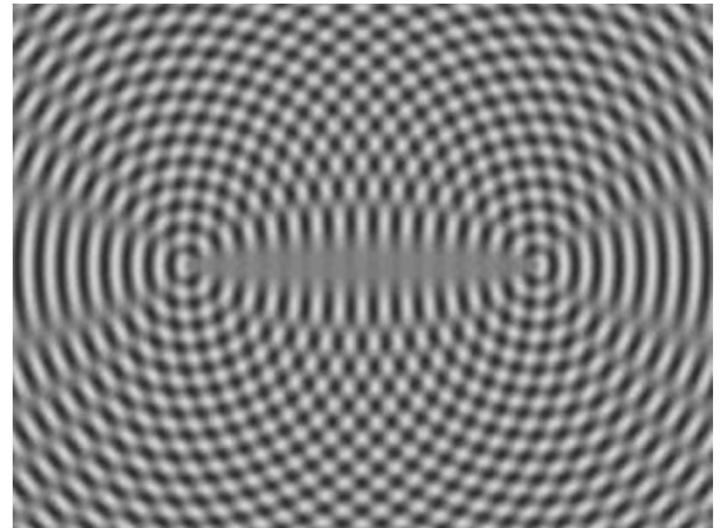


# Mécanisme d'attraction dans l'état métallique

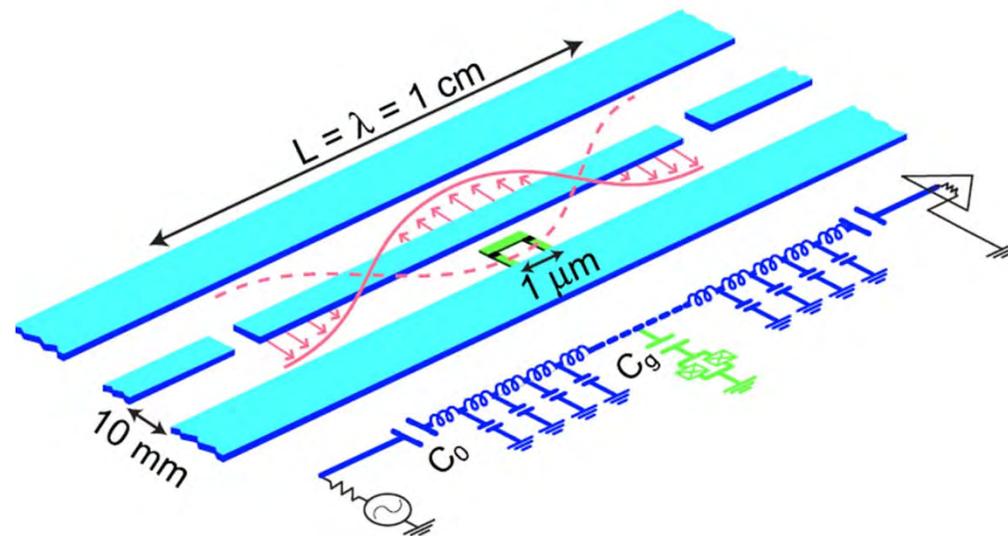
# Ondes



# Interférence



# L'ordinateur quantique



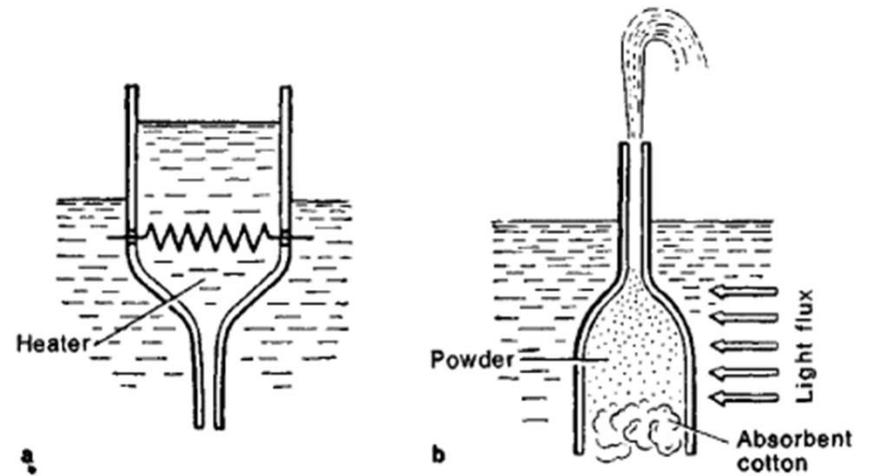
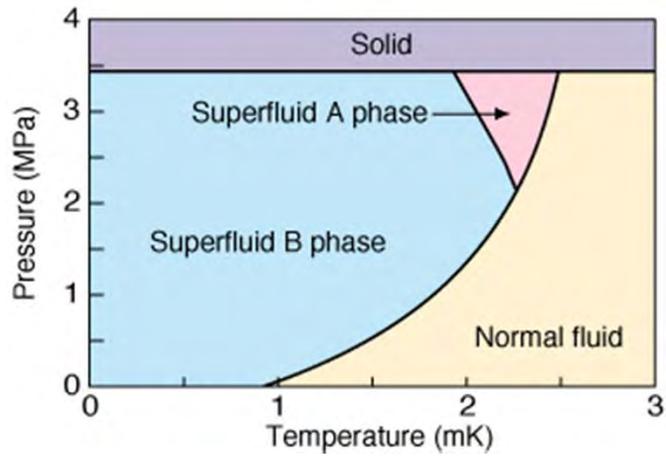
Alexandre Blais, et al. Phys. Rev. A **69**, 062320 (2004)



# La supraconductivité partout



# $^3\text{He}$ superfluid



# Le noyau des atomes (Rutherford 1911)

PHYSICAL REVIEW

VOLUME 110, NUMBER 4

MAY 15, 1958

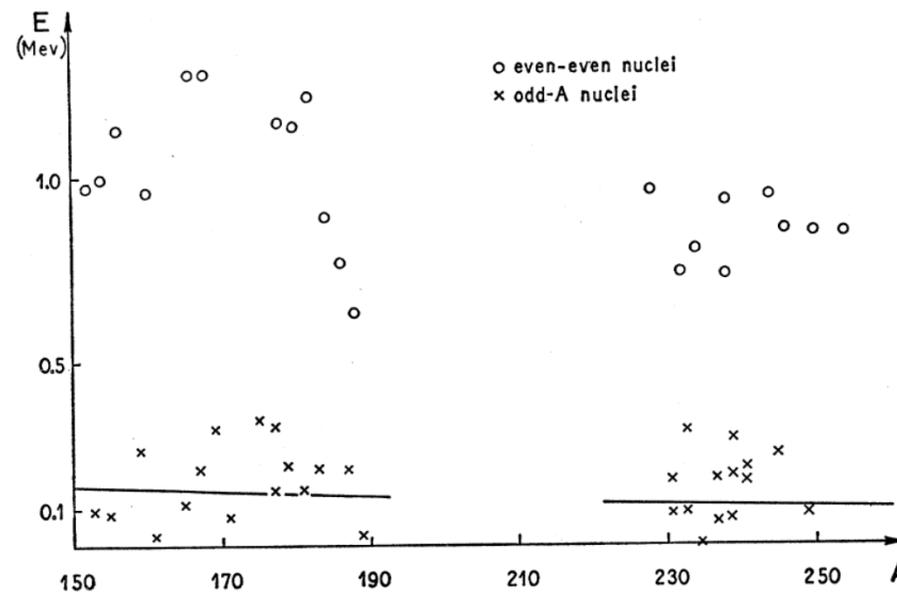
## Possible Analogy between the Excitation Spectra of Nuclei and Those of the Superconducting Metallic State

A. BOHR, B. R. MOTTELSON, AND D. PINES\*

*Institute for Theoretical Physics, University of Copenhagen, Copenhagen, Denmark, and Nordisk Institut for Teoretisk Atomfysik, Copenhagen, Denmark*

(Received January 7, 1958)

The evidence for an energy gap in the intrinsic excitation spectrum of nuclei is reviewed. A possible analogy between this effect and the energy gap observed in the electronic excitation of a superconducting metal is suggested.



# Les étoiles à neutron



La nébuleuse du crabe (4 juillet 1054) en bleu et blanc  
Credit & Copyright: Jay Gallagher (U. Wisc.), WIYN,  
AURA, NOAO, NSF

# Les atomes ultra-froids

Vol 443 | 26 October 2006 | doi:10.1038/nature05224

nature

LETTERS

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## Evidence for superfluidity of ultracold fermions in an optical lattice

J. K. Chin<sup>1</sup>, D. E. Miller<sup>1</sup>, Y. Liu<sup>1</sup>, C. Stan<sup>1</sup>†, W. Setiawan<sup>1</sup>, C. Sanner<sup>1</sup>, K. Xu<sup>1</sup> & W. Ketterle<sup>1</sup>



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# Le modèle standard des particules élémentaires (unification des interactions électro-faibles)

$$SU(2) \otimes U(1) \rightarrow U(1)$$

$$\begin{pmatrix} \phi_1 \\ \phi_2 \end{pmatrix} \rightarrow \begin{pmatrix} 0 \\ \nu \end{pmatrix}$$

### Standard Model of FUNDAMENTAL PARTICLES AND INTERACTIONS

The Standard Model summarizes the current knowledge in Particle Physics. It is the quantum theory that includes the theory of strong interactions (Quantum Chromodynamics or QCD) and the unified theory of weak and electromagnetic interactions (electroweak). Gravity is included in this chart because it is one of the fundamental interactions even though not part of the "Standard Model."

#### FERMIONS

**matter constituents**  
spin = 1/2, 3/2, 5/2, ...

| Leptons spin = 1/2                   |                         |                 |      | Quarks spin = 1/2 |                                 |                 |      |
|--------------------------------------|-------------------------|-----------------|------|-------------------|---------------------------------|-----------------|------|
| Flavor                               | Mass GeV/c <sup>2</sup> | Electric charge | Spin | Flavor            | Approx. Mass GeV/c <sup>2</sup> | Electric charge | Spin |
| $\nu_e$ electron neutrino            | <1.10 <sup>-6</sup>     | 0               | 1/2  | u up              | 0.003                           | 2/3             | 1/2  |
| $\bar{\nu}_e$ anti-electron neutrino | <1.10 <sup>-6</sup>     | 0               | 1/2  | d down            | 0.006                           | -1/3            | 1/2  |
| $\nu_\mu$ muon neutrino              | <0.000011               | -1              | 1/2  | c charm           | 1.3                             | 2/3             | 1/2  |
| $\bar{\nu}_\mu$ anti-muon neutrino   | <0.000011               | -1              | 1/2  | s strange         | 0.1                             | -1/3            | 1/2  |
| $\nu_\tau$ tau neutrino              | <0.000011               | -1              | 1/2  | t top             | 175                             | 2/3             | 1/2  |
| $\bar{\nu}_\tau$ anti-tau neutrino   | <0.000011               | -1              | 1/2  | b bottom          | 4.3                             | -1/3            | 1/2  |

**Spin** is the intrinsic angular momentum of particles. Spin is given in units of  $\hbar$ , which is the quantum unit of angular momentum, where  $\hbar = 1.054 \times 10^{-34}$  J s and  $\hbar = 6.582 \times 10^{-16}$  eV s.

**Electric charge** is given in units of the proton's charge. In SI with the electric charge of the proton is  $1.60 \times 10^{-19}$  coulombs.

The **strong** color of particles plays a role in the chromodynamics (QCD). This energy gained by color interaction is called a potential difference of the color. **Masses** are given in GeV/c<sup>2</sup> (Conversion: 1 GeV = 1.602 × 10<sup>-10</sup> J, 1 eV = 1.602 × 10<sup>-19</sup> J). The mass of the proton is 938 GeV/c<sup>2</sup> = 1.67 × 10<sup>-27</sup> kg.

#### BOSONS

**force carriers**  
spin = 0, 1, 2, ...

| Unified Electroweak spin = 1 |                         |                 |      | Strong (color) spin = 1 |                         |                 |      |
|------------------------------|-------------------------|-----------------|------|-------------------------|-------------------------|-----------------|------|
| Name                         | Mass GeV/c <sup>2</sup> | Electric charge | Spin | Name                    | Mass GeV/c <sup>2</sup> | Electric charge | Spin |
| $\gamma$ photon              | 0                       | 0               | 1    | g gluon                 | 0                       | 0               | 1    |
| $W^+$                        | 80.4                    | +1              | 1    |                         |                         |                 |      |
| $W^-$                        | 80.4                    | -1              | 1    |                         |                         |                 |      |
| $Z^0$                        | 91.1876                 | 0               | 1    |                         |                         |                 |      |

**Color Charge**  
Each quark carries one of three types of "strong charge," also called "color charge." These charges are red, green, and blue. They are not related to the color of visible light. There are eight possible types of color charge for quarks, but only three colors are observed in nature. The color charges are carried by gluons, which interact by exchanging gluons. Leptons, photons, and  $W$  and  $Z$  bosons have no strong interactions and hence no color charge.

**Quarks Confined in Mesons and Baryons**  
We cannot isolate quarks and gluons; they are confined in color-neutral particles called **hadrons**. This confinement (confinement) results from the exchange of gluons among the color-charged constituents. As color-charged particles (quarks and gluons) move apart, the energy of the color field between them increases. This energy eventually is converted into additional quark-antiquark pairs (see Figure below). The quarks and antiquarks then combine into hadrons. Hence, as the particles separate, new types of hadrons have been observed to appear (mesons  $q\bar{q}$  and baryons  $qqq$ ).

**Residual Strong Interaction**  
The strong binding of color-neutral protons and neutrons to form nuclei is due to residual strong interactions between their color charge constituents. It is similar to the residual strong interaction that binds electrically neutral atoms to form molecules. It can also be viewed as the exchange of mesons between the hadrons.

Structure within the Atom

#### PROPERTIES OF THE INTERACTIONS

| Property  | Interaction          | Gravitational       |                     | Weak                 |                     | Electromagnetic     |                     | Strong              |  |
|---|----------------------|---------------------|---------------------|----------------------|---------------------|---------------------|---------------------|---------------------|--|
|   |                      | Acts on             | Mass-Energy         | Flavor               | Electric Charge     | Color Charge        | Residual            |                     |  |
| Particles experiencing:                               | All                  | All                 | Quarks, Leptons     | Electrically charged | Quarks, Gluons      | Hadrons             |                     |                     |  |
| Particles mediating:                                  | Graviton             | $W^+$ $W^-$ $Z^0$   | $\gamma$            | Gluons               |                     |                     |                     |                     |  |
| Strength compared to gravity (at 10 <sup>-16</sup> m) | 10 <sup>-41</sup>    | 10 <sup>-5</sup>    | 10 <sup>-13</sup>   | 10 <sup>-2</sup>     | 10 <sup>13</sup>    | 10 <sup>3</sup>     | 10 <sup>13</sup>    | 10 <sup>13</sup>    |  |
| Range   | > 10 <sup>26</sup> m | 10 <sup>-17</sup> m | 10 <sup>-17</sup> m | 10 <sup>-17</sup> m  | 10 <sup>-17</sup> m | 10 <sup>-17</sup> m | 10 <sup>-17</sup> m | 10 <sup>-17</sup> m |  |

#### Mesons $q\bar{q}$

Mesons are fermions. There are about 100 types of mesons.

| Type     | Name                                      | Quark | Antiquark | Mass GeV/c <sup>2</sup> | Spin |
|----------|---|-------|-----------|-------------------------|------|
| $\pi^+$  | $u\bar{d}$                                | u     | $\bar{d}$ | 0.140                   | 0    |
| $\pi^0$  | $\frac{1}{\sqrt{2}}(u\bar{u} - d\bar{d})$ | u     | $\bar{u}$ | 0.135                   | 0    |
| $\pi^-$  | $d\bar{u}$                                | d     | $\bar{u}$ | 0.140                   | 0    |
| $\rho^+$ | $u\bar{d}$                                | u     | $\bar{d}$ | 0.770                   | 1    |
| $\rho^0$ | $\frac{1}{\sqrt{2}}(u\bar{u} - d\bar{d})$ | u     | $\bar{u}$ | 0.770                   | 1    |
| $\rho^-$ | $d\bar{u}$                                | d     | $\bar{u}$ | 0.770                   | 1    |

#### Matter and Antimatter

For every particle there is a corresponding antiparticle type, denoted by a bar over the particle symbol (antibaryon =  $\bar{b}$ , charge is shown). Particles and antiparticles have identical mass and spin but opposite charges. Some electrically neutral bosons ( $\gamma$ ,  $Z^0$ ,  $\pi^0$ ,  $\eta$ , and  $\eta'$ , but not  $\pi^{\pm}$ ,  $\rho^{\pm}$ ) are their own antiparticles.

**Figures**  
These diagrams are an artist's conception of physical processes. They are not exact and they do not represent a real, color-shaded area representing the cloud of gluons or the gluon field, and not the real quark paths.

$n \rightarrow p + e^- + \bar{\nu}_e$

$e^+e^- \rightarrow \gamma \rightarrow \mu^+\mu^-$

$p + p \rightarrow Z^0 + \text{associated hadrons}$

**The Particle Adventure**  
Visit the award-winning web feature The Particle Adventure at <http://www.feynman.com>. This chart has been made possible by the generous support of: U.S. Department of Energy, U.S. National Science Foundation, Lawrence Berkeley National Laboratory, Stanford Linear Accelerator, University of California, Lawrence Berkeley National Laboratory, Berkeley, CA, 94720. For information on charts, visit <http://www.slac.stanford.edu/education/education.html>. **BURLINGAME**, ILLUSTRATIONS, INC. <http://CPEPweb.org>



# Retour à l'histoire

# Heureusement que tout n'était pas connu

- Résistance nulle (sauf s'il y a un aimant proche)
- L'effet Meissner (pas parfait)
- Parfois pas transparent aux micro-ondes
- Effet isotopique (parfois en direction opposée)



# La théorie la mieux comprise

- En 1969, R.D. Parks deux volumes  
« Superconductivity »
- D'un des auteurs: « *C'est le dernier clou dans le cercueil de la supraconductivité* »



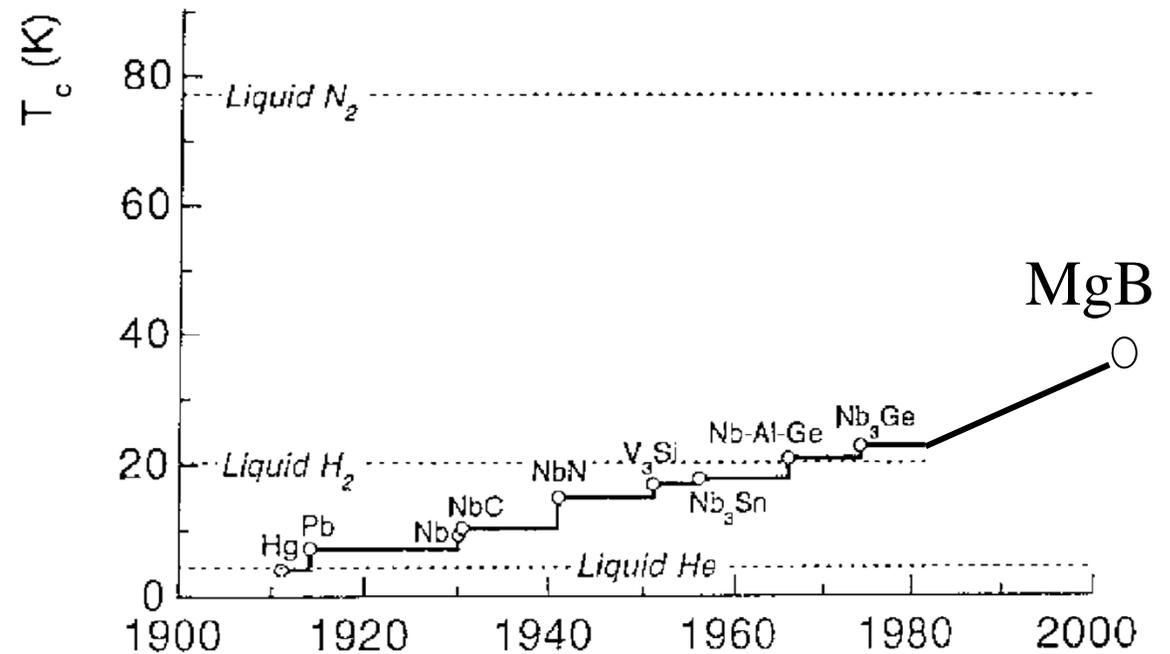
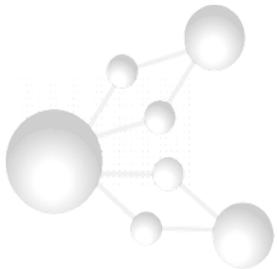
# La quête de nouveaux matériaux

Le but: la température de l'azote  
liquide!



# On croyait généralement que (1952)

- Métaux de transition (pas Cu,Au,Fe)
- Cubique
- Ne pas s'approcher de
  - 0
  - Aimants
  - Isolants



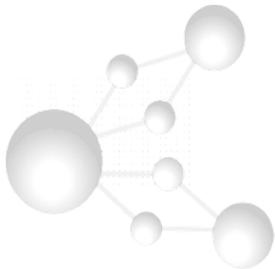
# Janvier 1986



OSNI

1986 : Bednorz et Muëller, IBM  
Zurich  
La-Ba-Cu-O  $T_c \sim 30-40K$

Effet Meissner ?



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# Ça va vite...

- Boston, "Materials Research Society"  
Décembre 1986
  - Koitchi Kitazawa et Shoji Tanaka Tokyo convainquent tout le monde.
- 16 février 1987, Houston:
  - Conférence de presse par **Paul Chu** pour annoncer la découverte de *Y-Ba-Cu-O*
  - $T_c = 93\text{ K}$  (vs 77 K)



# March meeting APS, 1987

- Titre du New York Times le lendemain:  
**"The Woodstock of Physics"**

- 3000 personnes jusqu'à 3 heures du matin

"They began lining up outside the New York Hilton Sutton Ballroom at 5:30PM for an evening session that would last until 3:00 AM"





The "Woodstock of physics." On March 18, 1987, thousands of physicists crammed a ballroom at the New York Hilton to celebrate the coming of the age of superconductivity.

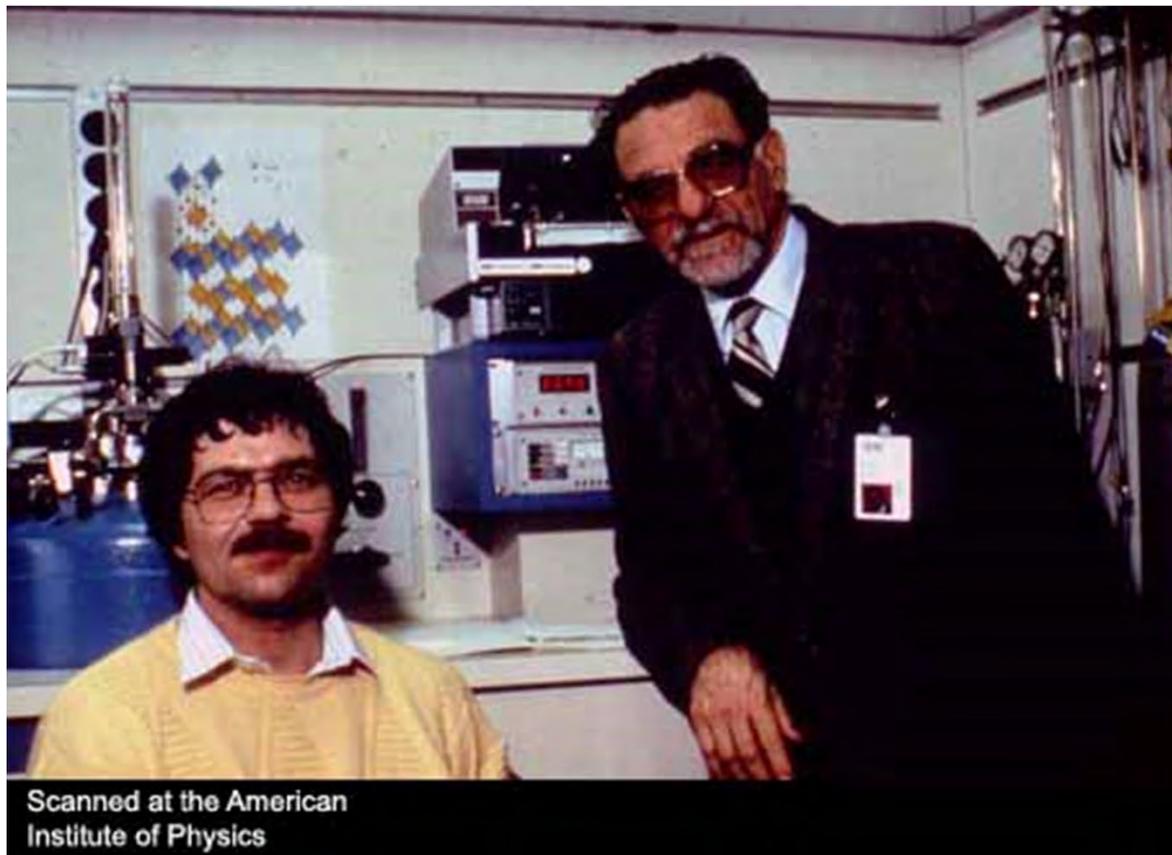
AMERICAN INSTITUTE OF PHYSICS

(right) Alex Müller, Paul Chu, and Shoji Tanaka, answering questions at the "Woodstock" meeting. Tanaka and Koichi Kitazawa were the first to confirm Bednorz and Müller's discovery, launching a worldwide race to find still better superconductors.

AMERICAN INSTITUTE OF PHYSICS







Scanned at the American  
Institute of Physics



# Ce qu'il y a de particulier avec ces supraconducteurs

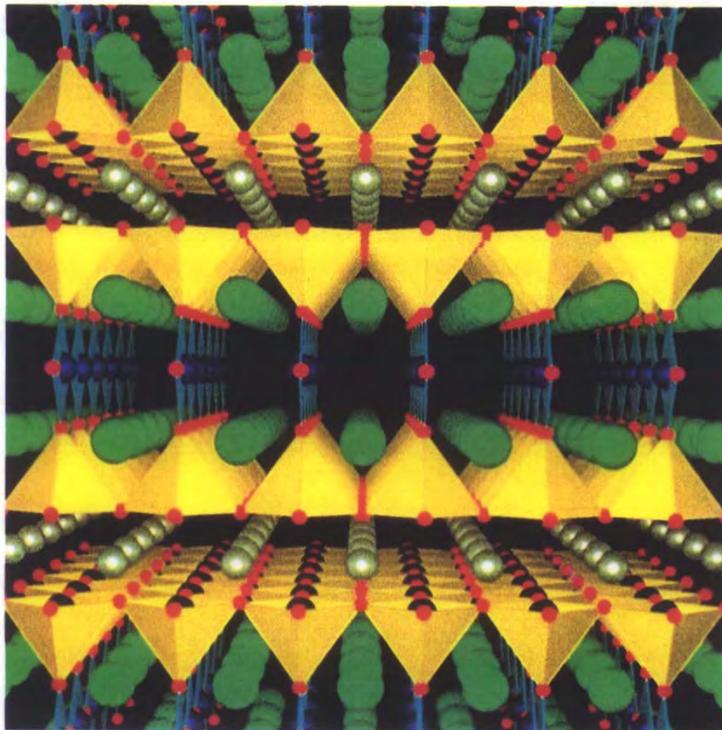


# Structure atomique

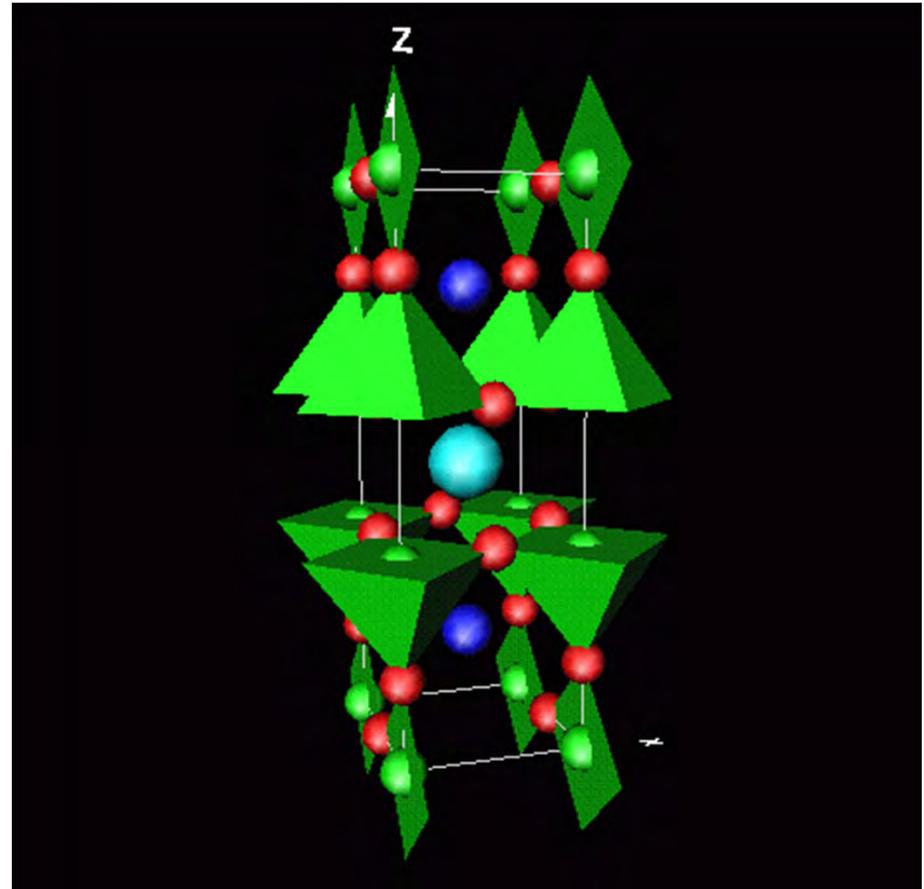
## SCIENTIFIC AMERICAN

JUNE 1988  
\$3.50

*How nonsense is deleted from genetic messages.  
R& for economic growth: aggressive use of new technology.  
Can particle physics test cosmology?*

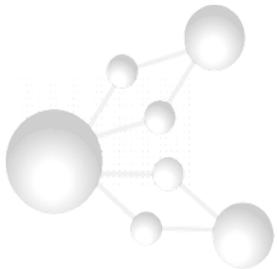


High-Temperature Superconductor belongs to a family of materials that exhibit exotic electronic properties.  
 $\text{YBa}_2\text{Cu}_3\text{O}_{7-\delta}$  92-37

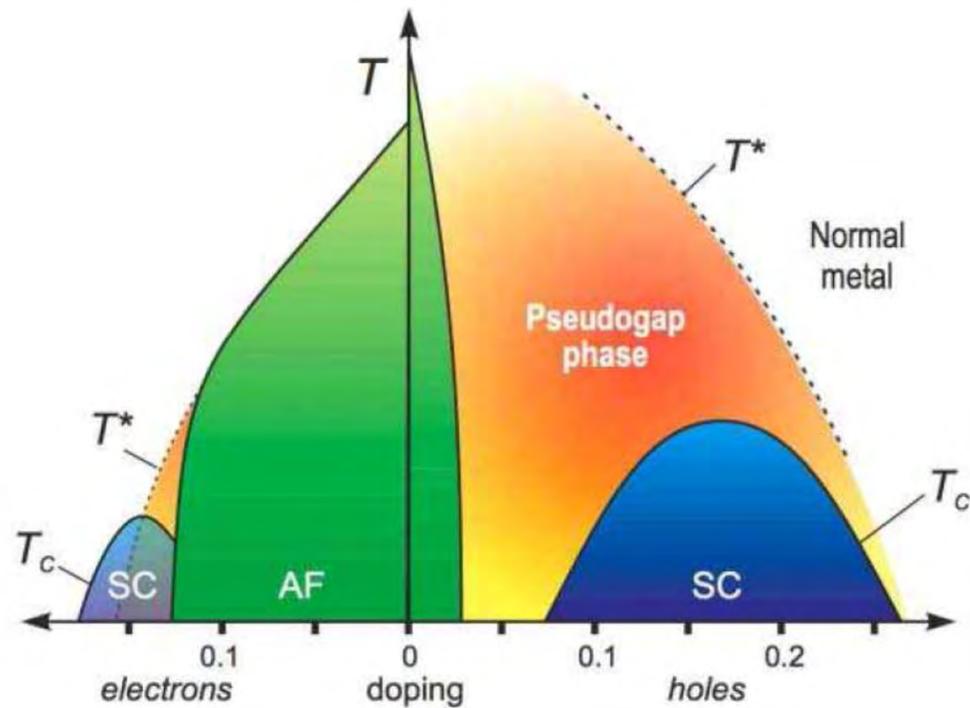


# Ce qu'il y a de particulier

- Métaux de transition
- Cubique
- S'éloigner de
  - O
  - Aimants
  - Isolants
- Cu
- En couche
- Près de
  - O
  - Aimants
  - Isolants



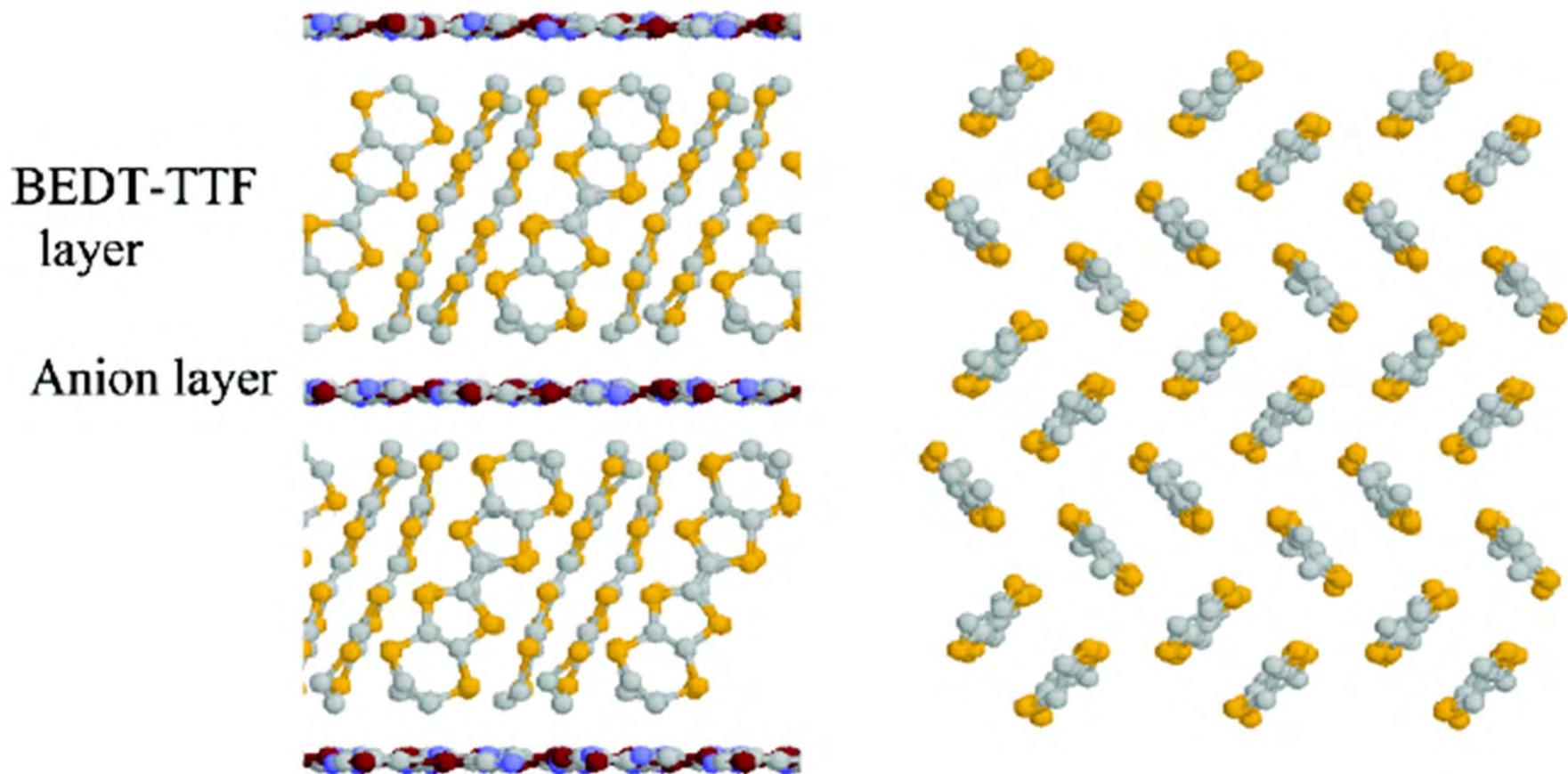
# Diagramme de phase



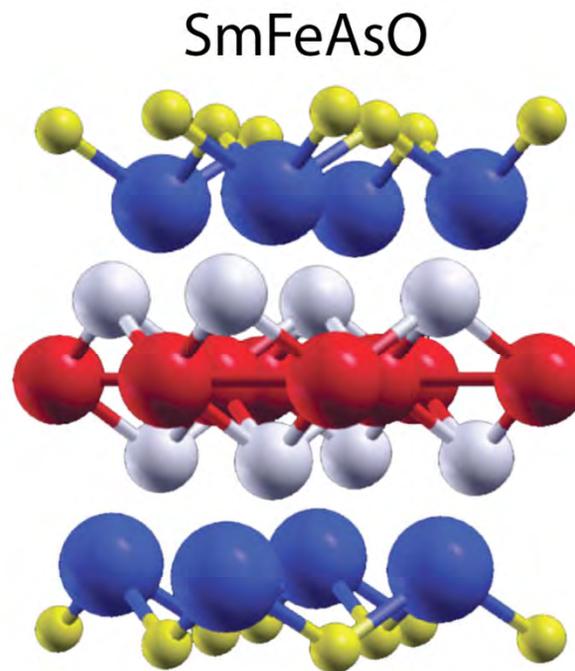
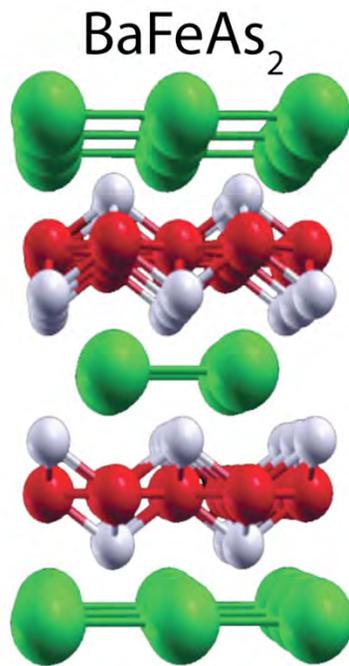
Fischer et al. Rev. Mod. Phys. 79, 353 (2007)



# Conducteurs organiques en couches ( $\kappa$ -BEDT-X)



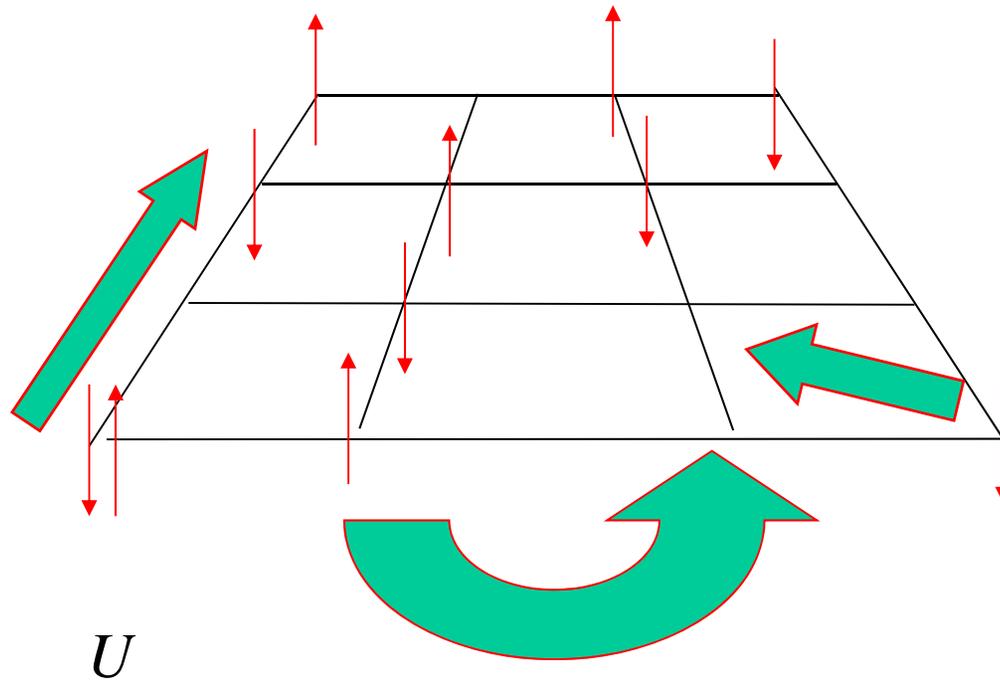
# Pnictures (2008)



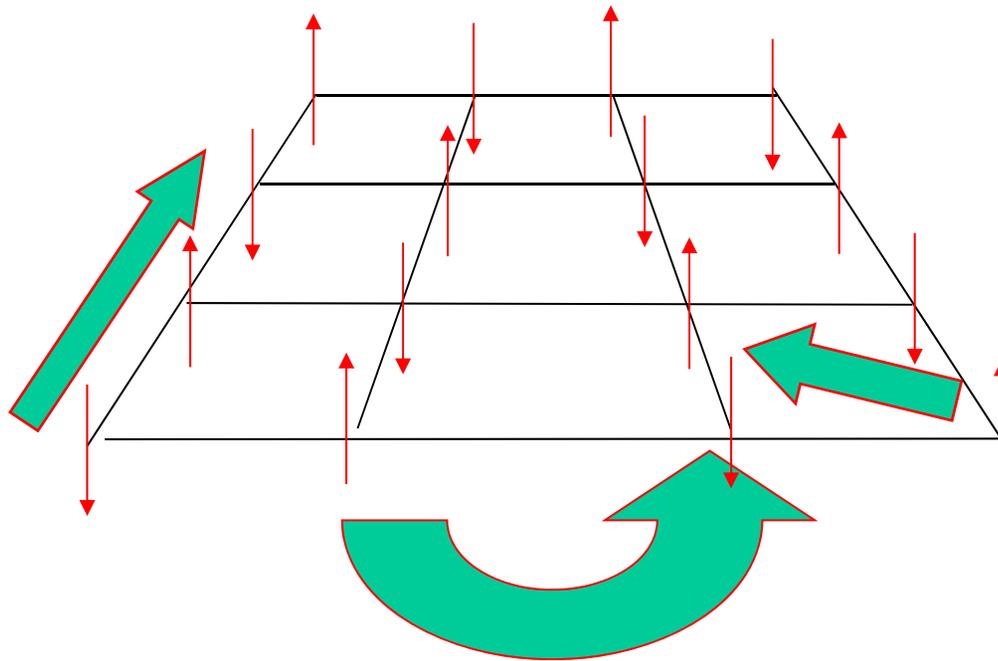
[http://www.stanford.edu/~tpd/research\\_hightc.html](http://www.stanford.edu/~tpd/research_hightc.html)



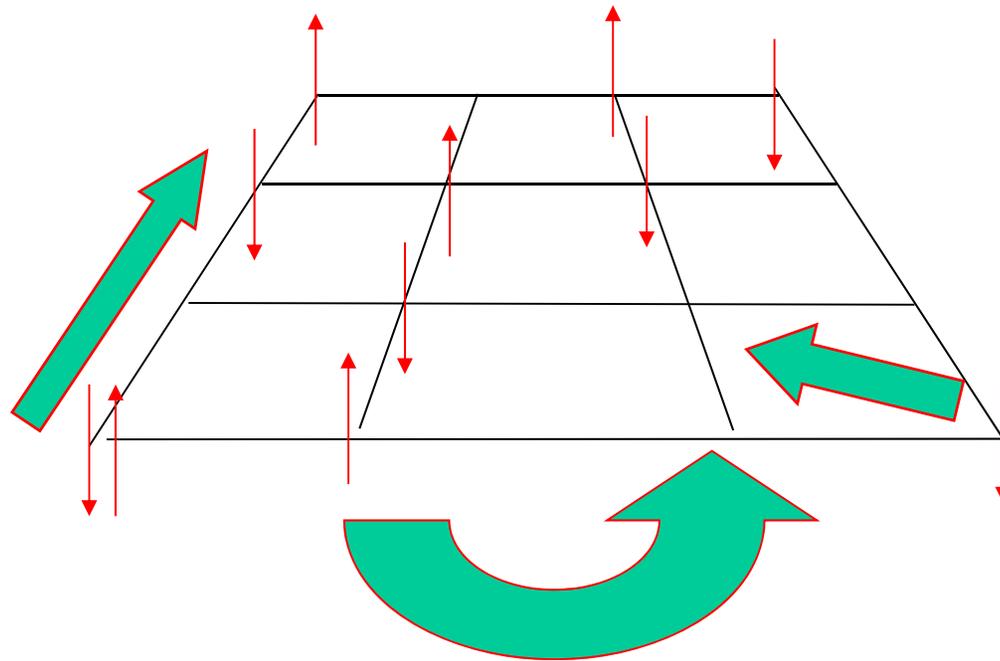
# Pourquoi est-ce si difficile à comprendre?



# Isolant

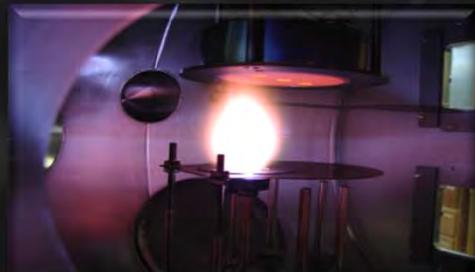
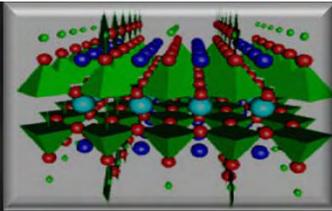


# Pourquoi est-ce si difficile à comprendre?



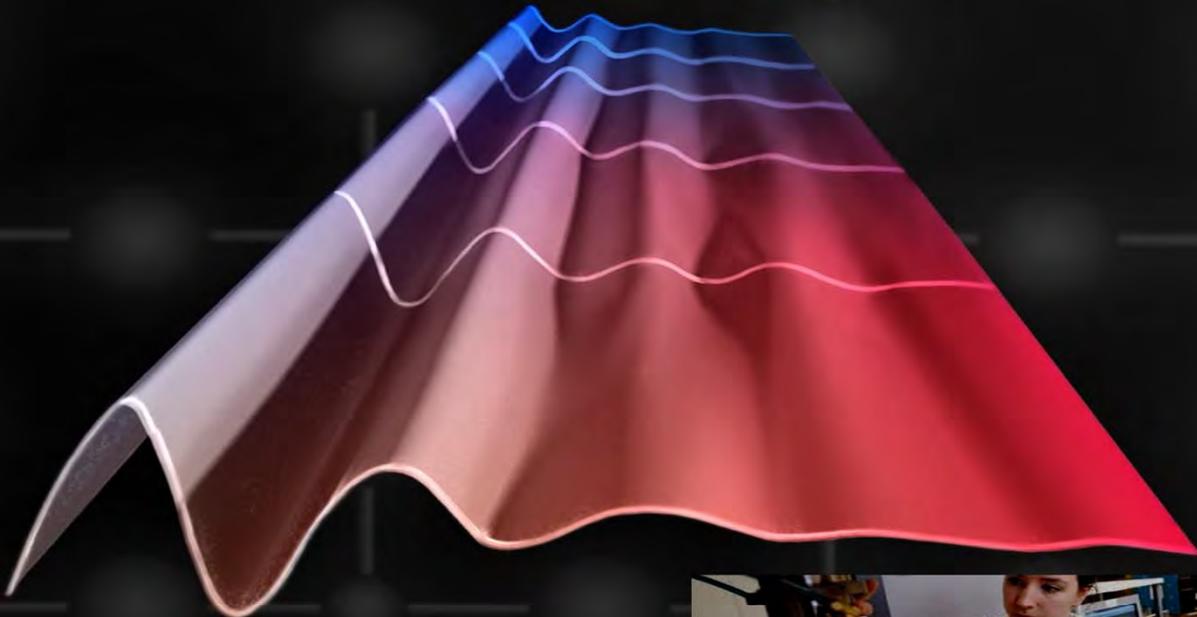


Scanned at the American Institute of Physics



$$H(t) = - \sum_{ij\sigma} t_{ij} c_{i\sigma}^\dagger c_{j\sigma} e^{-i \int_i^j d\mathbf{r}_{ij} \cdot \mathbf{A}(\mathbf{r}, t)} + U \sum_i n_{i\uparrow} n_{i\downarrow}$$

$$\Delta_{\mathbf{p}} = \frac{1}{V} \sum_{\mathbf{p}'} U(\mathbf{p} - \mathbf{p}') \langle c_{-\mathbf{p}'\downarrow} c_{\mathbf{p}'\uparrow} \rangle$$



$$|BCS(\theta)\rangle = \dots + e^{iN\theta} |N\rangle + e^{i(N+2)\theta} |N+2\rangle + \dots$$



# Conclusion

# Le rêve



## room-temperature superconductors

They would transform the grid—if they can exist at all By Michael Moyer

You can build a coal-fired power plant just about anywhere. Renewables, on the other hand, are finicky. The strongest winds blow across the high plains. The sun shines brightest on the desert. Transporting that energy into cities hundreds of kilometers away will be one of the great challenges of the switch to renewable energy. The most advanced superconducting cable can move those megawatts thousands of kilometers with losses of only a few percent. Yet there is a catch: the cable must be kept in a bath of liquid nitrogen at 77 kelvins (or -196 degrees Celsius). This kind of deployment, in turn, requires pumps

and refrigeration units every kilometer or so, greatly increasing the cost and complexity of superconducting cable projects. Superconductors that work at ordinary temperatures and pressures would enable a truly global energy supply. The Saharan sun could power western Europe via superconducting cables strung across the floor of the Mediterranean Sea. Yet the trick to making a room-temperature superconductor is just as much of a mystery today as it was in 1986, when researchers constructed the first superconducting materials that worked at the relatively high temperatures of liquid nitrogen (pre-

vious substances needed to be chilled down to 23 kelvins or less). Two years ago the discovery of an entirely new class of superconductor—one based on iron—raised hopes that theorists might be able to divine the mechanism at work in high-temperature superconductors [see “An Iron Key to High-Temperature Superconductivity?” by Graham P. Collins; SCIENTIFIC AMERICAN, August 2009]. With such insights in hand, perhaps a path toward room-temperature superconductors would come into view. But progress has remained slow. The winds of change don't always blow on cue.

www.ScientificAmerican.com

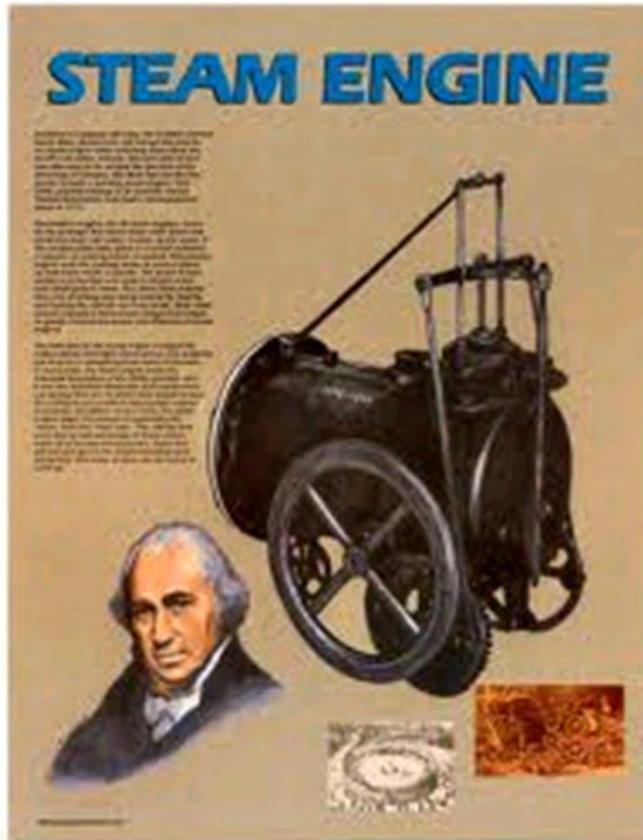
<http://www.physique.usherbrooke.ca/taillefer/Vulgarisation.html>



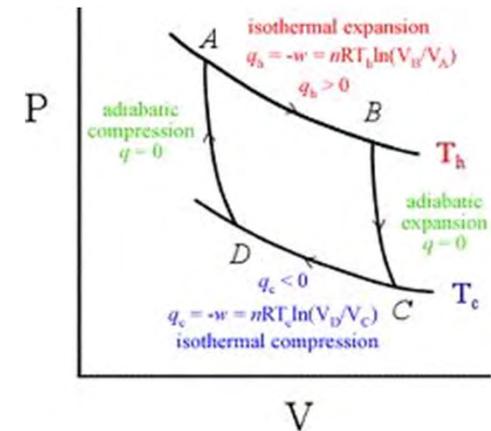
# Science et technologie, main dans la main



# Machine à vapeur et thermodynamique



Watts 1765



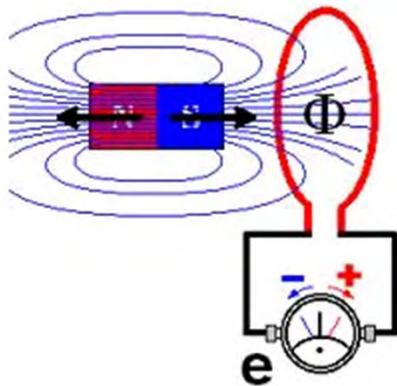
Carnot 1824



# Induction et le moteur électrique



Induction, Faraday (1831)



Moteur électrique, Tesla(1880)



# Induction



# Électron and television



Thomson, 1897

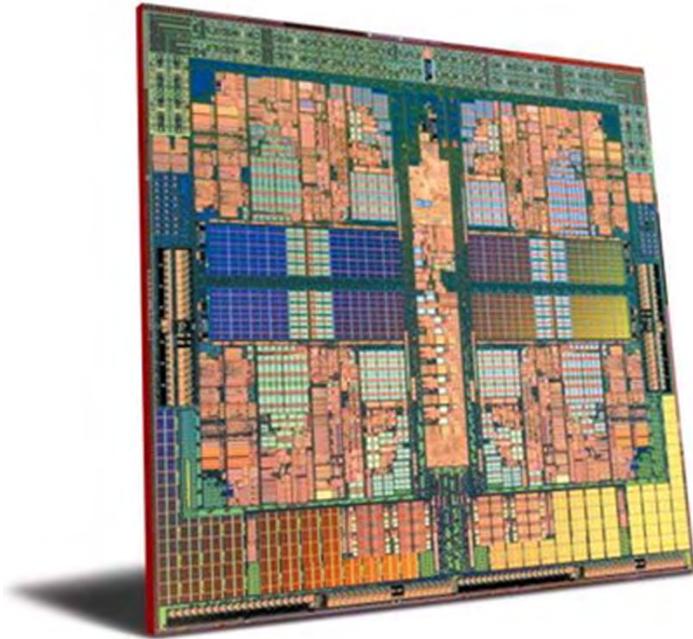


Télévision, 1940





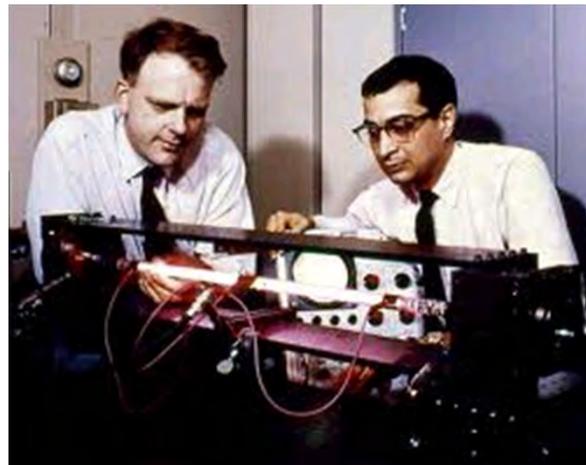
# Mécanique quantique et le transistor



# Laser et CD-ROM



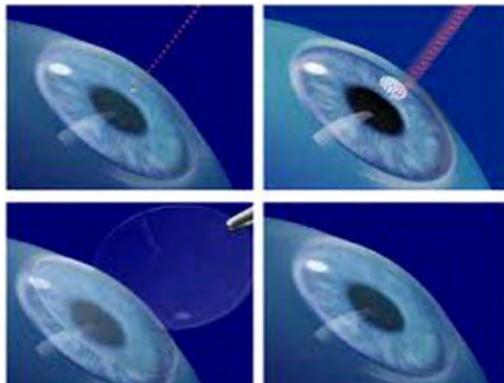
Stimulated emission 1925



Laser 1960



CD-ROM (1980-90)



Chirurgie oculaire



# Edward Bellamy (USA) 1887

- Roman: « Looking backward » 2000-1887
- Si nous pouvions inventer un dispositif pour offrir à tous de la musique dans leur maison, qui serait de qualité parfaite, de quantité illimitée, pour toutes les humeurs et qui commencerait et s'arrêterait lorsqu'on voudrait, alors nous aurions atteint la limite du bonheur pour l'humanité et nous pourrions cesser de chercher des améliorations.

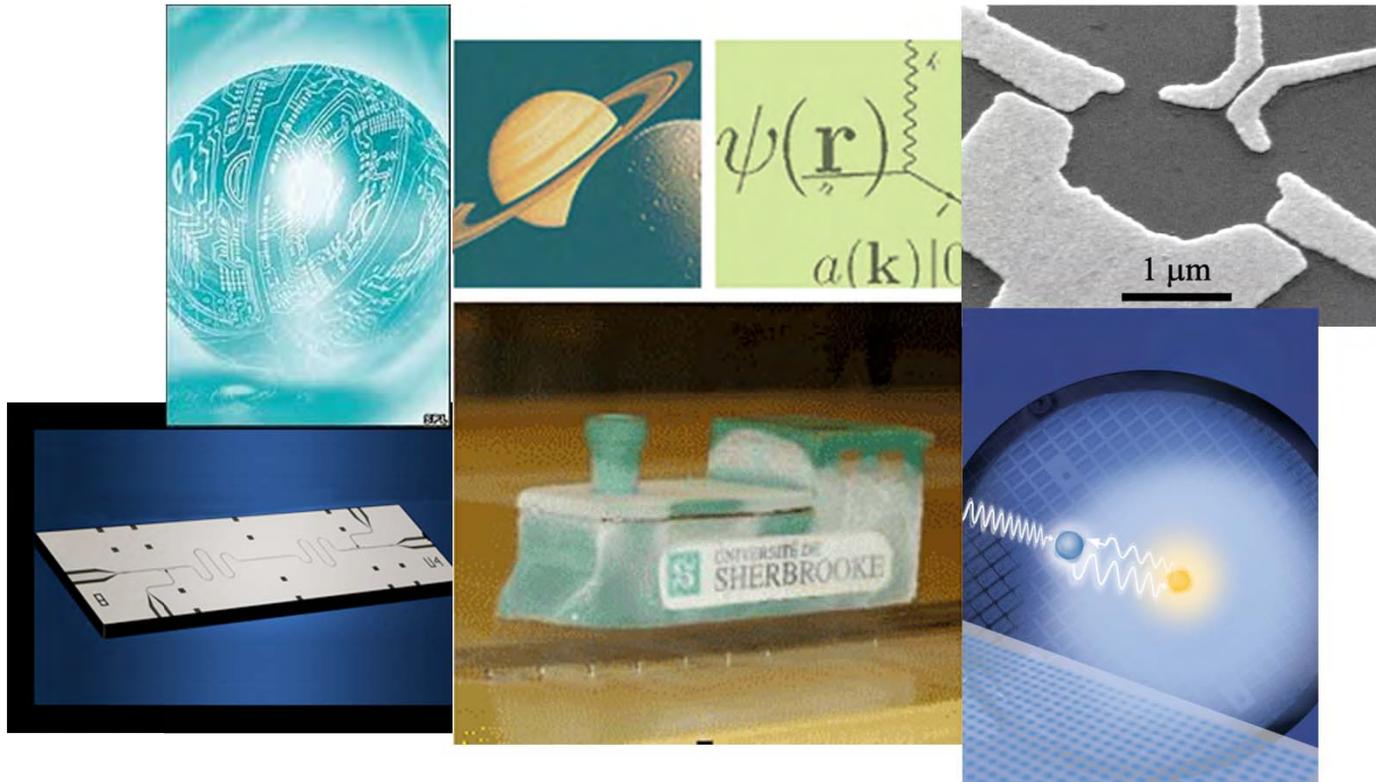


Merci



<http://sweetladiesbakery.com/gallery/female-cakes/>

# Le département de physique



de l'Université de Sherbrooke

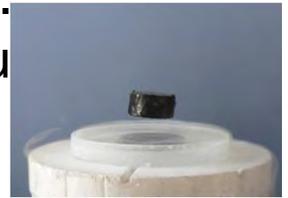


# La physique

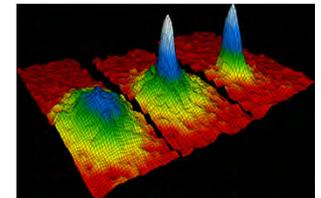
La physique est la plus ancienne des sciences et la science fondamentale par excellence. Elle cherche à comprendre les lois qui gouvernent le comportement de la nature de l'infiniment petit à l'infiniment grand (des quarks, électrons et neutrinos aux amas de galaxies).

Elle comportent différents champs de recherche tels que

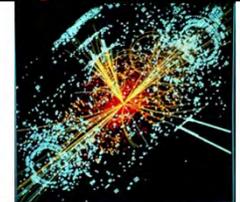
(1) La matière condensée



(2) La physique atomique et moléculaire



(3) La physique des particules (hautes énergies)



(4) L'astrophysique



La physique procède par expérimentation et par modélisation mathématique.



# Dans un bac en physique, on apprend:

- Les théories physiques qui expliquent les phénomènes observés dans les différents champs.
- Les techniques expérimentales qui permettent « d'interroger » la nature.
- Les méthodes de modélisation qui permettent l'analyse de systèmes complexes et leur formulation en termes mathématiques.
- Les méthodes de calcul et de simulation numériques qui permettent de tester nos modèles physiques.



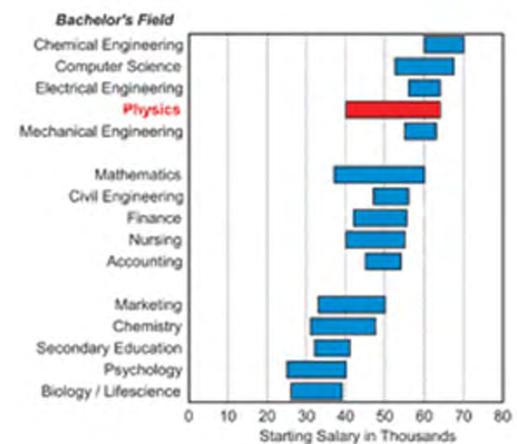
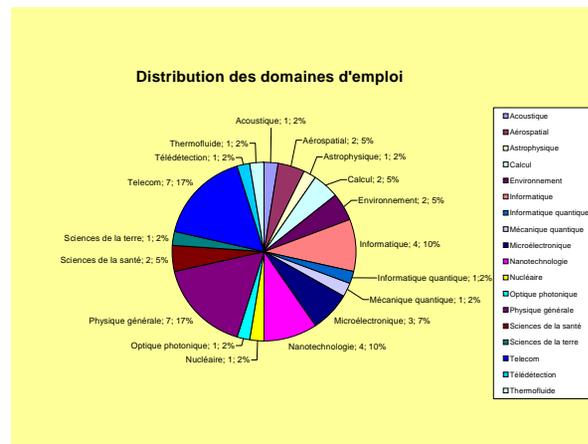
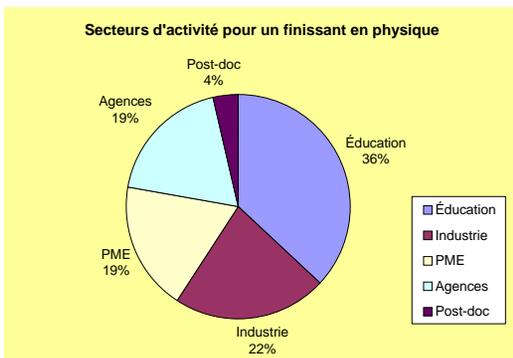
# Le bac à l'U. Sherbrooke

- Un baccalauréat en première classe qui couvre l'ensemble des champs de la physique.
- Un enseignement rigoureux donné par des professeurs qui sont tous eux-mêmes des chercheurs.
- Des expériences de laboratoire à la fine pointe de la recherche actuelle.
- Des petits groupes qui facilitent les contacts directs entre professeurs et étudiants.
- Un système d'alternance stages-études qui permet d'appliquer les connaissances acquises.
- Des bourses d'admission (de 1,000\$ à 3,500\$).



# Le débouchés

- Le bac en physique offre une formation générale. La majorité des étudiants décident ensuite de se spécialiser dans un champ de la physique en faisant une maîtrise et parfois un doctorat.
- D'autres étudiants se dirigent vers l'enseignement et l'industrie après le bac. Les stages permettent d'explorer cette filière d'emploi.



Des exemples concrets: notre promotion de 1999

FINISSANTS  
1996



*André-Philippe Vachon*

André-Philippe Vachon  
Baccalauréat en Physique  
Servo-Robo inc  
Chef de bureau et coordonateur des produits optiques pour le soudage laser automatisé



*Dominic Groulx*

1999



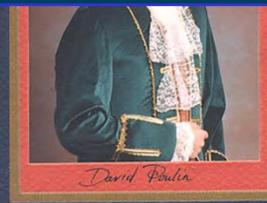
*Jacques Renaud*



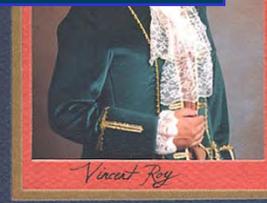
*Michel Péro-Labrière*



*Michel Béthune*



*David Poulin*



*Vincent Roy*



*Jonathan Lechance*



*Alexandre Faulou*



*Michel Fournier*



*Henrix Demers*



*Eric Cloutier*



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1996



*André-Philippe Vachon*



*Dominic Groulx*

1999



*Jacques Renaud*



*Michel Péro-Labrière*



*Michel Béthune*



*David Poulin*



*Vincent Roy*



*Jonathan Lechance*



*Alexandre Faulou*



*Michel Fournier*



*Henrix Demers*



*Eric Cloutier*



*Lechamps*

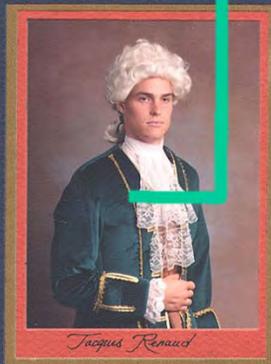
Dominic Groulx  
Baccalauréat en Physique  
Doctorat en Génie mécanique  
Université Dalhousie  
Professeur de génie mécanique  
Transfer de chaleur, mécanique des fluides



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1996



*André-Philippe Vachon*



*Jacques Renaud*



*Michel Péro-Labrière*



*Michel Béthoux*



*David Poulin*



*Vincent Roy*



*Dominic Groulx*

1999



*Jonathan Lechance*



*Alexandre Faulou*



*Michel Fournier*



*Henrix Demers*



*Eric Cloutier*

## Jacques Renaud

Baccalauréat en Physique

Maîtrise en Physique

Doctorat en Physique

DALSA semiconducteurs

Ingénieur de procédé de fabrication des  
gaufrettes semi-conductrices



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1996

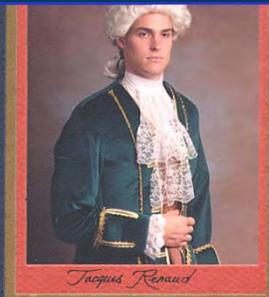


*André-Philippe Vachon*

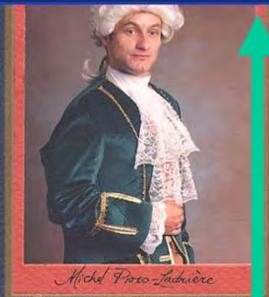


*Domercq Grosjean*

1999



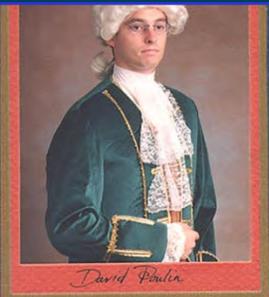
*Jacques Renaud*



*Michel Péro-Labrière*



*Michel Béthanger*



*David Paulin*



*Vincent Roy*



*Jonathan Lachance*



*Alexandre Faulou*



*Michel Fournier*



*Henrix Lévesque*



*Eric Cloutier*



*Mathieu Deschamps*

## Jonathan Lachance

Baccalauréat en Physique  
DALSA semi-conducteurs

Gestionnaire de projets technologiques,  
Responsable de la fabrication en salle blanche



## Michel Bélanger

Baccalauréat en Physique

Maîtrise en Génie aéronautique

Doctorat en Didactique des sciences

Université du Québec à Rimouski

Professeur en Sciences de l'éducation

Étude des structures cognitives engendrées  
par divers explications d'un même phénomène



## David Poulin

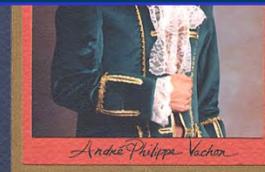
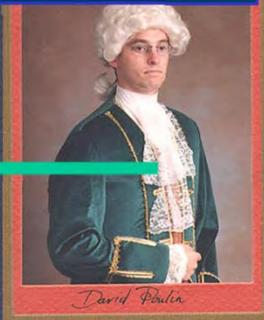
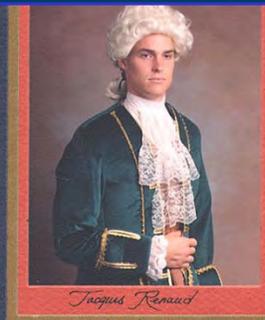
Baccalauréat en Physique

Maîtrise en Physique

Doctorat en Physique

Université de Sherbrooke

Professeur de Physique, informatique quantique  
théorique, correction d'erreur quantique, algorithmes



1999



UNIVERSITÉ DE  
SHERBROOKE

## Hendrix Demers

Baccalauréat en Physique

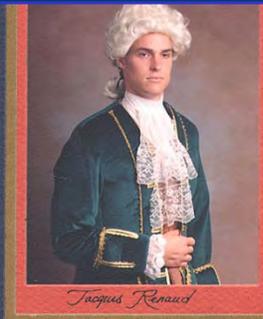
Maîtrise en génie mécanique

Doctorat en Génie des matériaux

Université de Sherbrooke

Chercheur post-doctoral, simulations Monte Carlo

Microscopie électronique, caractérisation biologique



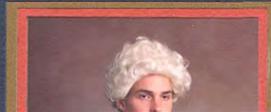
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# PHILOSOPHIÆ NATURALIS



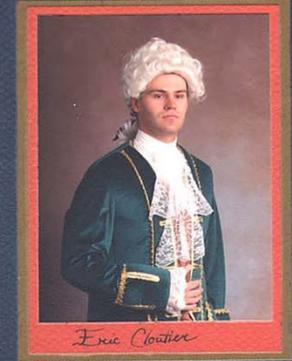
Mathieu Deschamps

Baccalauréat en Physique

Maîtrise en radiobiologie

CEGEP de Sherbrooke

Enseignant au département de physique



1999



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1996

# PHILOSOPHIÆ NATURALIS



Vincent Roy

Baccalauréat en Physique

Maîtrise en géographie appliquée

Recherche et développement pour la défense Canada

Télé détection, exploitation par image satellite



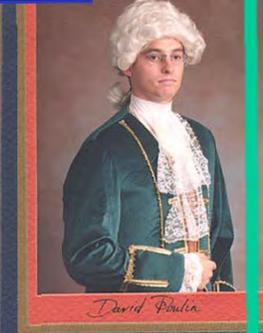
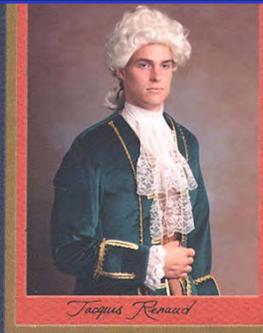
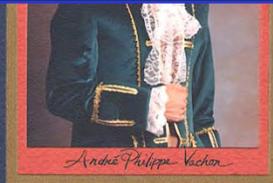
UNIVERSITÉ DE  
SHERBROOKE

## Éric Cloutier

Baccalauréat en Physique

Rolls-Royce Canada

Chef du contrôle de qualité et de sécurité des  
moteurs turbines.



1999

