

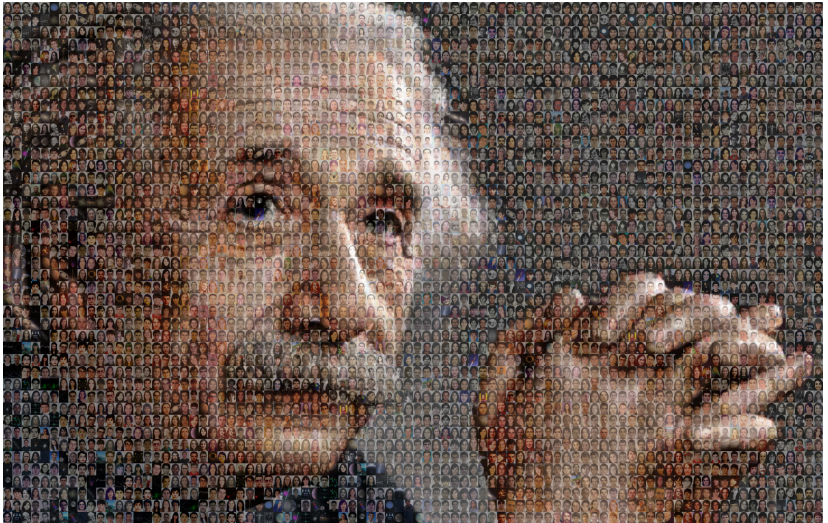
La conflictiva(?) relación entre Ciencia y Sociedad

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http://www.eweb.unex.es/eweb/fisteor/juan/juan_talks.html

Asociación para la Difusión de la Ciencia y Tecnología en Extremadura (ADiCiTEx)

Badajoz, 27 de Abril 2017



The most incomprehensible thing about the world is that it is comprehensible.

(Albert Einstein)

- Motivación.
- ¿Qué es la Ciencia?
- Una (muy) Breve Historia de la Ciencia.
- ¿Cómo se investiga?
- Un ejemplo: Del tambor al ADN.
 - 1 Universalidad de la Ciencia.
 - 2 Importancia de la Ciencia básica.
- ¿Está la Ciencia en peligro?
 - 1 Intelectuales postmodernos.
 - 2 Pseudociencias.
 - 3 Fundamentalismos.
 - 4 Los propios científicos.
- Conclusiones.

¿Qué es la Ciencia?

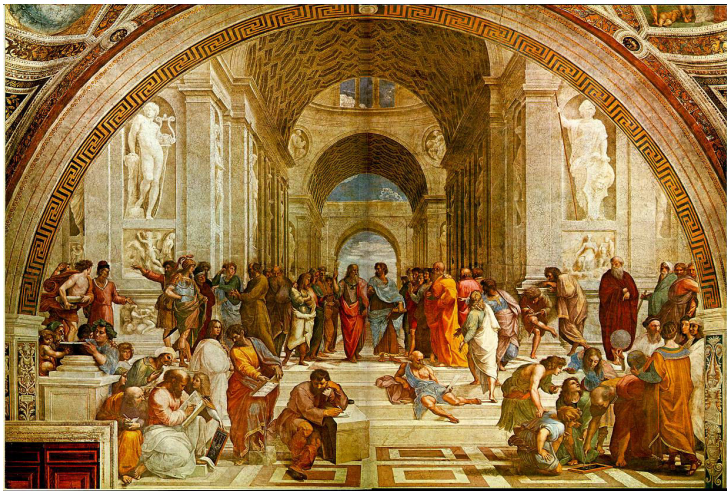
- 1 Esfuerzo intelectual *colectivo* enfocado al conocimiento racional del mundo natural (y social).
- 2 Corpus con todo el conocimiento significativo aceptado. Existencia de leyes objetivas que rigen la naturaleza y que están escritas en lenguaje matemático.
- 3 Comunidad de científicos con su estructura social y económica.
- 4 Tecnología.

¿Qué es la Ciencia?

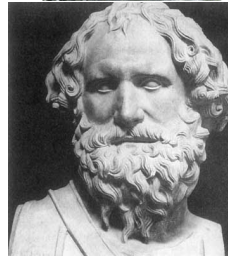
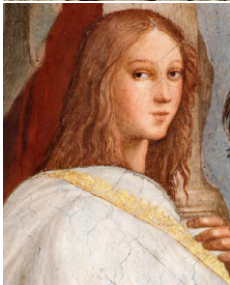
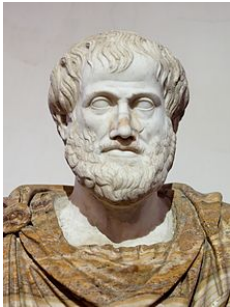
- ① Esfuerzo intelectual *colectivo* enfocado al conocimiento racional del mundo natural (y social).
- ② Corpus con todo el conocimiento significativo aceptado. Existencia de leyes objetivas que rigen la naturaleza y que están escritas en lenguaje matemático.
- ③ Comunidad de científicos con su estructura social y económica.
- ④ Tecnología.

*Thus, by science I mean, first of all, a worldview giving primacy to reason and observation and a methodology aimed at acquiring accurate knowledge of the natural and social world. This methodology is characterized, above all else, by the **critical spirit**: namely, the commitment to the incessant testing of assertions through observations and/or experiments-the more stringent the test better- and to revising or discarding those theories that fail the test... that all our empirical knowledge is tentative, incomplete and open to revision in the light of new evidence or cogent new arguments (though, of course, the most well-established aspect of scientific knowledge are unlikely to be discarded entirely).*

Μηδεις ἀγεωμέτρητος εἰσίτω μὸν τὴν στέγην.



Una (aún más breve) historia de la Ciencia



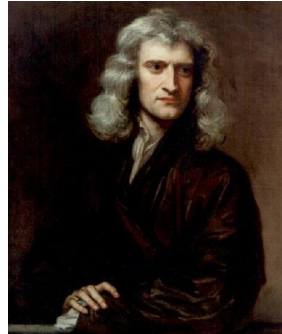
Una (aún más breve) historia de la Ciencia



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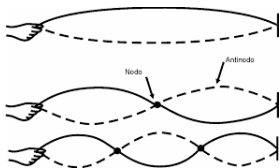
¿Cómo se investiga?





$$\frac{1}{v^2} \frac{\partial^2 \psi(t, x, y)}{\partial t^2} = \frac{\partial^2 \psi(t, x, y)}{\partial x^2} + \frac{\partial^2 \psi(t, x, y)}{\partial y^2}$$

(previo) La cuerda



$$\psi(t, x) = \sum_n a_n \sin(k_n x) e^{i\omega_n t}$$

$$\sin(k_n L) = 0, \quad k_n = \frac{n\pi}{L} = \frac{2\pi}{\lambda} = \frac{\omega}{v}$$

L es la longitud de la cuerda, ω la frecuencia y k es el número de ondas.

$$\psi(t, r, \phi) = \sum_{n,m} a_n J_n(k_{nm}r) e^{in\phi} e^{i\omega_{nm}t}$$

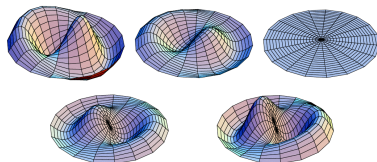
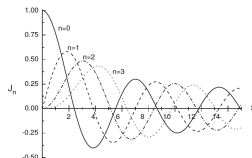


Figura 3.3. Evolución temporal a lo largo de un semiperíodo del primer modo de vibración $u_{1,1}^+(r, \theta) e^{i\omega_{1,1}t}$ para (de izquierda a derecha y de arriba hacia abajo) $t = 0, T/8, T/4, 3T/8, T/2$, donde $T = 2\pi/\omega_1$ es su periodo de oscilación.

Funciones de Bessel (de primera especie):

$$J_n(k_{nm}a) = 0, \quad k = \frac{2\pi}{\lambda} = \frac{\omega}{v}$$

a es el radio del tambor.



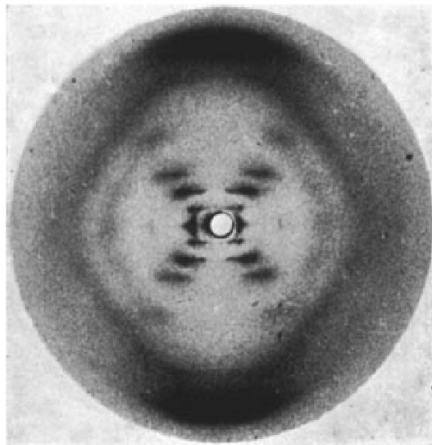
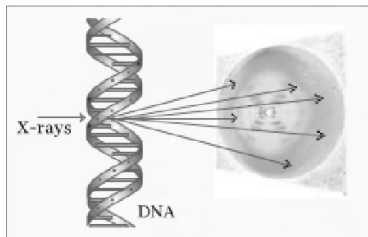
(Santos Bravo)

Friedrich Bessel

- Minden (1784)- Königsberg (1846).
- Astronomía: elementos Besselianos, uso del paralelejo en la medida de distancias a estrellas.
- Matemáticas: funciones de Bessel.
- Geodesia: Topografía de Prusia, elipsoide de Bessel, estudio de geodésicas en un elipsoide.



Difracción de Rayos X de una hélice



ADN: Rosalind Franklin

- Notting-Hill (1920)- Chelsea (1958).
- Química y cristalógrafa.
- Cambridge (1941).
- Estudió grafito, ADN, ARN y virus.
- 1951 King's College. Discrepancias con Randall y Wilkins.
- Birbeck College (1953).



Difracción de Rayos X de una hélice

Acta Cryst. (1952). 5, 581

The Structure of Synthetic Polypeptides. I. The Transform of Atoms on a Helix

BY W. COCHRAN

Crystallographic Laboratory, Cavendish Laboratory, Cambridge, England

F. H. C. CRICK

*The Medical Research Council Unit for the Study of the Molecular Structure of Biological Systems,
The Cavendish Laboratory, Cambridge, England*

AND V. VAND*

Chemistry Department, The University, Glasgow W. 2, Scotland

(Received 16 February 1952)

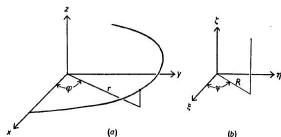


Fig. 1. (a) Cartesian (x, y, z) and cylindrical-polar (r, φ, z) coordinates of a point on a helix. (b) Corresponding coordinates of a point in reciprocal space.

length, radius r and axial spacing P . If the helix is defined by the equations

$$\left. \begin{aligned} x &= r \cos (2\pi z/P), \\ y &= r \sin (2\pi z/P), \\ z &= z, \end{aligned} \right\} \quad (1)$$

(see Fig. 1), the value of the Fourier transform at a point (ξ, η, ζ) in Fourier (reciprocal) space is given by

$$T(\xi, \eta, \zeta) = \int \exp [2\pi i(x\xi + y\eta + z\zeta)] dV,$$

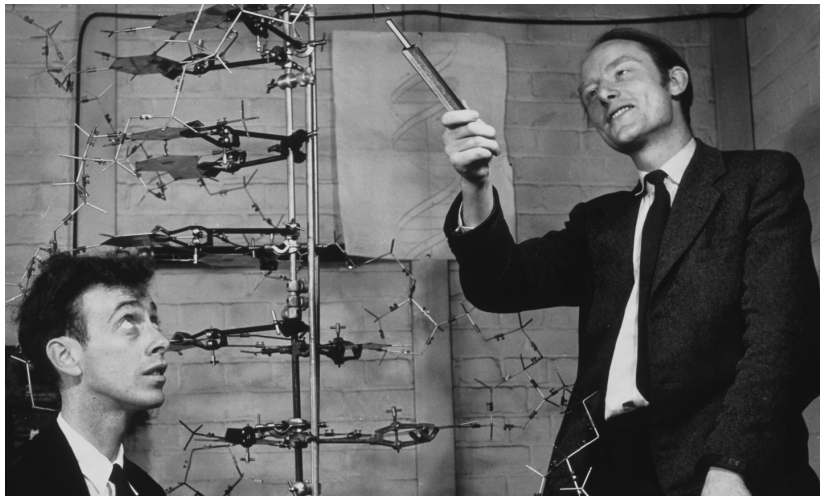
Hélice continua:

The result is

$$T(R, \psi, n/P) = J_n(2\pi Rr) \exp [in(\psi + \frac{1}{2}\pi)], \quad (3)$$

Hélice discreta:

$$F\left(R, \psi, \frac{l}{c}\right) = \sum_n T\left(R, \psi, \frac{n}{P}\right), \quad (6)$$



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- Buen ejemplo de interdisciplinariedad: Biología, Química, Física y Matemáticas.
- Ciencia Básica.
- Dió paso al descubrimiento de código genético.
- Revolución en Biología.
- Tremendas aplicaciones tecnológicas (biomedicina).
- Descubrimiento realizado de manera “sorprendente” (incluyendo los aspectos éticos).

- ¿La Ciencia es una construcción cultural?

...the postmodernist/poststructuralist subversion of conventional notions of truth. "Is it in the interests of women, African Americans, and other super-exploited people," Robbins asks, "to insist that truth and identity are social constructions? Yes and no," he asserts. "No, you can't talk about exploitation without respect for empirical evidence" – exactly my point. "But yes," Robbins continues, "truth can be another source of oppression."

(Alan Sokal)

¿Está la Ciencia en peligro? El caso Sokal



Transgressing the Boundaries:
Towards a Transformative Hermeneutics
of Quantum Gravity

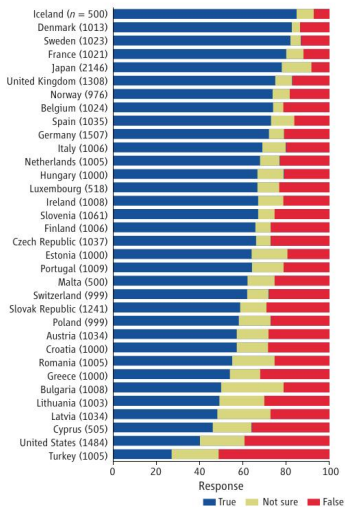
A Physicist Experiments With Cultural Studies

¿Está la Ciencia en peligro? Pseudociencias. Homeopatía

- 1 “Principios activos” extremadamente diluidos.
- 2 Tan extremadamente diluidos que pudieran no contener ninguna molécula del “principio activo”.
- 3 ¿Efecto Memoria?
- 4 Las fluctuaciones térmicas borran cualquier tipo de memoria en picosegundos!!

¿Está la Ciencia en peligro? Fundamentalismos

Human being, as we know them, developed from earlier species of animals?



(Miller et al. Science 313, 765-766 (2006))

- Fraude científico.
- Sacar de contexto (fuera de su rango de validez) los resultados.
- Politización de la Ciencia.
- Conflicto de intereses.
- Responsabilidad de las revistas especializadas (e.g. homeopatía y la revista Lancet).
- Se anuncian los resultados antes de ser aceptados por la revista científica.
- Se divulgan los resultados usando un lenguaje confuso.

Science no longer confronts nature as an objective observer, but sees itself as an actor in this interplay between man and nature.

(Werner Heisenberg)

- La aparición de nuevos escenarios teóricos como la teoría de cuerdas o la inflación cósmica (multiverso) ponen en duda la validez del método científico.
- *Scientific method: Defend the integrity of physics* (Ellis, Silk, Nature 516, 321–323 (2014)).

They began to argue — explicitly — that if a theory is sufficiently elegant and explanatory, it need not be tested experimentally, breaking with centuries of philosophical tradition of defining scientific knowledge as empirical. We disagree. As the philosopher of science Karl Popper argued: a theory must be falsifiable to be scientific.

...theorist Paul Steinhardt wrote in this journal that the theory of inflationary cosmology is no longer scientific because it is so flexible that it can accommodate any observational result. Theorist and philosopher Richard Dawid and cosmologist Sean Carroll have countered those criticisms with a philosophical case to weaken the testability requirement for fundamental physics.

Responsabilidad de los Científicos

...applaud the fact that Dawid, Carroll and other physicists have brought the problem out into the open. But the drastic step that they are advocating needs careful debate. This battle for the heart and soul of physics is opening up at a time when scientific results — in topics from climate change to the theory of evolution — are being questioned by some politicians and religious fundamentalists. Potential damage to public confidence in science and to the nature of fundamental physics needs to be contained by deeper dialogue between scientists and philosophers.

He[Carroll] offered two other requirements: a scientific theory should be “definite” and “empirical”. By definite, Carroll means that the theory says “something clear and unambiguous about how reality functions”. By empirical, he agrees with the customary definition that a theory should be judged a success or failure by its ability to explain the data.

He argues that inaccessible domains can have a “dramatic effect” in our cosmic back-yard, explaining why the cosmological constant is so small in the part we see. But in multiverse theory, that explanation could be given no matter what astronomers observe. All possible combinations of cosmological parameters would exist somewhere, and the theory has many variables that can be tweaked.

To state that a theory is so good that its existence supplants the need for data and testing in our opinion risks misleading students and the public as to how science should be done and could open the door for pseudoscientists to claim that their ideas meet similar requirements.

Yet numerous historical examples point to how, in the absence of adequate data, elegant and compelling ideas led researchers in the wrong direction, from Ptolemy's geocentric theories of the cosmos to Lord Kelvin's 'vortex theory' of the atom and Fred Hoyle's perpetual steady-state Universe.

The imprimatur of science should be awarded only to a theory that is testable. Only then can we defend science from attack.

- Es la única herramienta conocida capaz de proporcionarnos conocimiento significativo sobre el mundo que nos rodea.
- Aumenta el corpus con todo el conocimiento aceptado.
- Como efecto secundario, desarrolla tremendamente el espíritu crítico en la sociedad (democrática).
- Permite la toma razonada de decisiones en otro tipo de ámbitos.





(George Gamow)



Función de Airy:

$$I \propto \text{Ai}^2(z)$$

¡Muchas gracias por su atención!