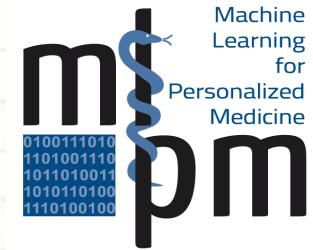


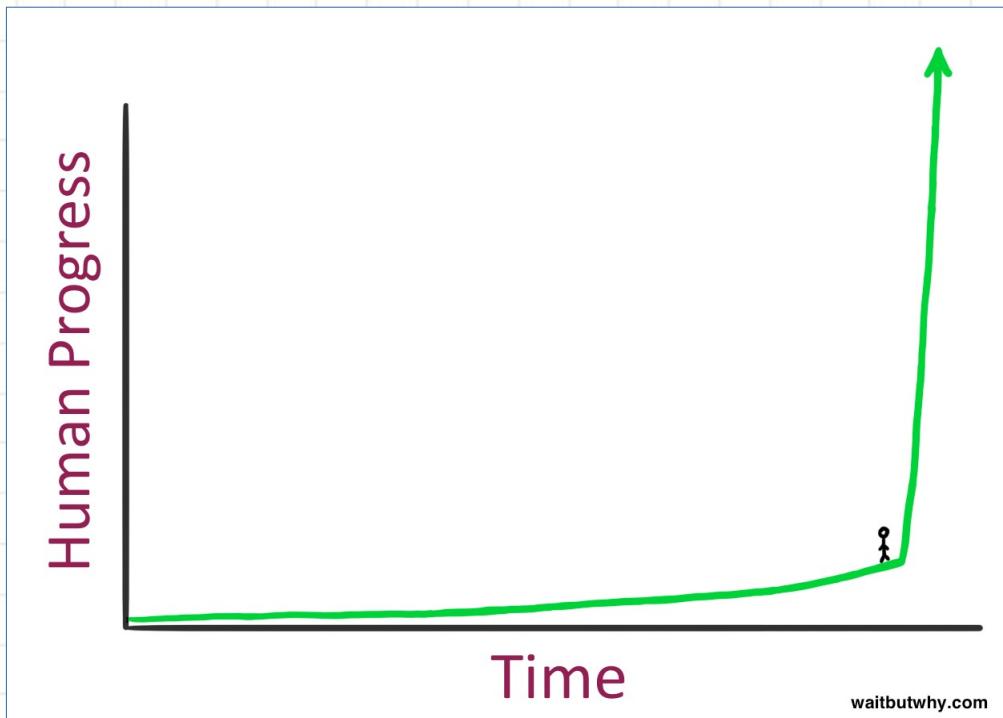
# **EL ESPÍRITU CIENTÍFICO: REVOLUCIONES DEL SIGLO XX**

Melanie F. Pradier  
Personal Docente e Investigadora, UC3M



# La aceleración del progreso

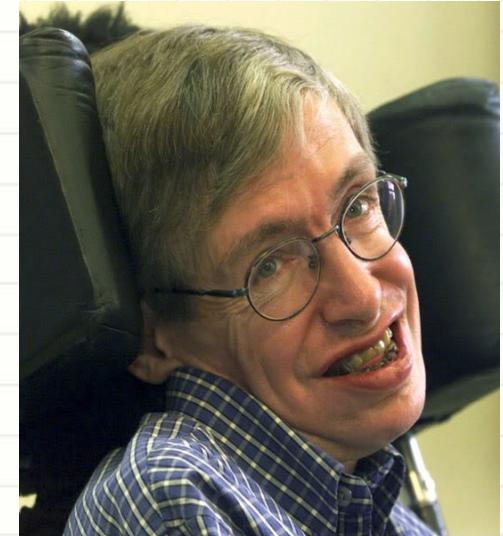
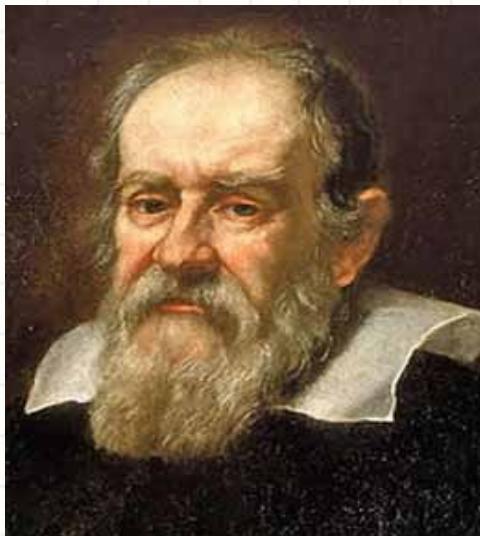
*We are on the edge of change comparable to the rise of human life on Earth. — Vernor Vinge, mathematician.*



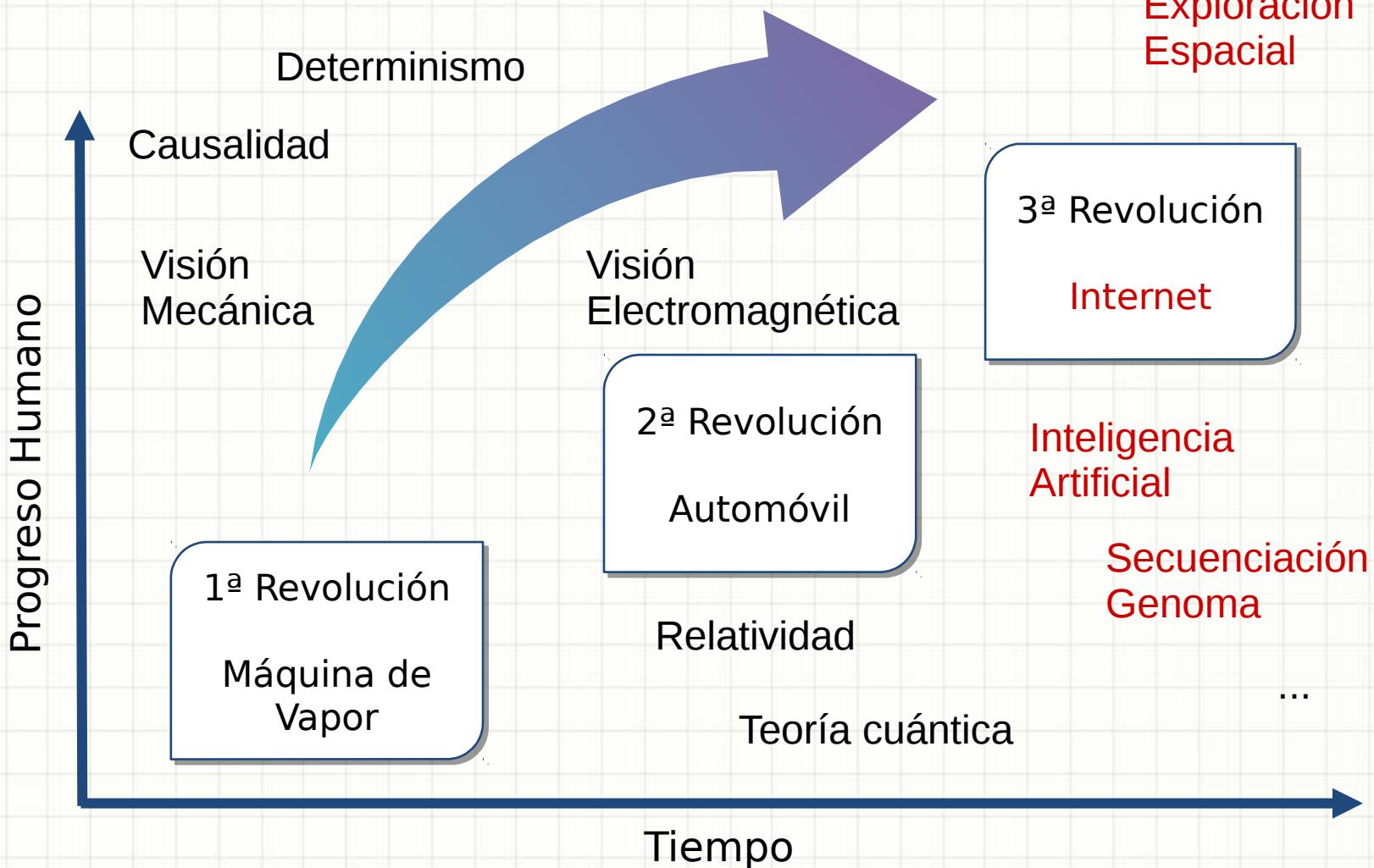
# La aceleración del progreso

“The law of Accelerating Returns”, Ray Kurzweil, computer scientist.

Source: Kurzweil, The Singularity is Near, 39.



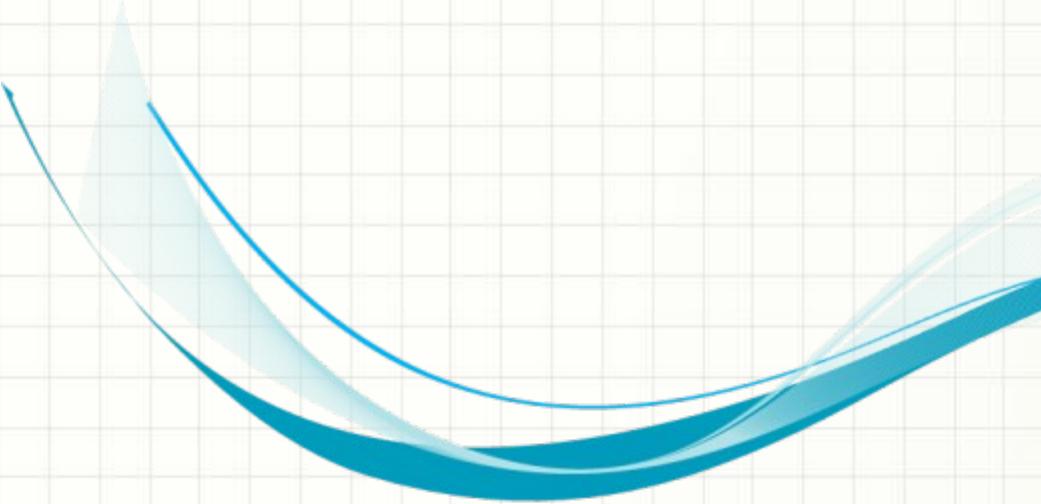
# Contexto Histórico



# Lo que os quiero contar...

1. Internet
2. Secuenciación del genoma
3. Exploración espacial

- Discusión Abierta:
  - Big Data, Aprendizaje Máquina
  - Lo que hago yo
  - ...



# Internet

# Internet: elementos básicos

1

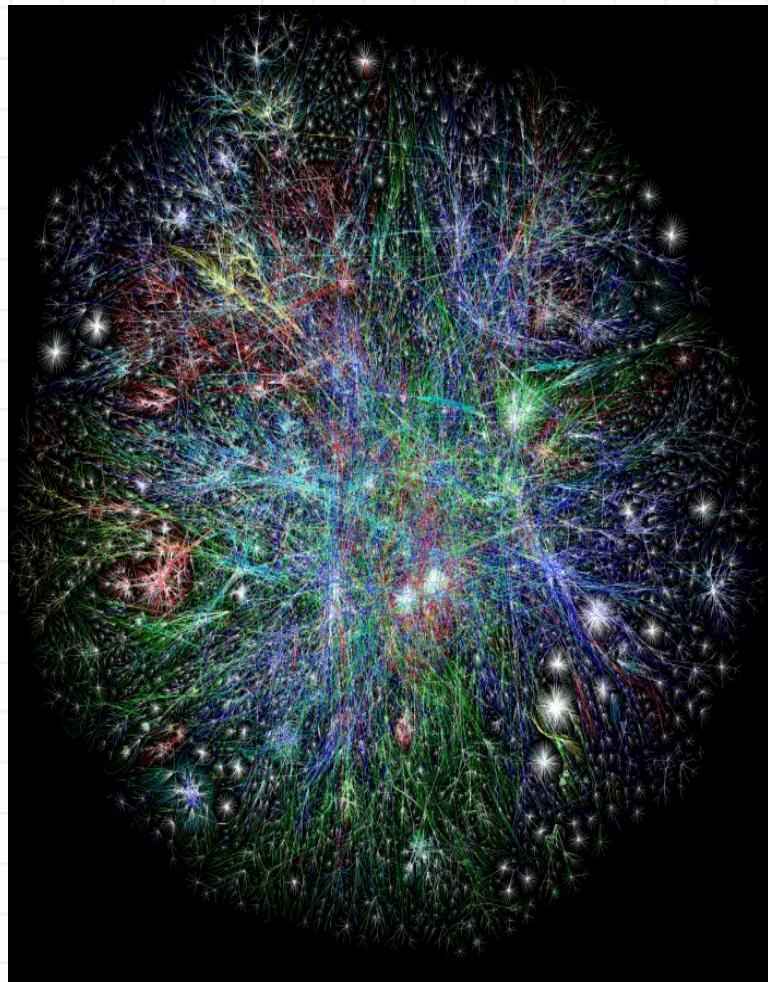
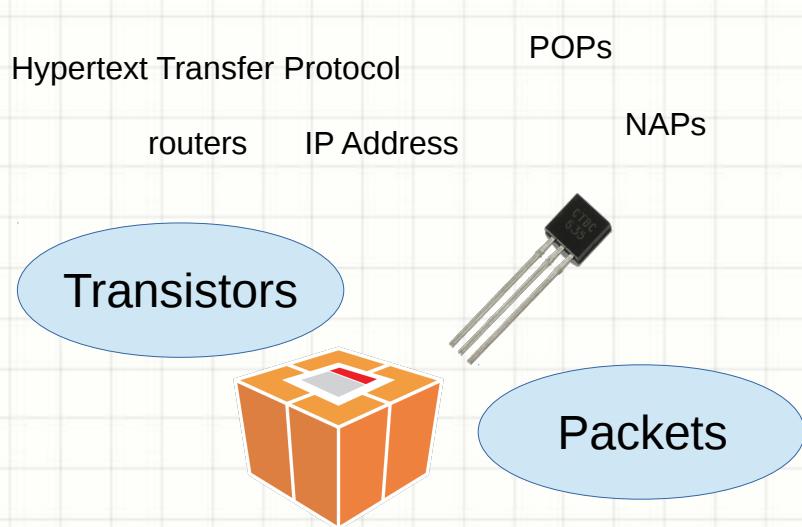
Interconnected Network

2

Data Packing Rules

3

Data Routing

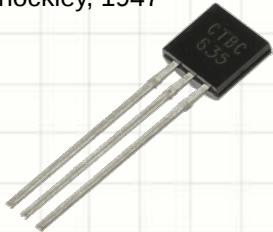


<http://www.opte.org/>

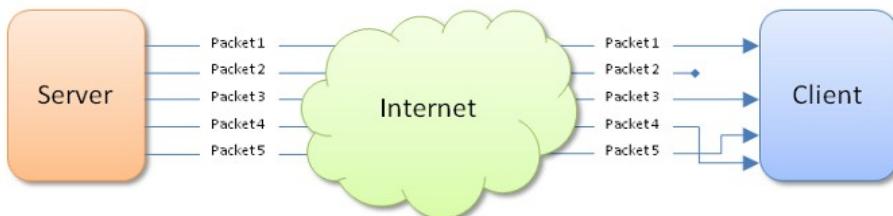
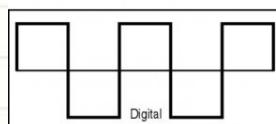
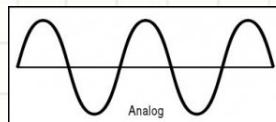
# Internet: elementos básicos

John Bardeen, Walter Brattain,  
and William Shockley, 1947

## Transistors

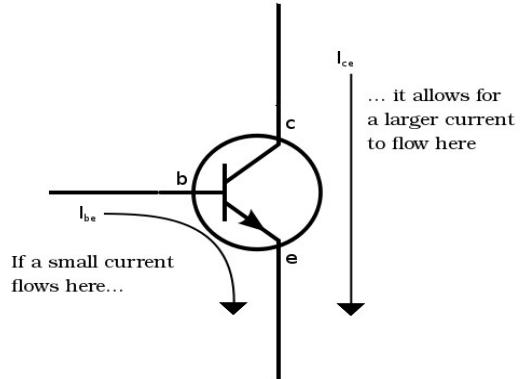


- ✓ Electromagnetismo
- ✓ Teoría Cuántica



In this diagram:

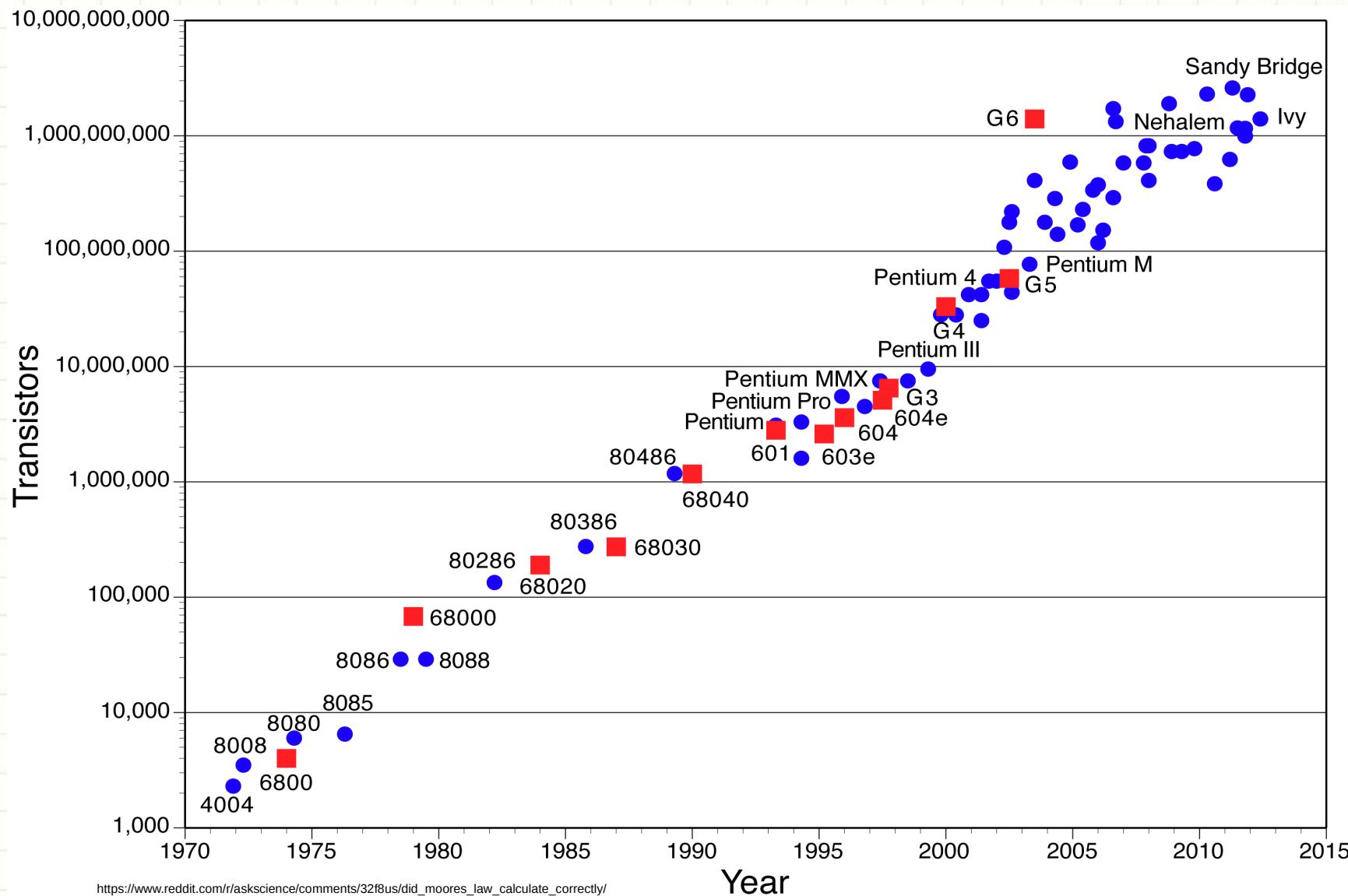
- Packet1 makes it to the client as expected
- Packet2 never makes it to the client
- Packet3 makes it to the client as expected
- Packet5 arrives at the client prior to packet 4



## Packets

- ✓ Teoría de la Información
  - Códigos de fuente
  - Códigos de canal

# El transistor (Ley de Moore)



# ¿Internet en el futuro?

2020: Las consolas desaparecerán. Los juegos se convertirán en **juegos multijugadores masivos online**, según prevé Alex St. John, fundador de Wild Tangent.

2021: El dinero en efectivo, las tarjetas de crédito y los monederos online estarán obsoletos. La **banca online** será el método de pago favorito de los europeos, según la propia Trustly.

2025: Los 130 millones de **libros** del planeta estarán **digitalizados**, según Google.

2030: Los micropagos y las transacciones móviles ofrecerán a los **países en desarrollo** un mejor acceso a los sistemas de crédito. El **aprendizaje online** cambiará de forma drástica la educación en los países en desarrollo, prevé Bill Gates.

2032: Internet acabará con la industria de Hollywood, según Jimmy Wales, fundador de Wikipedia.

2035: Los teléfonos móviles ya no existirán, según Renee James, presidenta de Intel.

2040: **Todas las cosas que nos rodean serán inteligentes** y enviarán datos. Zapatos, mesas, frigoríficos, etc..., afirma Mitchel Baker, fundadora de Mozilla.

2050. Tu mejor amigo será una computadora. Te mirará a la cara y sabrá reconocer tu estado de ánimo, afirma Steve Wozniak, cofundador de Apple.

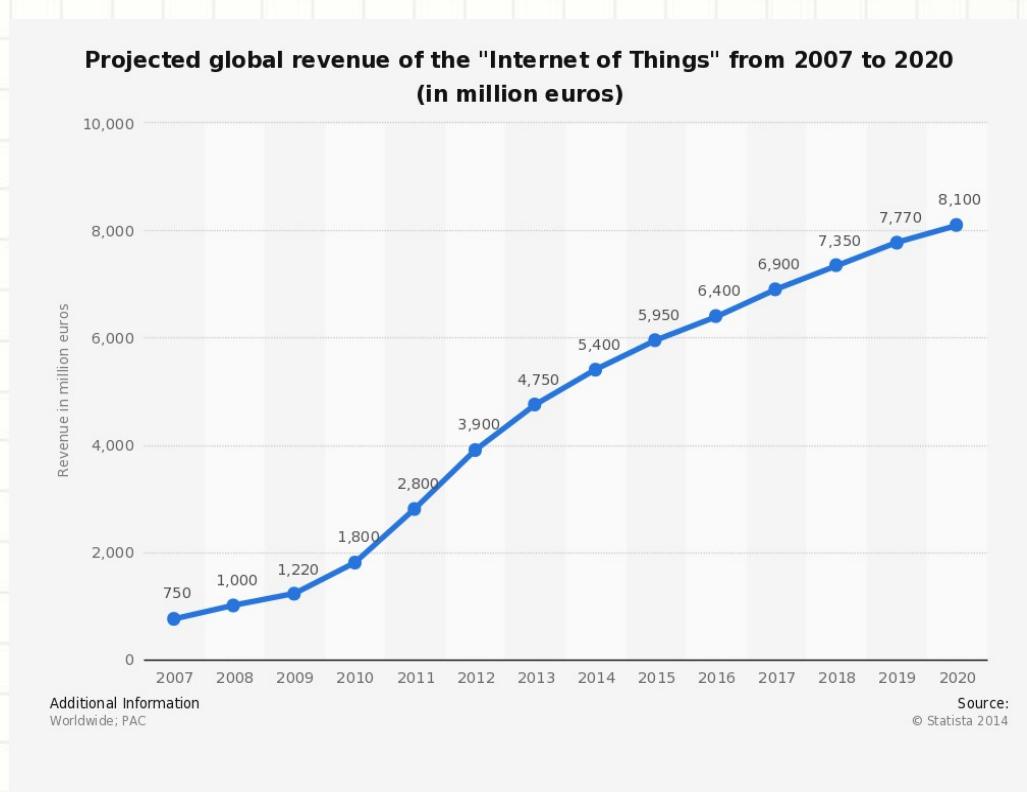
<http://www.bolsamania.com/noticias/tecnologia/como-sera-internet-en-2050-las-10-previsiones-mas-increibles-de-los-expertos--726347.html#sthash.1gTCJ3Ru.dpuf>

<http://www.rtve.es/noticias/20120423/jimmy-wales-fundador-wikipedia-pronostica-internet-acabara-hollywood/517928.shtml>

<http://www.xatakamovil.com/futuro/desapareceran-los-telefonos-moviles-en-2035>

# En el futuro cercano

- On-demand
- Privacy/Open Source
- Collaborative
- Internet of Things
- ➔ Wireless

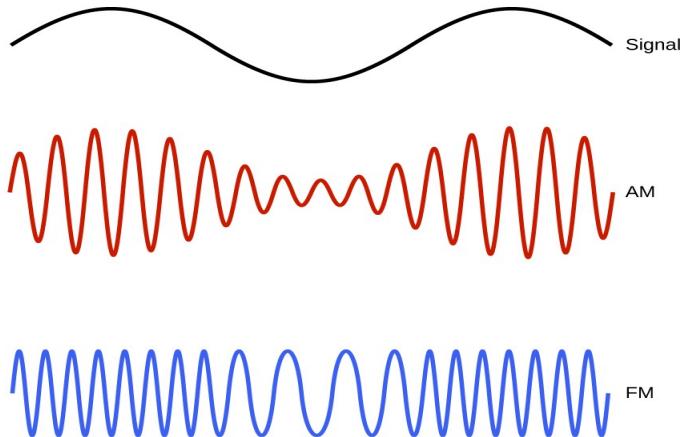


<http://phys.org/news/2015-05-technology-fundamentally-future-wireless.html>

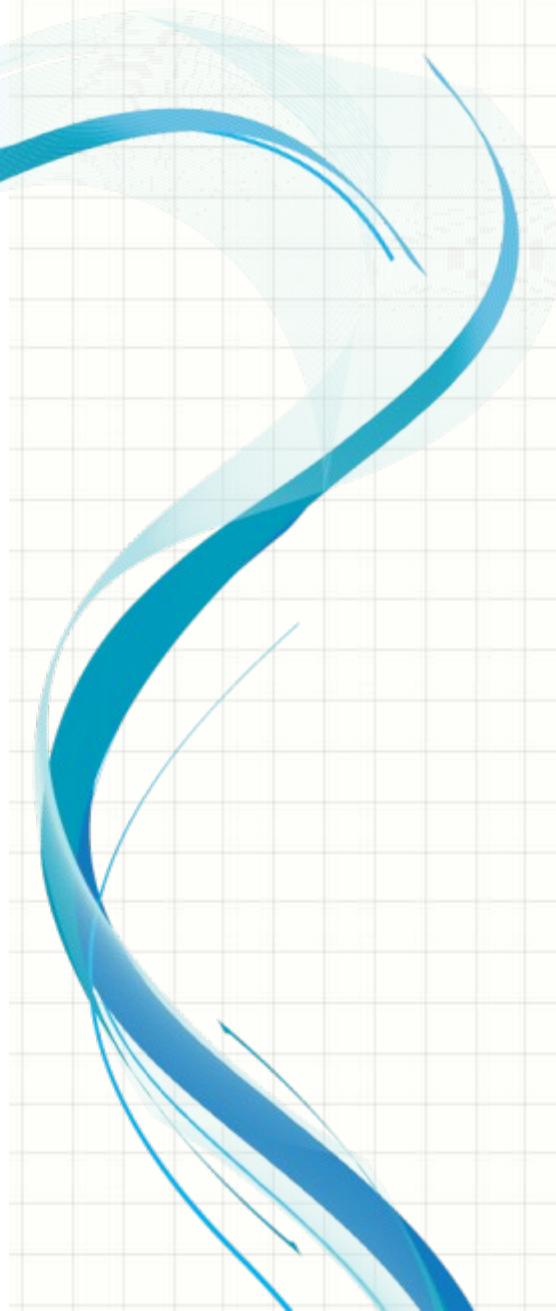
<http://www.theguardian.com/technology/internet-of-things>

# La Radio

- Wireless Communication
- Guglielmo Marconi (1897)
- 1920: Primer broadcast comercial
- Impacto profundo en la sociedad



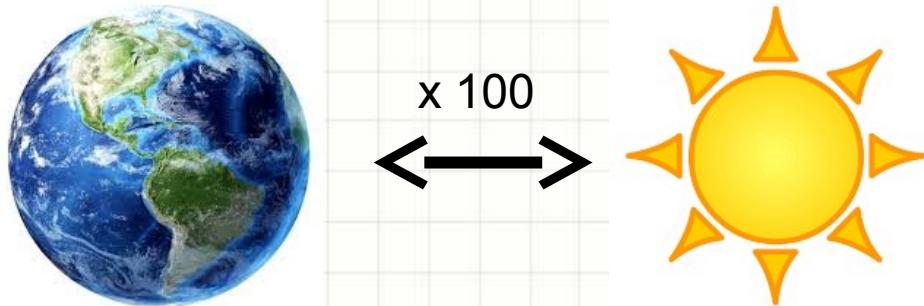
En la práctica:  
Receptor AM

A decorative graphic in the top-left corner consists of several thin, wavy lines in shades of blue and white, resembling stylized DNA strands or flowing water, set against a light gray grid background.

# **La Era Genética**

# El ADN

- Rosalind Franklin, James Watson y Francis Crick (1953)
- ¿Cuánto ADN hay en una célula?
  - 1.80m
- ¿Cuántas células tenemos?
  - Aprox. 100 trillones
- ¿Cuánto ADN tenemos en total?



- “Junk DNA”: casi el 98%!!



**Table 8-1****Genome Sizes of Various Organisms**

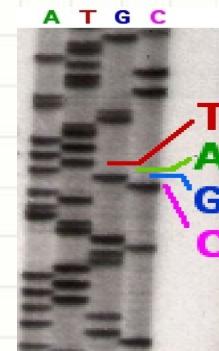
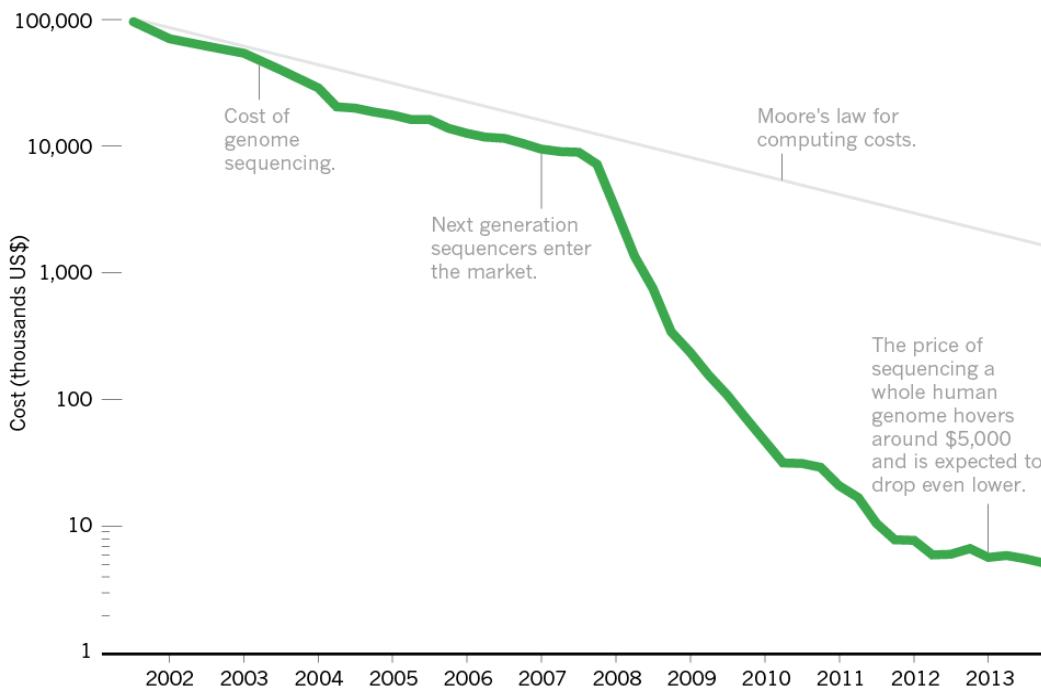
<i>Species</i>	<i>Number of Base Pairs</i>	<i>Number of Genes</i>
HIV virus	9,700	9
<i>E. coli</i>	4,600,000	3,200
Yeast	12,000,000	6,532
Flu bacteria	19,000,000	1,700
Roundworm	103,000,000	20,158
Mustard weed	120,000,000	27,379
Fruit fly	180,000,000	14,422
Chicken	1,000,000,000	15,926
Mouse	3,400,000,000	22,974
Corn	2,500,000,000	50,000–60,000
Human	3,000,000,000	22,258
Grasshopper	180,000,000,000	unknown
<i>Amoeba dubia</i>	670,000,000,000	unknown
Salamander	765,000,000,000	unknown

# Secuenciación Genoma

- Proyecto Genoma Humano (1990-2003)

## Falling fast

In the first few years after the end of the Human Genome Project, the cost of genome sequencing roughly followed Moore's law, which predicts exponential declines in computing costs. After 2007, sequencing costs dropped precipitously.

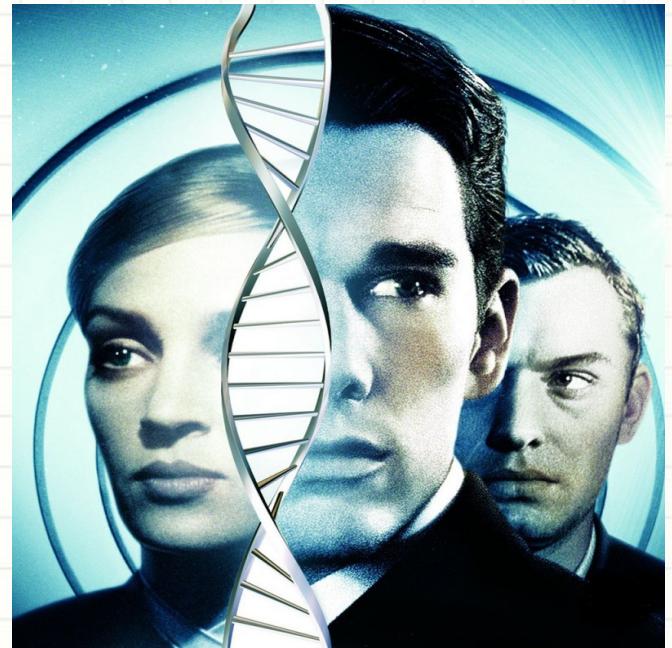


Marcaje  
Radioactivo

En la práctica:  
Extracción ADN

# ¿Qué consecuencias tiene?

- Agricultura
  - Pan sin gluten
  - Maíz resistente a plagas
  - Salmón de mayor crecimiento
- Medicina Personalizada
  - Transplante de Órganos (células madre)
  - Terapia Génica (por ej. cáncer)



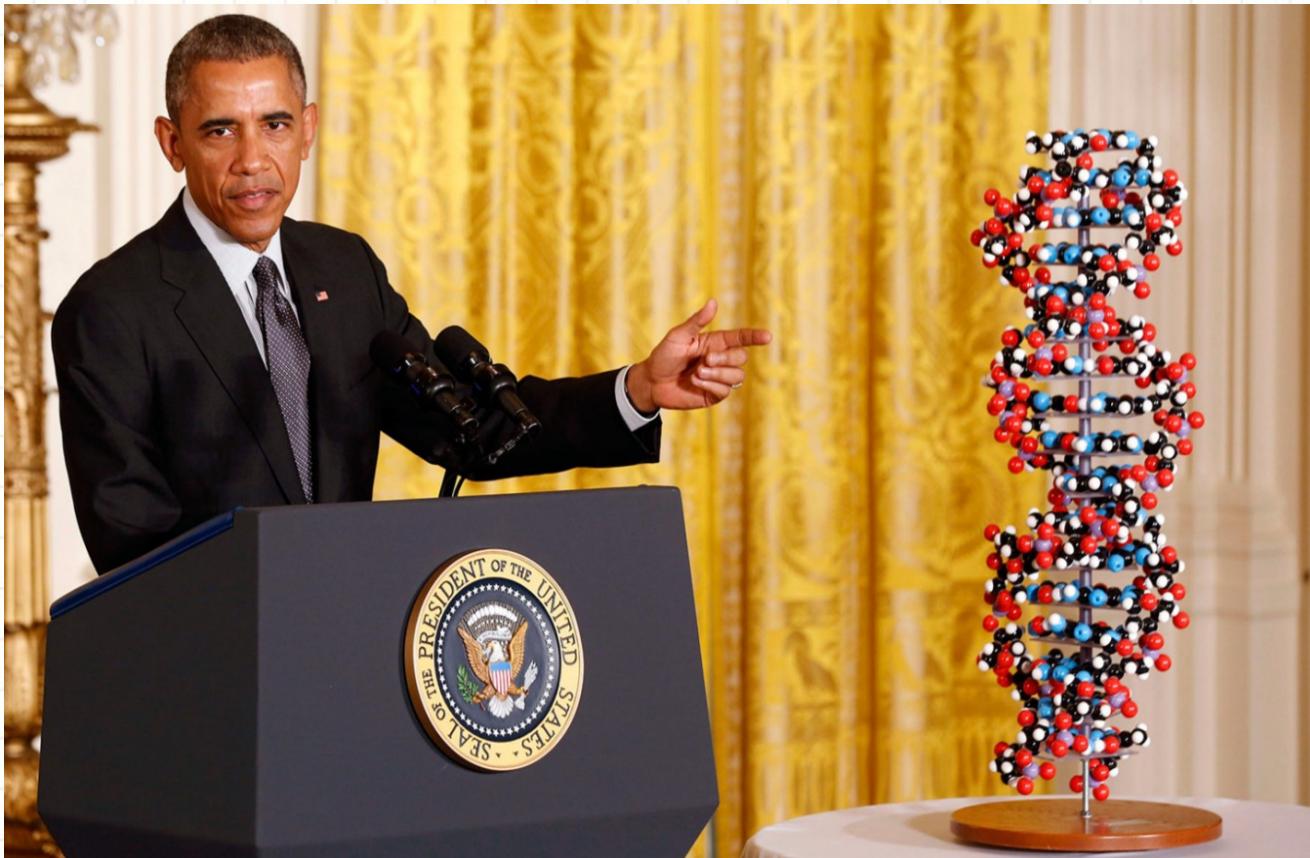
# Medicina Personalizada

¿Por qué ahora?

Datos para EEUU	Hace diez años	Ahora (datos del 2014)
Coste secuenciación genoma	\$22,000,000	\$1000-\$5000
Tiempo secuenciación genoma	2 años	< 1 día
Número de móviles	1M (< 2%)	160M (58%)
Electronic Health Records	20-30%	>90%
Poder de Cómputo	$n$	$n \times 16$

[Francis Collins, The Biology of Genomes, Cold Spring Harbor Laboratory, 5-9 de Mayo 2015]

# Medicina Personalizada



“Precision medicine speech”, 20 de enero de 2015

Presupuesto de \$215 Millones

HUMANS

# British Scientists Gain Approval To Edit DNA In Human Embryos

Updated February 2, 2016 · 6:26 PM ET

Published February 1, 2016 · 4:34 PM ET



ROB STEIN



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All Things Considered

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British regulators are giving the go-ahead to edit DNA in human embryos. Scientists say it could lead to cures for diseases, but critics fear it will lead to designer babies.

BIOTECNOLOGÍA

## LOGRAN ENCONTRAR SECUENCIAS DE ADN EN MINUTOS EN LUGAR DE DÍAS

Se trata de un nuevo sistema disponible para investigadores como código abierto

Juan Scaliter - 08/02/2016



IMPRIMIR



ENVIAR



3



Me gusta



14



Twittear



When your genome costs less than your iPhone: The beautiful, terrifying future of DNA sequencing

By Jo Best



embryos. As NPR's health correspondent, Rob Stein, reports, that's extremely controversial.

A decorative graphic in the top-left corner consists of several thick, flowing lines in shades of blue and white, resembling stylized waves or liquid. They curve from the bottom left towards the top right, partially overlapping each other.

# Exploración Espacial

- En una noche estrellada, 2.500 estrellas



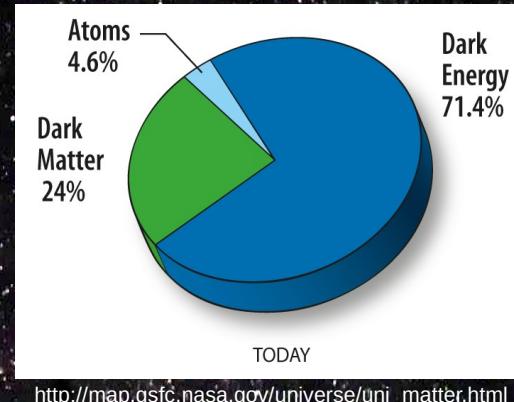
- Total:  $10^{22} - 10^{24}$  estrellas  
(Equivale a 10.000 estrellas / grano de arena)

- Similares al sol: entre 5-20%
  - Que tengan planetas similares a la tierra, entre 22-50%

- Ahora suponemos:

- .1% de los planetas tiene vida
  - 1% vida inteligente

Debería haber **100.000** civilizaciones inteligentes en nuestra galaxia !!



So where is  
everybody?



&gt; Current Issue &gt; vol. 110 no. 48 &gt; Erik A. Petigura, 19273–19278, doi: 10.1073/pnas.1319909110



## Prevalence of Earth-size planets orbiting Sun-like stars

Erik A. Petigura<sup>a,b,1</sup>, Andrew W. Howard<sup>b</sup>, and Geoffrey W. Marcy<sup>a</sup>

### Author Affiliations

Contributed by Geoffrey W. Marcy, October 22, 2013 (sent for review October 18, 2013)

A correction has been published

Abstract

Full Text

Authors & Info

Figures

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### Significance

A major question is whether planets suitable for biochemistry are common or rare in the universe. Small rocky planets with liquid water enjoy key ingredients for biology. We used the National Aeronautics and Space Administration *Kepler* telescope to survey 42,000 Sun-like stars for periodic dimmings that occur when a planet crosses in front of its host star. We found 603 planets, 10 of which are Earth size and orbit in the habitable zone, where conditions permit surface liquid water. We measured the detectability of these planets by injecting synthetic planet-caused dimmings into *Kepler* brightness measurements. We find that 22% of Sun-like stars harbor Earth-size planets orbiting in their habitable zones. The nearest such planet may be within 12 light-years.

### Abstract

Determining whether Earth-like planets are common or rare looms as a touchstone in the question of life in the universe. We searched for Earth-size planets that cross in front of their host stars by examining the brightness measurements of 42,000 stars from National Aeronautics and Space Administration's *Kepler* mission. We found 603 planets, including 10 that are Earth size ( $1 - 2 R_{\oplus}$ ) and receive comparable levels of stellar energy to that of Earth ( $0.25 - 4 F_{\oplus}$ ). We account for *Kepler*'s imperfect detectability of such planets by injecting synthetic planet-caused dimmings into the *Kepler* brightness measurements and recording the

### This Issue



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Masthead (PDF)  
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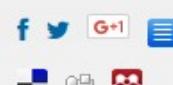
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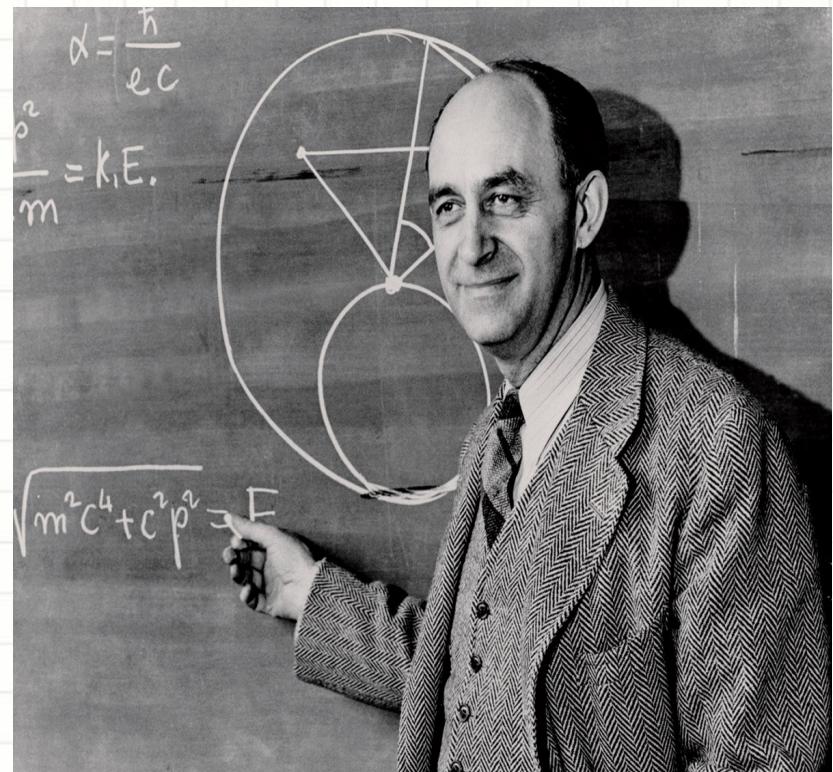
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# La paradoja de Fermi

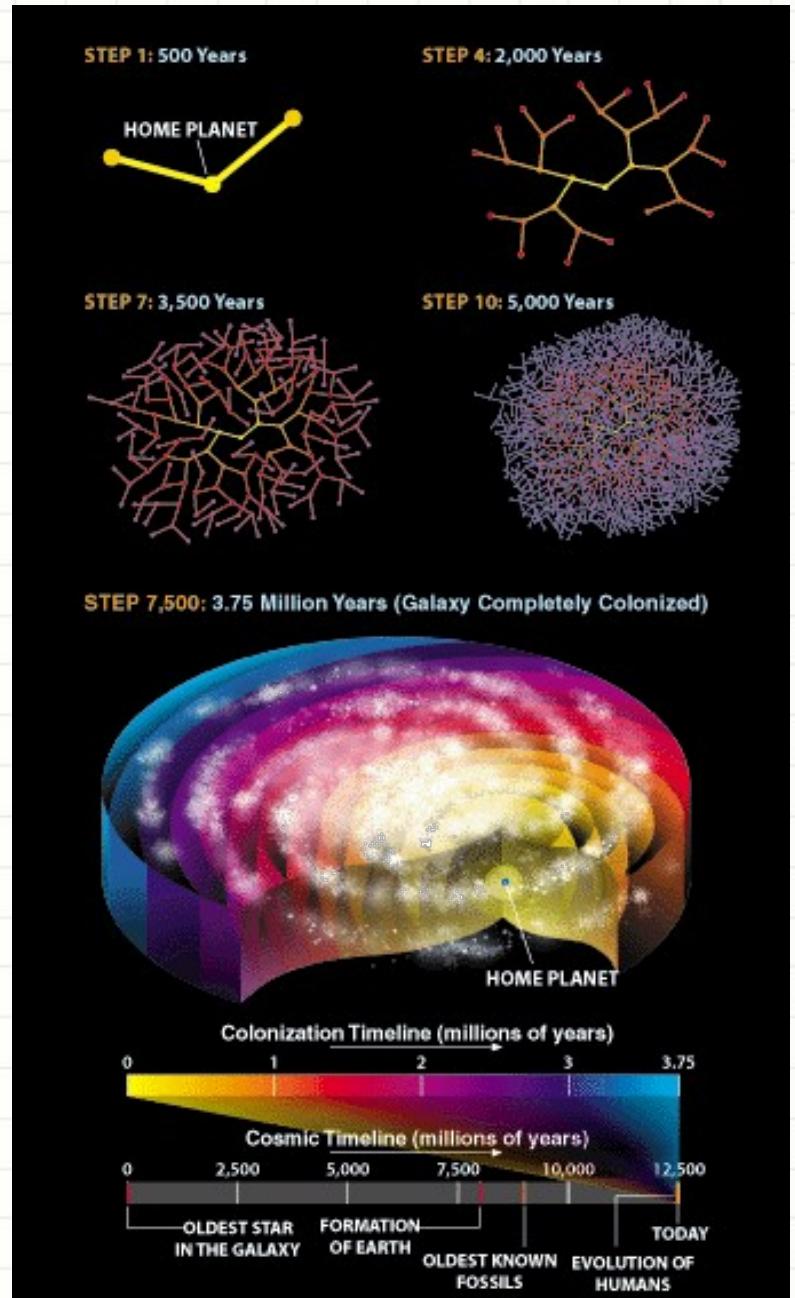
- ¿Por qué no hemos encontrado vida extraterrestre?
- SETI: Search for Extraterrestrial Intelligence (~80s)



Enrico Fermi (1901-1954)

# Escala Kardashev

- Civilizaciones en función del avance energético
  - Tipo I: planeta
  - Tipo II: estrella
  - Tipo III: galaxia
- Nosotros: Tipo I (0.7)

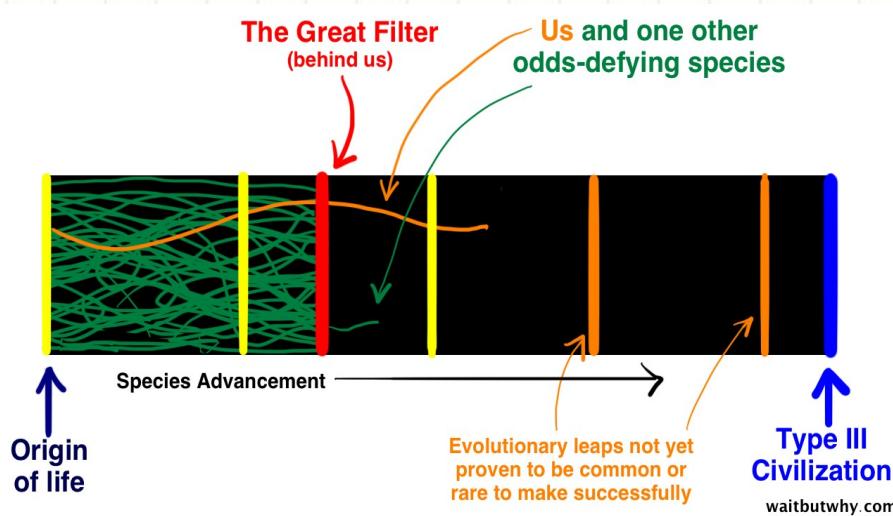


<http://channel.nationalgeographic.com/chasing-ufos/articles/what-is-the-wow-signal/>

Source: Scientific American: "Where Are They"

# Respuestas a la paradoja

- Estamos sólos: Teoría del “Gran Filtro”



- No hemos coincidido en tiempo o espacio
  - Nuestra historia sólo 5.500 años
  - Quizás Tecnología aún primitiva

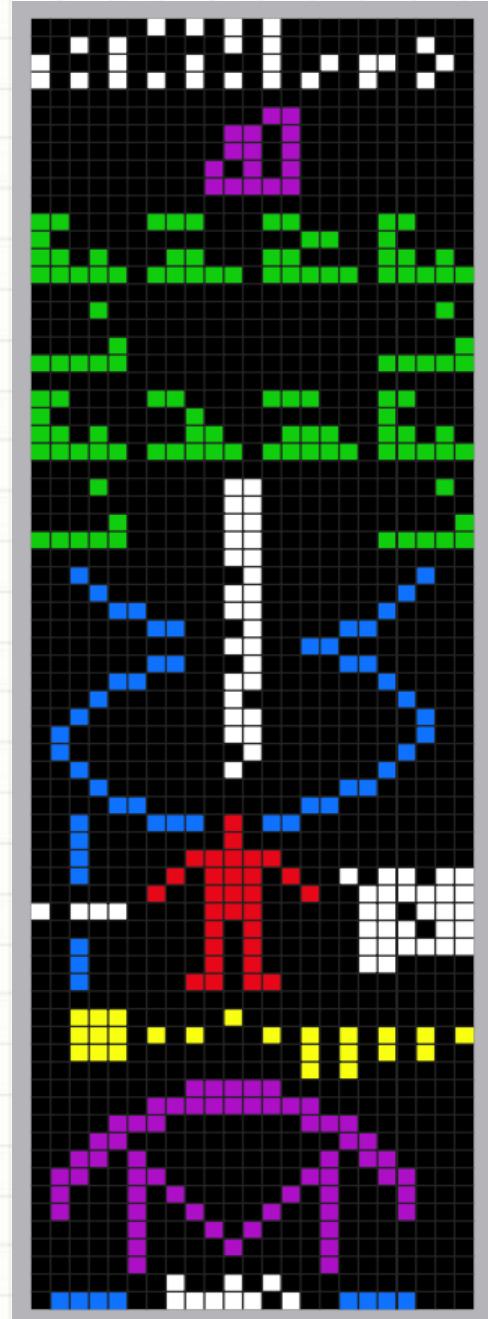
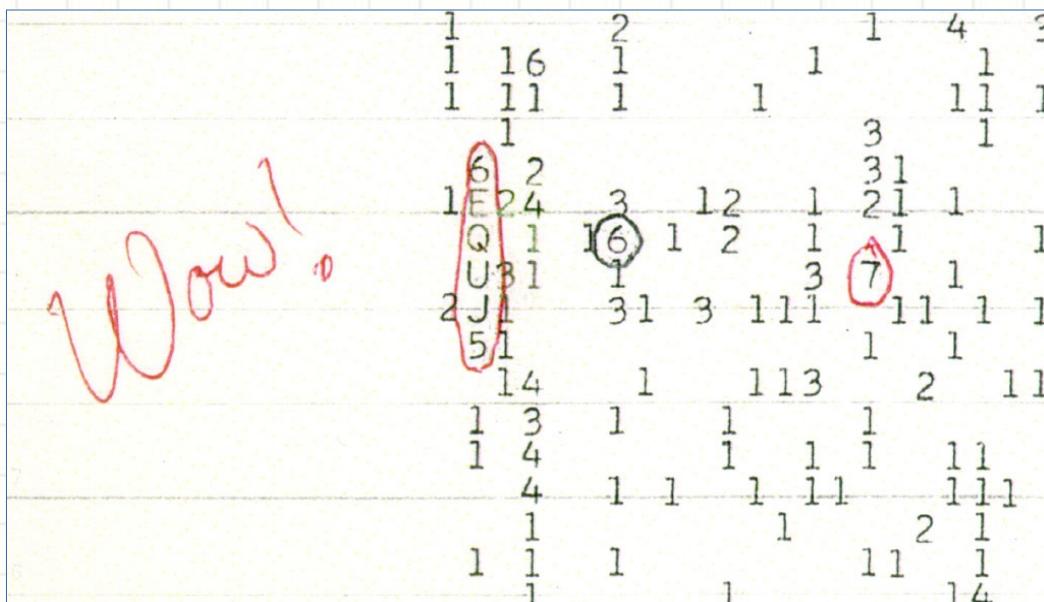


*Lets say we have an ant hill in the middle of the forest. And right next to the ant hill, they're building a ten-lane super-highway. And the question is "Would the ants be able to understand what a ten-lane super-highway is? Would the ants be able to understand the technology and the intentions of the beings building the highway next to them?*

*Michio Kaku, theoretical physicist.*

# Curiosidades

- The Arecibo message (1974)
- The Wow Signal (1977)



# Conclusiones

- Vivimos tiempos interesantes
- Ciencia se construye
- Fundamental espíritu crítico
- Trabajo multidisciplinar
- ¿Qué queréis hacer vosotros?



"What will most affect the future of humanity?"

"the internet; sustainable energy; space exploration, artificial intelligence; and reprogramming the human genetic code." - *Elon Musk*

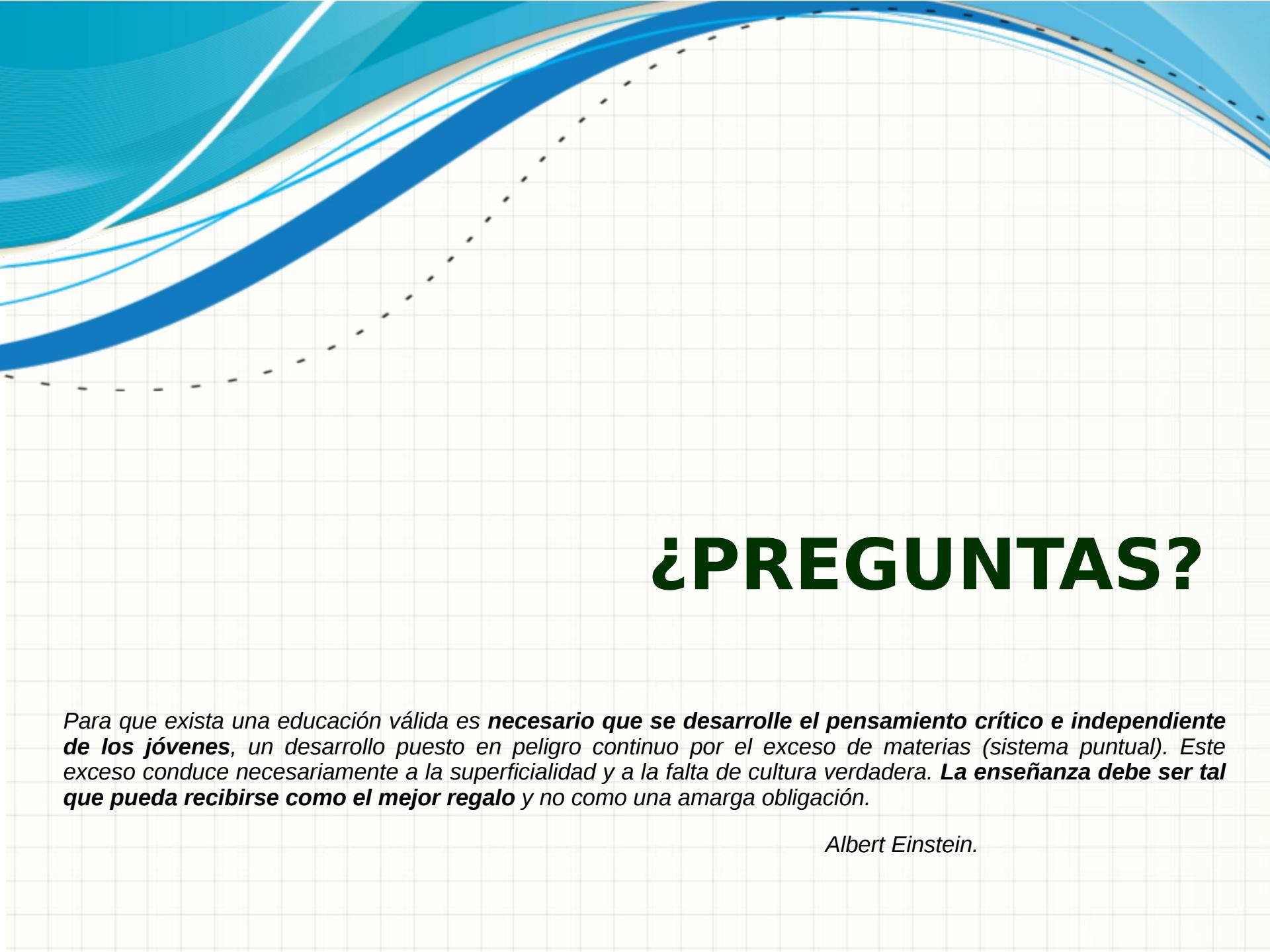
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## Enlaces Interesantes

[<http://waitbutwhy.com/>](http://waitbutwhy.com/)

[<http://www.thenakedscientists.com>](http://www.thenakedscientists.com)

[<http://www.scientificamerican.com/article/inventions-what-are-the-10-greatest-of-our-time/>](http://www.scientificamerican.com/article/inventions-what-are-the-10-greatest-of-our-time/)



# ¿PREGUNTAS?

Para que exista una educación válida es **necesario que se desarrolle el pensamiento crítico e independiente de los jóvenes**, un desarrollo puesto en peligro continuo por el exceso de materias (sistema puntual). Este exceso conduce necesariamente a la superficialidad y a la falta de cultura verdadera. **La enseñanza debe ser tal que pueda recibirse como el mejor regalo** y no como una amarga obligación.

Albert Einstein.

# Machine Learning

