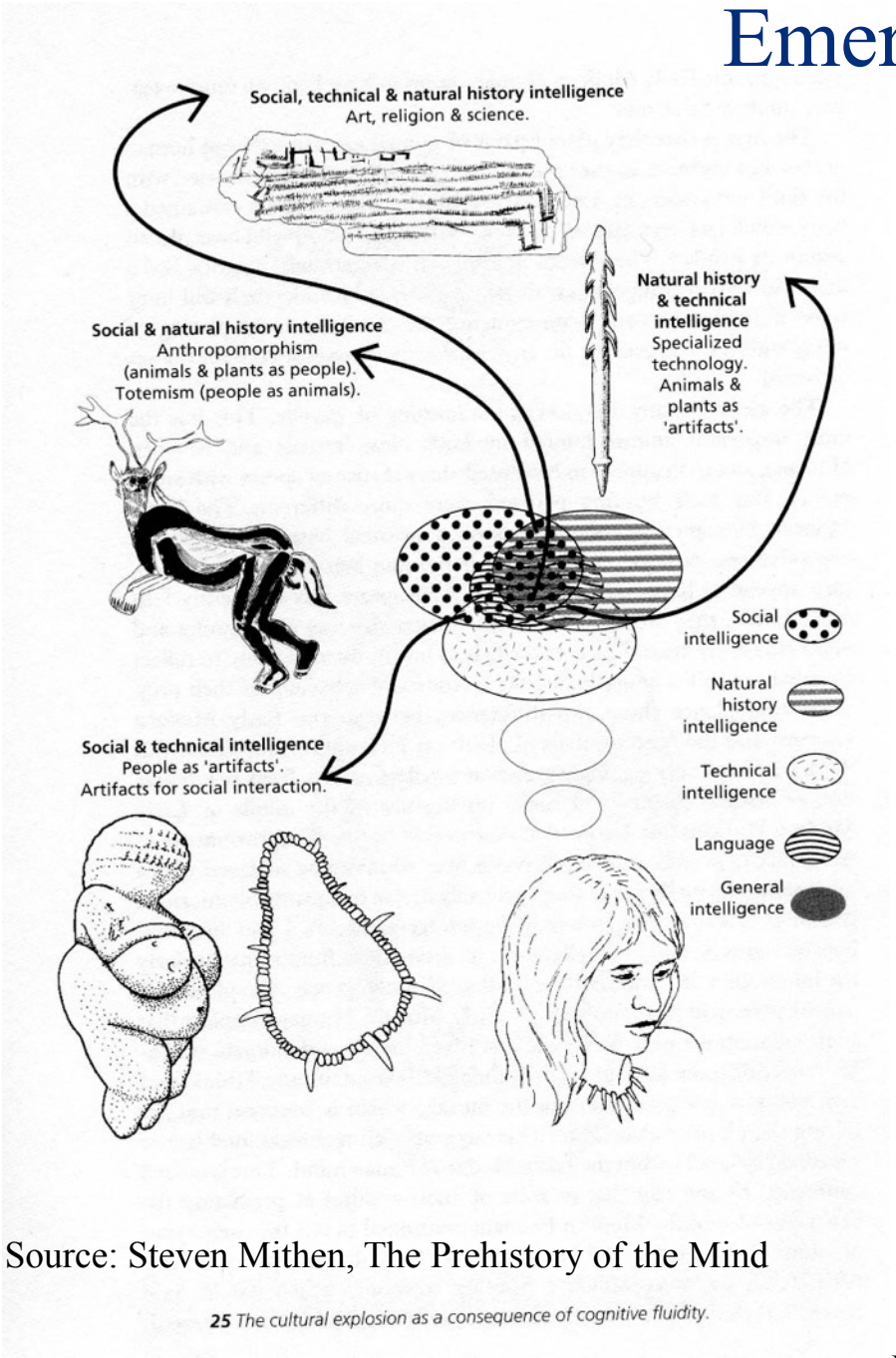
Random steps in the history of science

4.2.2011

Jarl-Thure Eriksson

Mnajdra Temple ca 3600 BC, Malta.
(J-T Eriksson 2012)

Emergence of human cognition



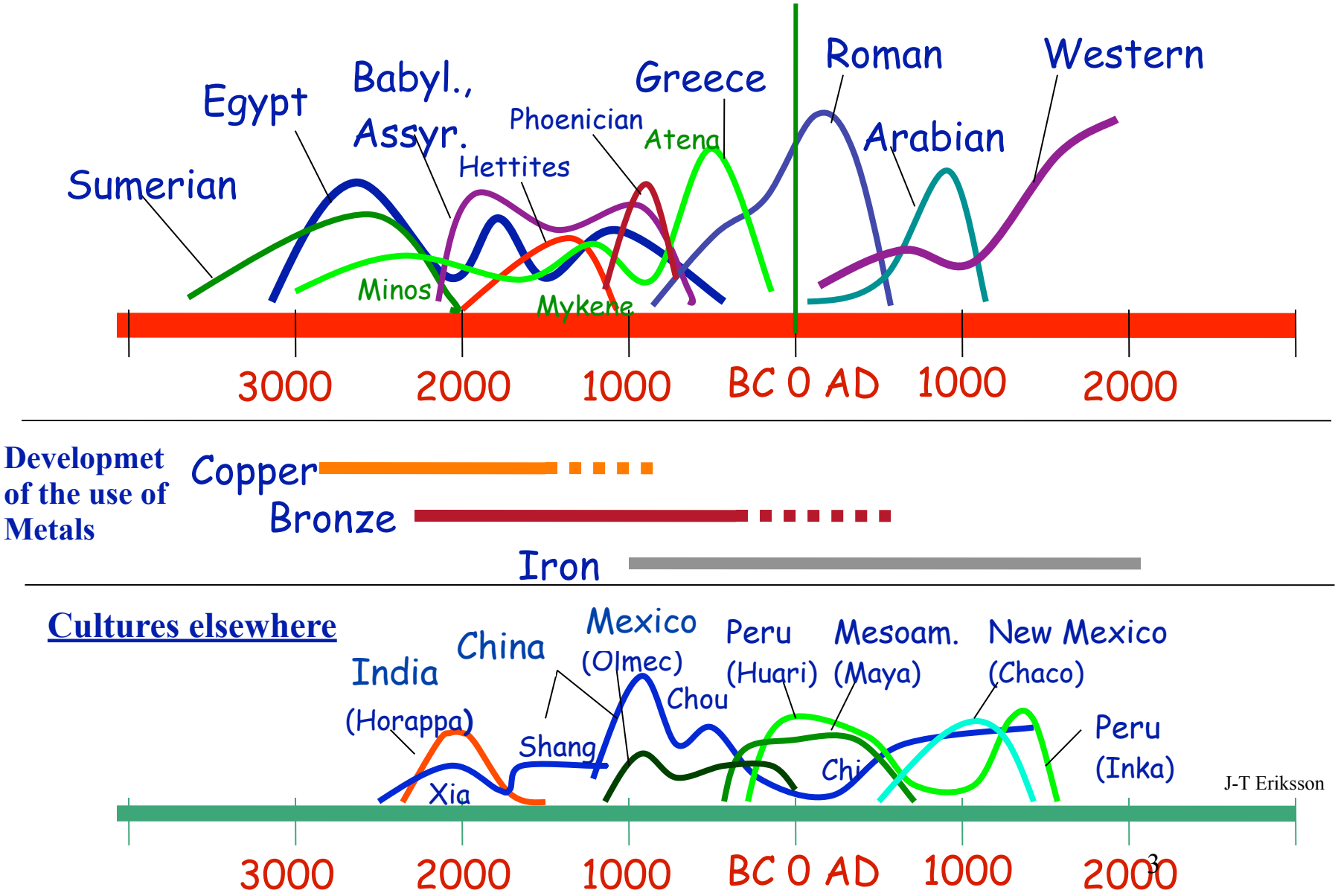
Source: Steven Mithen, The Prehistory of the Mind

Intellectual skills were distributed into different brain areas in the primitive human being. Areas did not communicate.

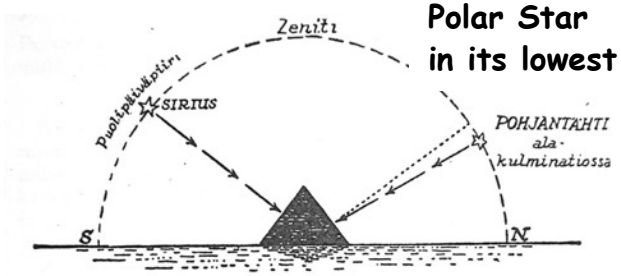
The development of language facilitated cognitive thinking.

30.000 years ago a giant developmental leap in brain function:
Fantasy removed the human being from a stiff anchoring to the instant of reality.

”Roots of the Western Culture”



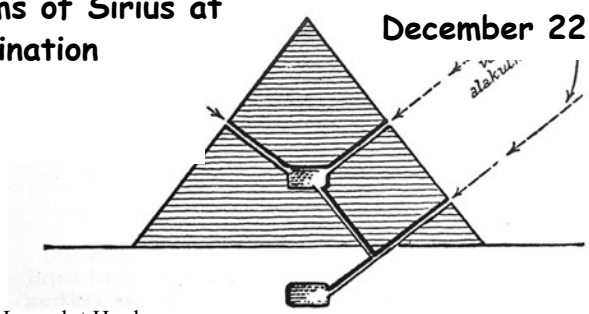
Only heaven knows



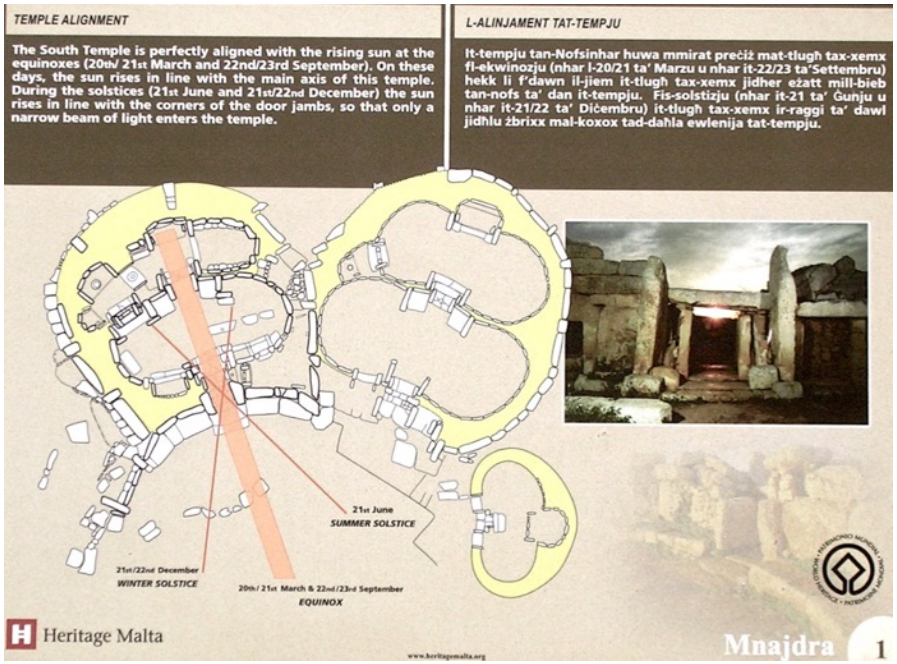
Polar Star
in its lowest position

Beams of Sirius at culmination

Polar Star beams entering December 22,



Lancelot Hogben



Mnajdra Temple, Malta. (J-T Eriksson 2012)

The pyramids are in themselves architectural and structural wonders considering the age over 5 millennia.

Moreover they reveal features related to an astronomical calender.

Most cultures believed that heaven and star constellations had on influence on the future. Hence they observed the sky and recorded unusual events, cf. Chinese records of supernovas.

Origin of scientific thought: the Greek philosophers

Platon and Aristoteles
Painting by Michelangelo, the Vatican

Greek philosophy emerged in the 6th and flourished in the 4th century. Most famous are.

Sokrates
Platon
Aristoteles

Features:

1. Initially based on argumentation and discussion.
2. Questions related to life and social needs.
3. Logics of language.
4. Contemplation over natural phenomena and deduction into mental models.

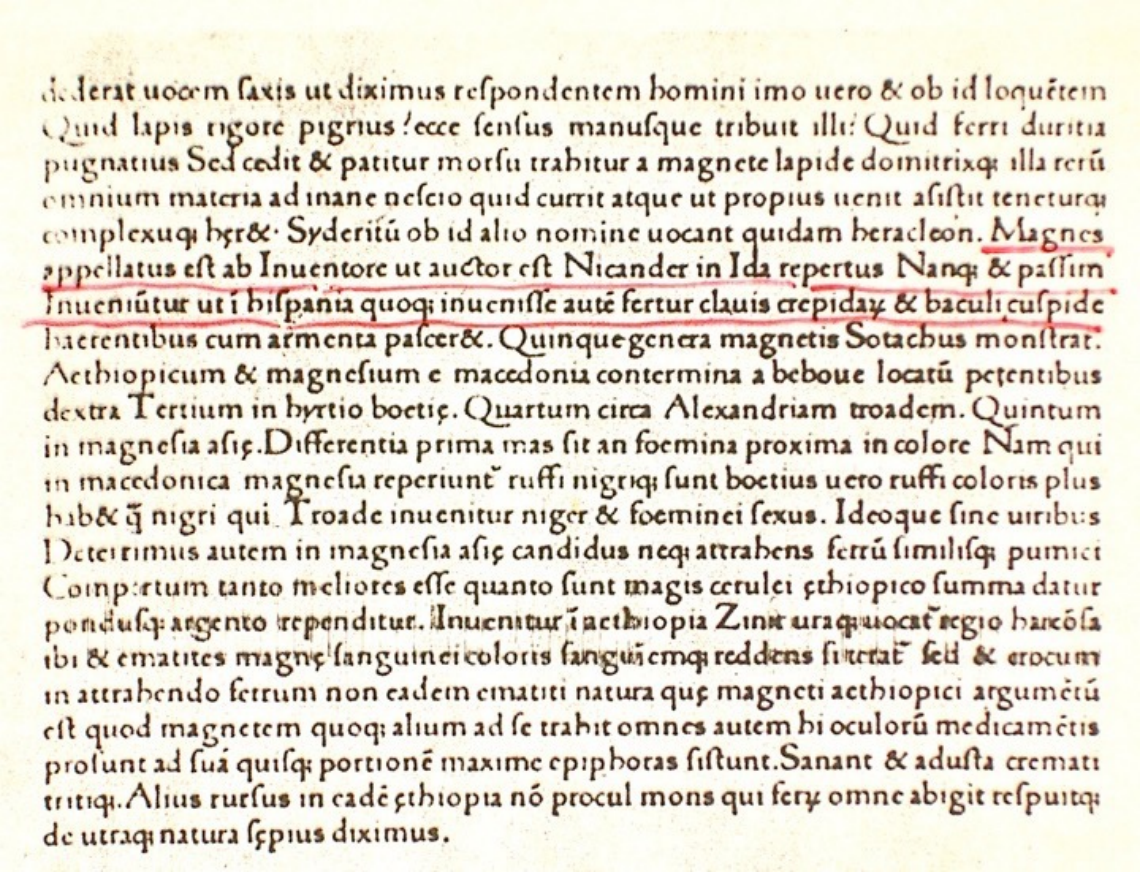
Impact

- fundamental on human thinking and social interaction,
- less successful in natural science due to the lack of empiric verification.

Magnetism, the mystery phenomenon

First compass used by the Chinese Emperor ca 200 BC

Naturalis Historie by Pliny the Elder, 37 “books”



dederat uocem ſaxis ut diximus reſpondentem homini imo uero & ob id loquẽtem
Quid lapis rigore pigrius? ecce ſenſus manuſque tribuit illi? Quid ferri duritia
pugnatius Sed cedit & patitur morſu trahitur a magnete lapide domitrixq; illa rerũ
omnium materia ad inane neſcio quid currit atque ut propius uenit aſiſtit teneturq;
complexuq; hęr&· Syderitũ ob id alio nomine uocant quidam heracleon. Magnes
appellatus eſt ab Inuentore ut auctor eſt Nicander in Ida repertus Nanq; & paſſim
Inueniũtur ut ĩ hiſpania quoq; inueniſſe autẽ fertur clauis crepidaꝝ & baculi cuſpide
haerentibus cum armenta paſcer&. Quinque genera magnetis Sotachus monſtrat.
Aethiopicum & magneſium e macedonia contermina a beboue locatũ petentibus
dextra Tertium in hyrtio boetię. Quartum circa Alexandriam troadem. Quintum
in magneſia aſię. Differentia prima mas ſit an foemina proxima in colore Nam qui
in macedonica magneſia reperiuntur ruffi nigriq; ſunt boetius uero ruffi coloris plus
hab& q̃ nigri qui Troade inuenitur niger & foeminei ſexus. Ideoque ſine uiribus
Deteriimus autem in magneſia aſię candidus neq; attrahens ferrũ ſimiliſq; pumici
Comperiumtanto meliores eſſe quanto ſunt magis ceruleĩ ęthiopico ſumma datur
pondu ſq; argento reponditur. Inuenitur ĩ aethiopia Zinnt uraq; uocat regio hanc ōſa
ibi & ematites magnę ſanguinei coloris ſanguĩ emq; reddens ſi teratur ſed & crocum
in attrahendo ferrum non eadem ematiti natura quę magneti aethiopici argumẽtũ
eſt quod magnetem quoq; alium ad ſe trahit omnes autem hi oculorũ medicamẽtis
proſunt ad ſuá quiſq; portionẽ maxime epiphoras ſiſtunt. Sanant & aduſta cremati
tritiq;. Alius rurſus in cadẽ ęthiopia nõ procul mons qui ferę omne abigit reſpuitq;
de utraq; natura ſępius diximus.

Free translation: According to the author Nikander, Magnes is considered the inventor, as he noticed that the sandal buckle sticked to the iron tip of his shepherd’s staff, when herding his cattle on the slopes of the Ida mountain.

Pliny the Elder, b. 23 AD, died at the eruption of Vesuvius in 79 AD. Provincial governor of the Roman Empire. Natural philosopher, author.

Peter Peregrinus description of the compass rose in the 13th century

Epistola de Magnete, 1269

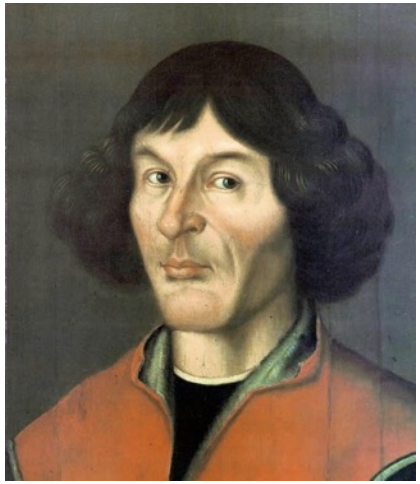
The World goes around and around

Out of the medieval darkness

After Columbus 1st trip to America in 1492 it was quite clear that the Earth was a globe.

Discrepancy in the Julian calender led to new studies of the movements of the planets and the Earth in relation to the sun. This was one factor behind Copernicus' Heliocentric theory, published in 1543, but known to the church already 1536.

Illustration of the planetary system with the Sun in the centre. From the book "De revolutionibus orbium coelestium" by Copernicus.



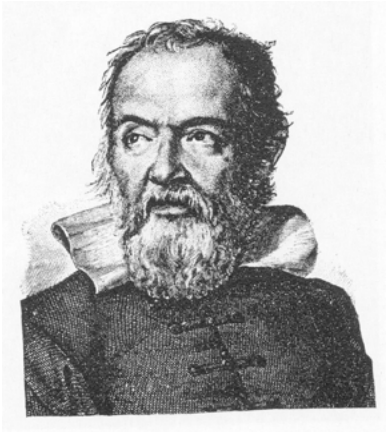
Nicolaus Copernicus
1473-1543

Source: Leonardo da Vinci

Leonardo da Vinci creating mental models of turbulence

The complex phenomena of Nature have to be studied and mentally processed before generalizing theories or mathematical models can be formulated.

Science and philosophy of the Enlightenment era



Galilei
1564-1642

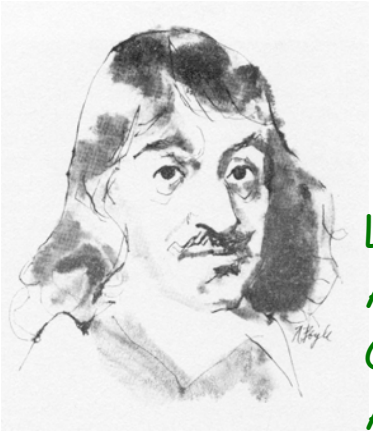
Empiric method
Theory of motion

Newton
1642-1727

Mechanics&dynamics
Optics
Gravitaion
Calculus
Principia

Heliocentric. Telescope 1637 1684

1604 1609 Discours Nova Methodus 1687



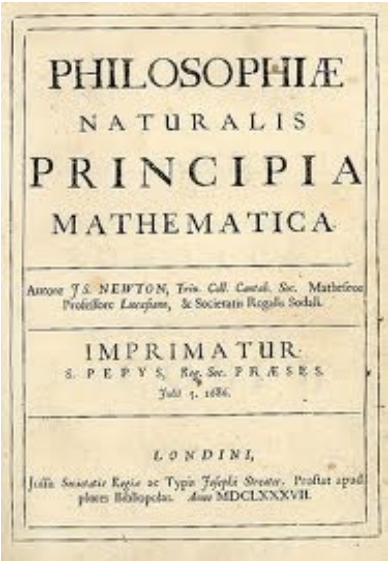
Descartes
1596-1650

Lawyer, pholosopher
Anatomy
Consciousness
Analytic geometry

Leibniz
1646-1716

Lawyer, diplomat
Pholosopher
Calculus

Isaak Newton


PHILOSOPHIÆ
NATURALIS
PRINCIPIA
MATHEMATICA

Autore J. S. NEWTON, Trin. Coll. Cantab. Soc. Matheseos Professore Lucasiano, & Societatis Regalis Sodali.

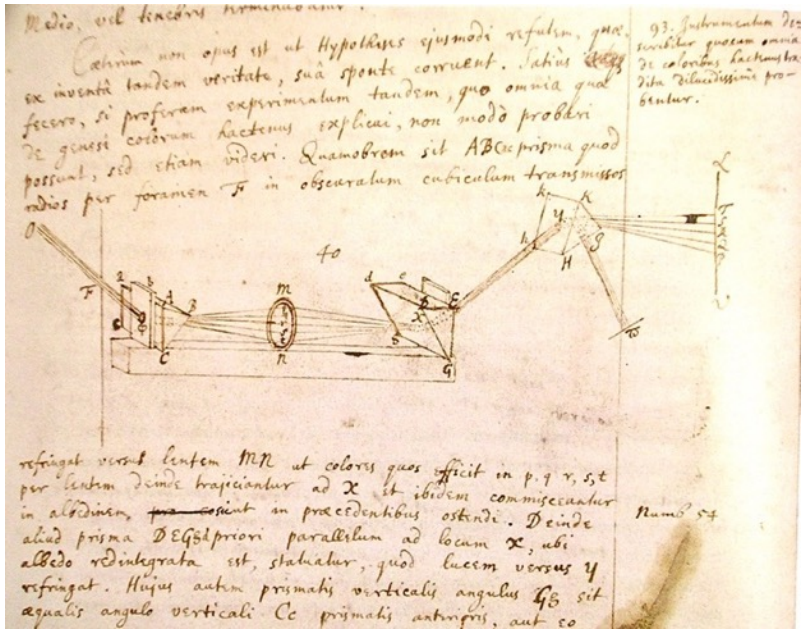
IMPRIMATUR.
S. PEPYS, Reg. Soc. PRÆSES.
Julii 5. 1686.

LONDINI,
Jussu Societatis Regiæ ac Typis Josephi Streater. Prostat apud plures Bibliopolas. Anno MDCLXXXVII.

Isaak Newton, 1643-1729, English physicist

Impact:
- the laws of moving rigid bodies
- optics and the nature of light (corpuscle theory)
- the law of gravitation facilitating the calculation of the orbital movements of celestial bodies

Death mask of Isaak Newton, age 85



Original notes by Newton: The light spectrum

Leibniz original text from 1684, 3 years before Newton published his Principia

MENSIS OCTOBRIS A. M DC LXXXIV. 467

NOVA METHODUS PRO MAXIMIS ET MINIMIS, itemque tangentibus, quæ nec fractas, nec irrationales quantitates moratur, & singulare pro illis calculi genus, per G. G. L.

SIt axis AX, & curvæ plures, ut V V, W W, Y Y, Z Z, quarum ordinatæ, ad axem normales, V X, W X, Y X, Z X, quæ vocentur respective, v, w, y, z; & ipsa A X abscissa ab axe, vocetur x. Tangentes sint V B, W C, Y D, Z E axi occurrentes respective in punctis B, C, D, E. Jam recta aliqua pro arbitrio assumta vocetur dx, & recta quæ sit ad dx, ut v (vel w, vel y, vel z) est ad V B (vel W C, vel Y D, vel Z E) vocetur dv (vel dw, vel dy vel dz) sive differentia ipsarum v (vel ipsarum w, aut y, aut z) His positis calculi regulæ erunt tales: TAB. XII

Sit a quantitas data constans, erit da æqualis o, & d ax erit æqua dx: si sit y æqu v (seu ordinata quævis curvæ Y Y, æqualis cuivis ordinatæ respondenti curvæ V V) erit dy æqu. dv. Jam *Additio & Subtractio*: si sit z — y + w + x æqu. v, erit d z — y + w + x seu d v, æqu d z — d y + d w + d x. *Multiplicatio*, d x v æqu. x d v + v d x, seu posito y æqu. x v, fiet d y æqu. x d v + v d x. In arbitrio enim est vel formulam, ut x v, vel compendio pro ea literam, ut y, adhibere. Notandum & x & d x eodem modo in hoc calculo tractari, ut y & dy, vel aliam literam indeterminatam cum sua differentiali. Notandum etiam non dari semper regressum a differentiali Æquatione, nisi cum quadam cautione, de quo alibi. Porro *Divisio*, d $\frac{v}{y}$ vel (posito z æqu. $\frac{v}{y}$) d z æqu. $\frac{+v\,dy - y\,dv}{yy}$

Quoad *Signa* hoc probe notandum, cum in calculo pro litera

Gottfried Liebniz , lawyer and librarian at the Library of Hanover.

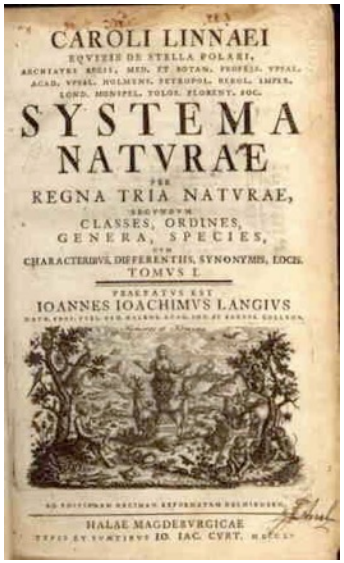
Along with Descartes and Spinoza the most influential philosopher of the 17th century.

Mathematics was merely a hobby. Background problem: finding minimas and maximas of a function.

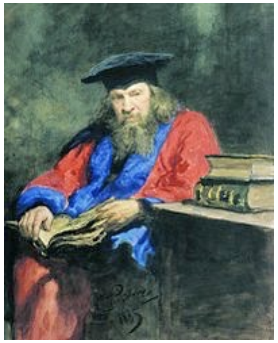
Leibniz infinitesimal definitions (dx, dy) were more formal and logic than the nomenclature developed by Newton.

Large scale systematization

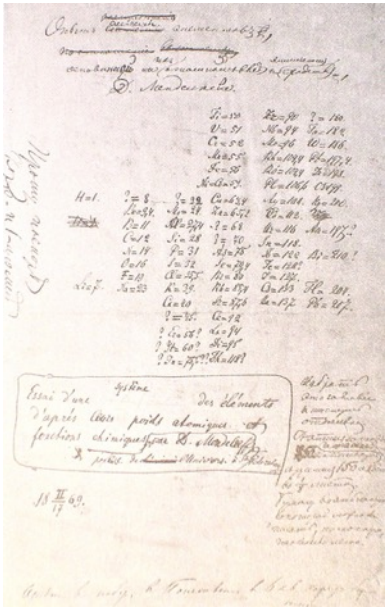
Carl Linnæus, 1707-1778, Swedish naturalist
- studied medicine, lecturer in botany
- thesis on plant sexuality in 1729
- visit to Holland in 1936 resulted in the maturation of the great idea of organizing plants according to their reproduction mechanism
- Systema Naturæ first published in **1738**



Charls Darwin, 1809-1882, English naturalist
- medical studies
- interest in botany
- journey of the Beagle, 1831-36
- publication of The Origin of Species in **1859**

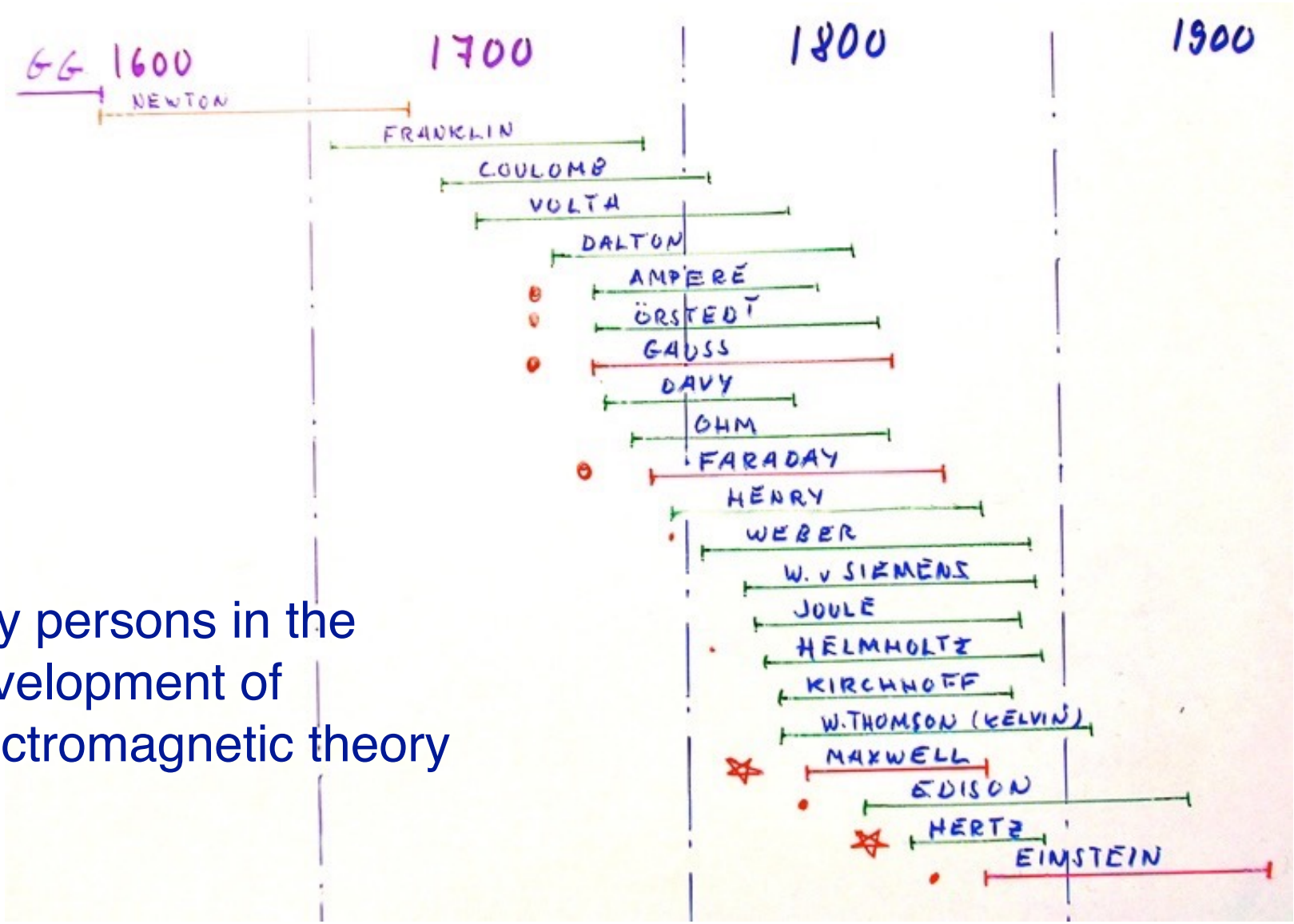


Dmitrij Mendelejev, 1834-1907
- Russian chemist
- professor at universities in St Petersburg 1864-90
- published his first version of the Periodic System in **1869**



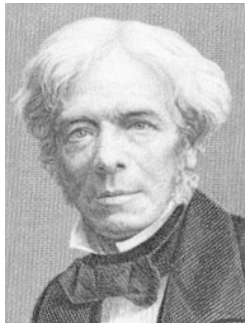
Notes by Mendelejev

Key persons in the development of electromagnetic theory



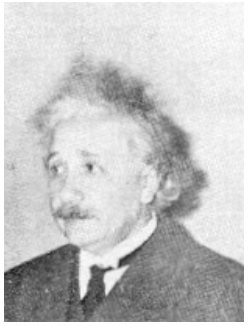
Dalton
1766-1844

"Atoms"

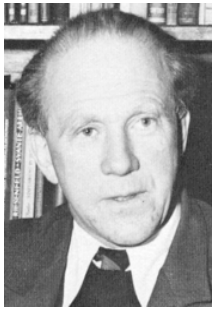


Faraday
1791-1867
Fundamentals of electricity and magnetism

Maxwell
1831-1879
Electro-magnetic-theory



Einstein
1879-1955
Theory of Relativity
Photons



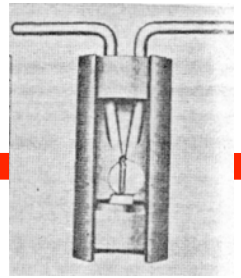
Heisenberg
Quntum mechanics
Uncertainty principle

Bardeen
Transistor
Theory of superconduct.

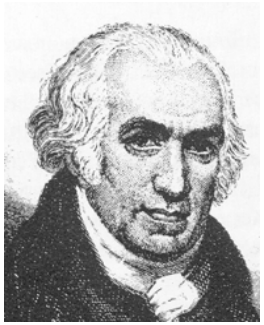
1800

Science

1900



Engineering



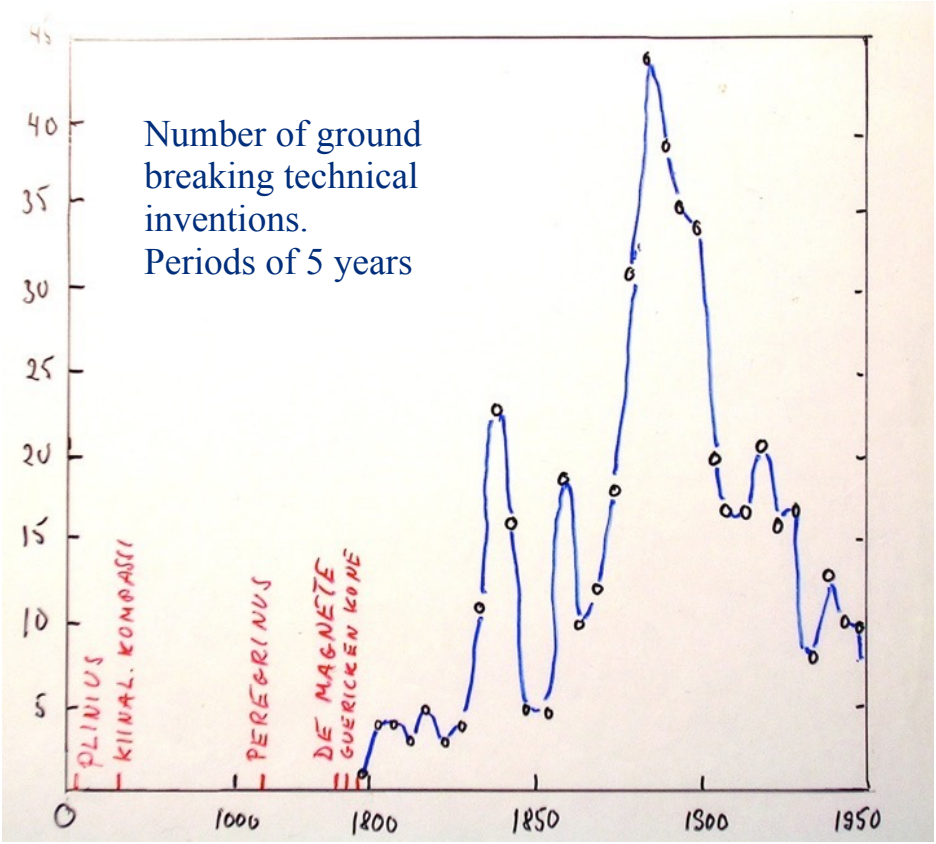
James Watt
1736-1819
Steam engine

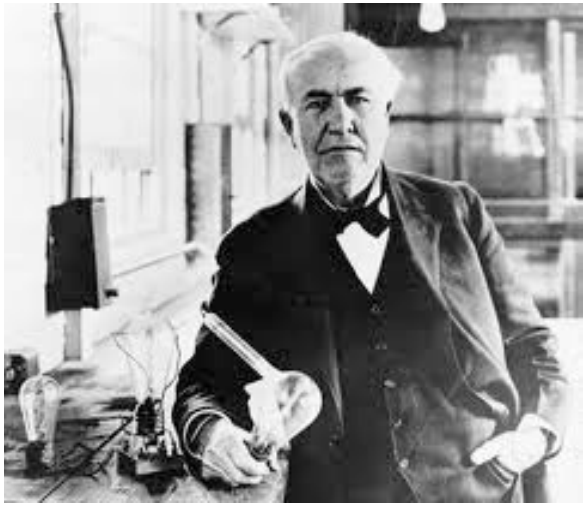
Daguerre
1787-1851
Photography

Edison
1847-1931
Electric bulb
Phonograph
Motion Picture

Orwille
Wright
1871-1931
Motor
Aeroplane

Marconi
1874-1937
Wireless telecomm





Edison and his electric light bulb, 1878

Phonographe, 1877

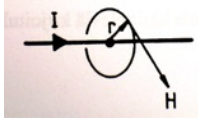
Cinematopgraphe, 1894

Bell's telephone, 1876

From Volta and Ampere to Maxwell and Einstein: The development of electromagnetic theory

$$I = \oint \bar{H} \cdot d\bar{l}$$

$$I = 2\pi r H \;\Rightarrow\; H = \frac{I}{2\pi r}$$



Ampere's law

$$e = -\frac{d\phi}{dt}$$

$$\int \bar{D} \cdot d\bar{A} = \int \rho_q \, dV$$

$$\phi_s \qquad Q$$

$$\nabla \cdot \mathbf{D} = \rho$$
$$\nabla \cdot \mathbf{B} = 0$$
$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$
$$\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t}$$

$$\tau = \beta(t - vx/c^2),$$
$$\xi = \beta(x - vt),$$
$$\eta = y,$$
$$\zeta = z,$$
$$\beta = 1/\sqrt{(1 - v^2/c^2)}.$$

1800 1820 1820 1831 1836 1841 1873 1888 1905

Volta electric pillar battery

Oersted finds the connection between e-current and m-field

Faraday's induction law

Gauss theorem

Thomson/Kelvin Electric flux

Maxwells "Treatise.." Maxwell's 4 laws

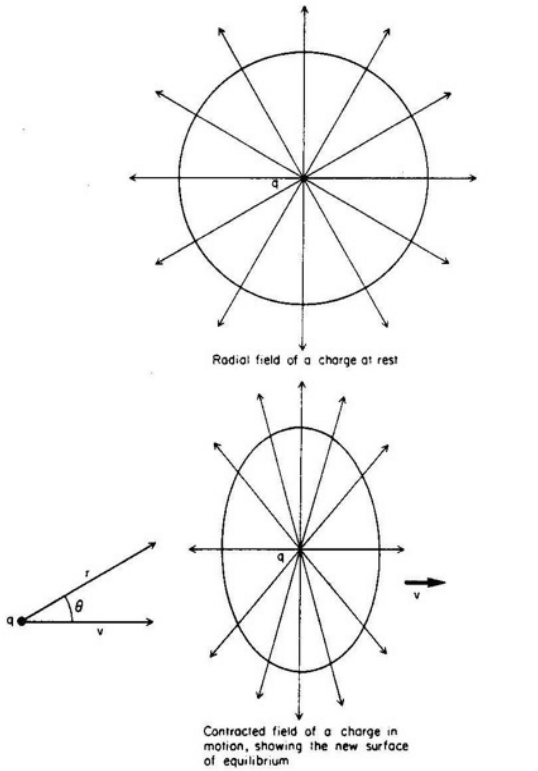
Heaviside's equ. of moving charge

Einstein's Special relativity

$$\epsilon E = \frac{q}{r^2} \frac{1 - (v^2/c^2)}{[1 - (v^2/c^2)\sin^2\theta]^{3/2}}$$

Source: J-T Eriksson

The roots of Special Relativity



8.1. The electric field lines around a charge at rest and one in motion, showing the contraction of the surface of equilibrium at high velocity.

Oliver Heaviside's equation of field contraction of a moving charge, 1888

$$\epsilon E = \frac{q}{r^2} \frac{1 - (v^2/c^2)}{[1 - (v^2/c^2)\sin^2\theta]^{3/2}}$$

Mathematical formalism of late 19th century:

	Maxwell		Heaviside
	Cartesians	*Quaternions*	*Vectors*
(A)	$a = dH/dy - dG/dz$ $b = dF/dz - dH/dx$ $c = dG/dx - dF/dy$	$\mathfrak{B} = V\nabla\mathfrak{A}$	$\mathbf{B} = \text{curl}\ \mathbf{A}$
(A′)	$da/dx + db/dy + dc/dz = 0$	$S\nabla\mathfrak{B} = 0$	$\text{div}\ \mathbf{B} = 0$

Source: Hunt, The Maxwellians, Cornell UnivPress

General Relativity

The General Relativity theory was published by Einstein at the end of 1915.

The theory gives a geometric explanation of gravitation, meaning that a massive body causes a distortion of space-time, a 4-dimensional coordinate system in accordance with Special Relativity.

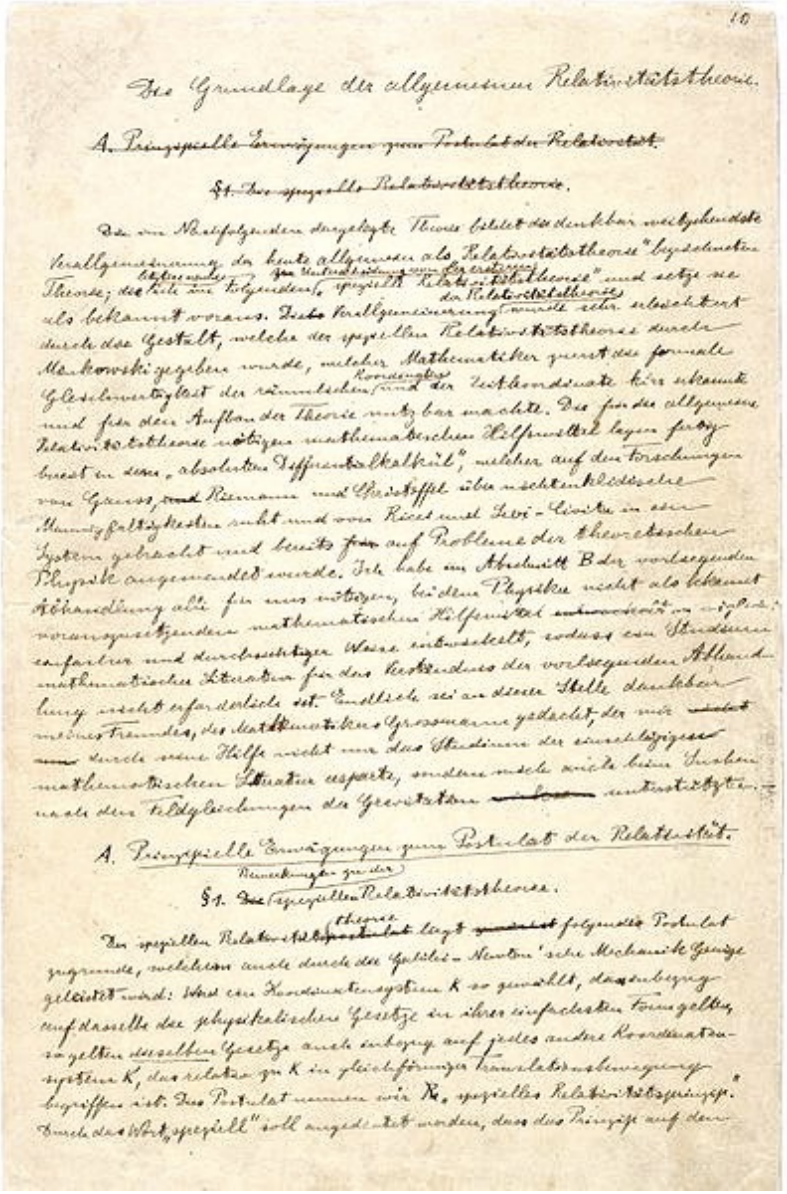
The theory is a cornerstone in modern cosmology.

General relativity

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

Einstein field equations

The manuscript of the General Theory of Relativity: A. Einstein, Die Grundlage der allgemeinen Relativitätstheorie, Annalen der Physik, 49, 1916



10

Die Grundlage der allgemeinen Relativitätstheorie.

~~A. Prinzipielle Erwägungen zum Postulat der Relativität.~~

~~§1. Die spezielle Relativitätstheorie.~~

Die im Nachfolgenden dargelegte Theorie bildet die denkbar weitgehendste Verallgemeinerung der heute allgemein als "Relativitätstheorie" bezeichneten Theorie; die letztere nennen wir im folgenden, zur Unterscheidung von der ersteren, "spezielle Relativitätstheorie" und setzen sie als bekannt voraus. Die Verallgemeinerung der Relativitätstheorie wird sich erleichtert durch die Gestalt, welche der speziellen Relativitätstheorie durch Minkowski gegeben wurde, welcher Mathematiker zuerst die formale Gleichwertigkeit der räumlichen Koordinaten und der Zeitkoordinate klar erkannte und für den Aufbau der Theorie nutzbar machte. Das für die allgemeine Relativitätstheorie nötige mathematische Hilfsmittel liegen fertig bereit in dem "absoluten Differentialkalkül", welcher auf den Forschungen von Gauss, Riemann und Christoffel über nichteuklidische Mannigfaltigkeiten ruht und von Ricci und Levi-Civita in ein System gebracht und bereits auf Probleme der theoretischen Physik angewendet wurde. Ich habe im Abschnitt B der vorliegenden Abhandlung alle für uns notigen, bei dem Physiker nicht als bekannt voraussetzenden mathematischen Hilfsmittel in einer einfachen und durchsichtigen Weise entwickelt, sodass ein Studium mathematischer Literatur für das Verständnis der vorliegenden Abhandlung nicht erforderlich ist. Endlich sei an dieser Stelle dankbar meines Freundes, des Mathematikers Grossmann gedacht, der mir durch seine Hilfe nicht nur das Studium der einschlägigen mathematischen Literatur ersparte, sondern mich auch beim Suchen nach den Feldgleichungen der Gravitation unterstützte.

A. Prinzipielle Erwägungen zum Postulat der Relativität.

§1. Die spezielle Relativitätstheorie.

Der speziellen Relativitätstheorie liegt folgendes Postulat zugrunde, welches auch durch die Galilei-Newton'sche Mechanik gefordert wird: Wird ein Koordinatensystem K so gewählt, dass bezüglich auf dasselbe die physikalischen Gesetze in ihrer einfachsten Form gelten, so gelten dieselben Gesetze auch bezüglich auf jedes andere Koordinatensystem K', das relativ zu K in gleichförmiger translatorischer Bewegung begriffen ist. Das Postulat nennen wir "spezielles Relativitätsprinzip". Durch das Wort "spezielle" soll angedeutet werden, dass das Prinzip auf den

Planck presenting the Planck-medal to Einstein in 1929.

Dirac

Dirac in December 1933 with Heisenberg (Nobel 1932) and Schrödinger (co-winner 1933). Mother Flo next to Dirac.

The Quantum Theory of the Electron.

By P. A. M. Dirac, St. John's College, Cambridge.

(Communicated by R. H. Fowler, F.R.S.—Received January 2, 1928.)

The new quantum mechanics, when applied to the problem of the structure of the atom with point-charge electrons, does not give results in agreement with experiment. The discrepancies consist of "duplexity" phenomena, the observed number of stationary states for an electron in an atom being twice the number given by the theory. To meet the difficulty, Goudsmit and Uhlenbeck have introduced the idea of an electron with a spin angular momentum of half a quantum and a magnetic moment of one Bohr magneton. This model for the electron has been fitted into the new mechanics by Pauli,* and Darwin,† working with an equivalent theory, has shown that it gives results in agreement with experiment for hydrogen-like spectra to the first order of accuracy.

The question remains as to why Nature should have chosen this particular model for the electron instead of being satisfied with the point-charge. One would like to find some incompleteness in the previous methods of applying quantum mechanics to the point-charge electron such that, when removed,

Paul Adrian Maurice Dirac, 1902-1984

- relativistic model of the electron, Dirac equation, 1927, prediction of the positron
- Dirac delta function
- the Monopole prediction
- Fermi-Dirac statistics
- Dirac large number hypothesis

Mathematical formulation

The Dirac equation in the form originally proposed by Dirac is:

$$\left(\beta mc^2 + \sum_{k=1}^{3} \alpha_k p_k c\right) \psi(\mathbf{x}, t) = i\hbar \frac{\partial \psi(\mathbf{x}, t)}{\partial t}$$

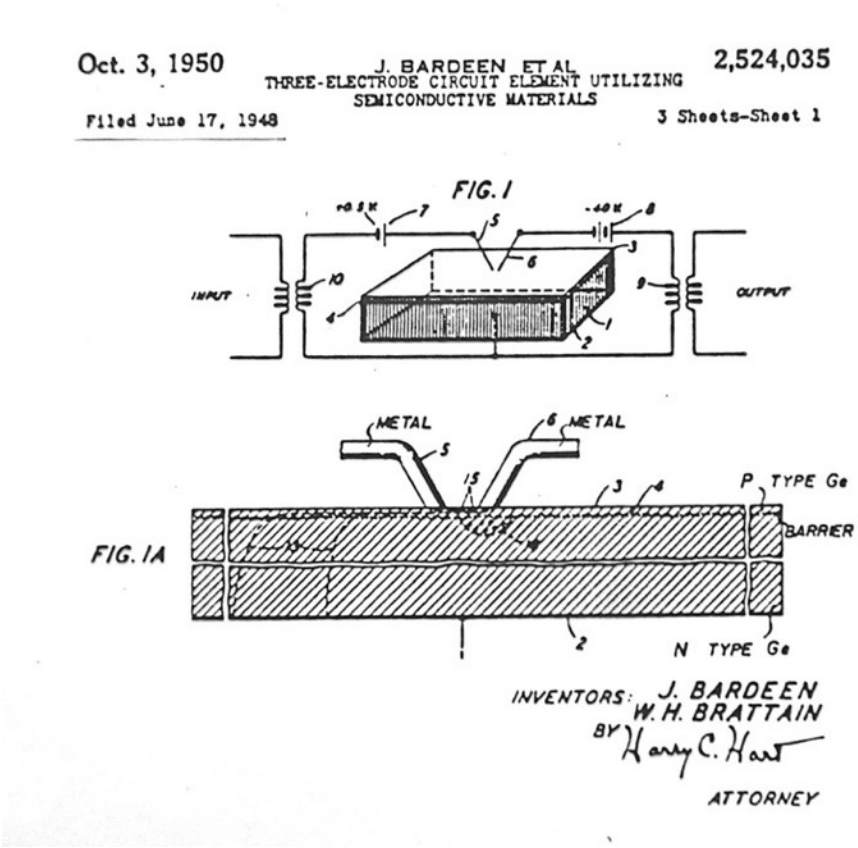
where

m is the rest mass of the electron,

The transistor

J-T Eriksson

John Bardeen in 1988 at a Nobel Summer Seminar in Northern Sweden



Oct. 3, 1950 J. BARDEEN ET AL 2,524,035
THREE-ELECTRODE CIRCUIT ELEMENT UTILIZING SEMICONDUCTIVE MATERIALS
Filed June 17, 1948 3 Sheets-Sheet 1

FIG. 1

FIG. 1A

INVENTORS: J. BARDEEN
W. H. BRATTAIN
BY Harry C. Hart
ATTORNEY

The original patent of the transistor, filed June 17, 1948. Only Bardeen's and Brattain's names mentioned. Shockley's missing due to a dispute concerning the final design.

Anatomy and brain

Andrea Vesalius, 1514-1564,
anatomist and artist,
wellknown for his detaild
anatomic picturs

Classical Vesalius drawing
of the human brain,
mid 16th century

Left brain, right brain

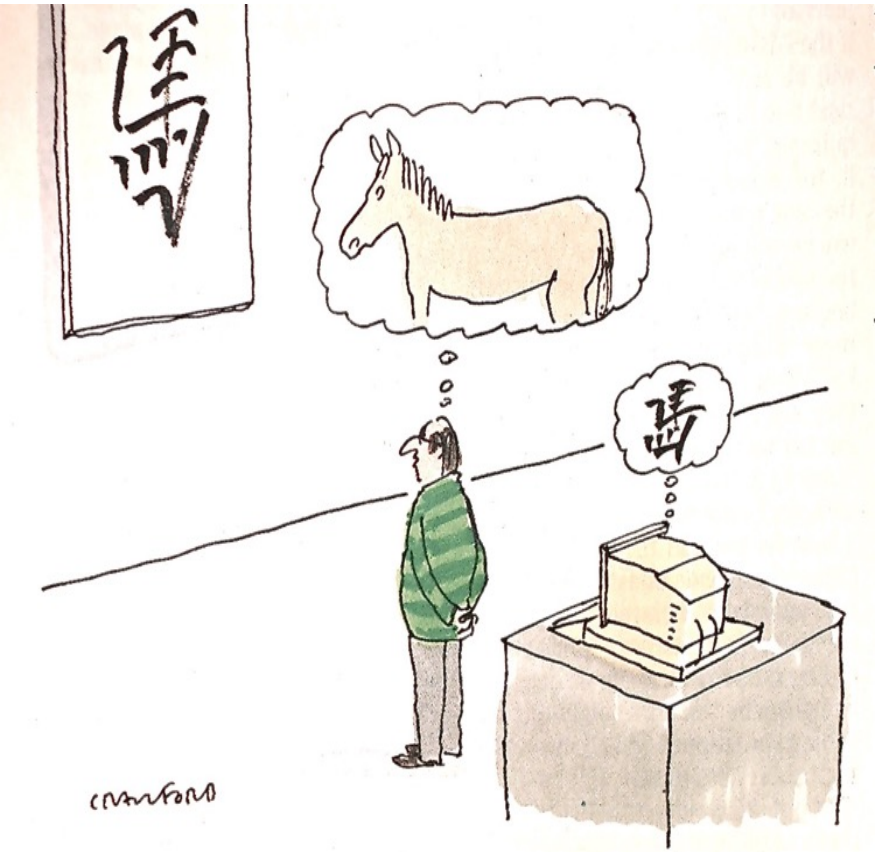
Left cortex hemisphere (“syntax” cognition)

- language, linear reasoning (grammar, vocabulary)
- arithmetic skills, basic mathematical abilities
- logic, analytic control

Right cortex hemisphere (creative cognition)

- intuition, large pattern recognition, reasoning
- mathematical estimation, numerical comparison
- language accentuation, intonation
- processing visual and musical stimuli
- facial perception
- artistic ability

Seeing beyond the syntax door: Consciousness



Computer programs are formal (syntactic).
Human minds have mental contents (semantics)

Source: Scientific American

Can a machine (computer) see a meaning?

A big question of the human mind is, how we put signals from our senses in a context and see continuity and meaning instead of symbols or landscapes.

To a computer the Chinese symbol for horse is just a collection of lines, to a person mastering the Chinese language it is a horse. When we read a book, we immediately think of the meaning of words and sentences, not the letters.

Our subconscious put the read text in a context, that we consciously experience as a reality, a narrative of real occasions.

This is a hard nut to crack for artificial intelligence.

Ancient female scientists

Hypatia, 415-355 BC
- daughter to the head librarian of the Alexandria Library
- natural philosophy, geometry, astronomy
- wide correspondence with the Mediterranean culture circuits
- designed an astrolob for navigation

2300 BC

En Hedu'anna, ~2354 BC
-- priestess of Moon worship
-- made tables of moon movements

400 BC 300 BC

Theano, 5th centery BC
- - wife of Pythagora
- - writings about children's mind
- - writings about the Golden Cut

Historic female scientists

Caroline Herschel

1750-1848, Saksa/GB
- sister of William Herschel
- astronomer
- focused her research on Nebulas, of which she made a famous table system

Sofia Kovalevskaya

1850-1891, Russia/Germany/ Sweden
Mathematician
- protege of Weierstrasse
- partial diff. equations
- the rings of Saturn
- third female professor in Europe (Stockholm)

1700 **1800** **1900**

Sophia Germain

1776-1831, Germany
Mathematician
-- model of elasticity
-- studied the orbit data of Uranus
-- predicted the planet Neptunus

Ada Byron

Countess of Lovelace
1815-1850, GB
- assistant to Babbage
- invented the 1st data program

Emma Noether

1882-1935, Germany
Mathematician
Noether's theorem on conservation (eg. energy)

Female Nobelists

Marie Curie, nee Sklodowska
1867-1934, Poland/France
- chemist
- Nobel Prize in Physics 1903 for the discovery of radiactive radiation, with Pierre Curia end Henri Bequerel
- Nobel Prize in Chemistry 1911 for radium enrichment

Barbara McClintock, 1902-1992, USA
Nobel Prize in Medicine in 1983, ”jumping genes”
Pieneer in bioscience and genetics

Rita Levi-Montalcini, 1909-, Italy/USA
biochemist
Nobel Prize in Medicine in 1986, ”growth of nerve cells in the fetus”

Females without a Nobel Prize

Lise Meitner, 1878-1968, Germany
Physicist
Studied under Bolzmann in Vienna, PhD 1907

Professor at Berlin University, laboratory in the Keiser-Willhelm Institute

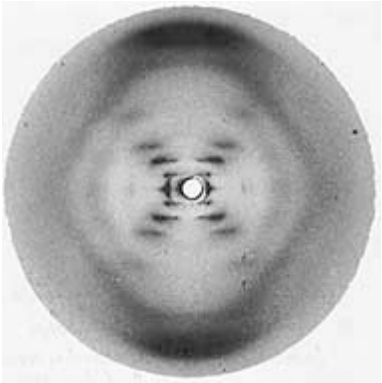
Discovered the first atomic fission reactons in 1938 in cooperation with Otto Hahn (Nobelist 1944)

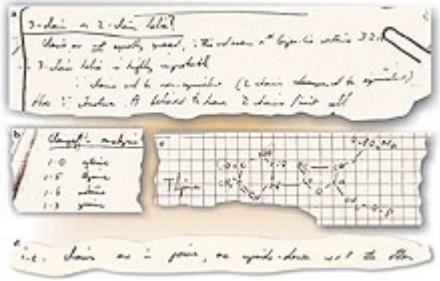
Refugee in Stockholm due to the Nazis

Females without a Nobel Prize

Rosalind Franklin, 1920-1957, Great Britain
PhD Cambridge 1945, physical chemistry
Focus: X-ray diffraction analysis

Franklin developed a procedure to prepare DNA-samples for x-ray diffraction analysis.
Diffraction images hinted of a spiral structure and offered means to measure the molecule.
She reported her results to the King's Medical Research Council in 1952. Crick realized the DNA double helix structure from the report.





Crick, Watson and Wilkins shared the Nobel Prize in Medicine in 1962. Before that Franklin had already died in cancer.

Females without a Nobel Prize

Jocelyn Bell Burnell, 2014
Courtesy The Royal Society of Edinburgh

Jocelyn Bell Burnell, b. 1943
in Northern Ireland
Alma Mater: Glasgow, Cambridge
Mentors: Antony Hewish, Fred Hoyle

Achievement: First discoverer of Pulsars in 1967.

Hewish received the Nobel Prize in Physics in 1974.

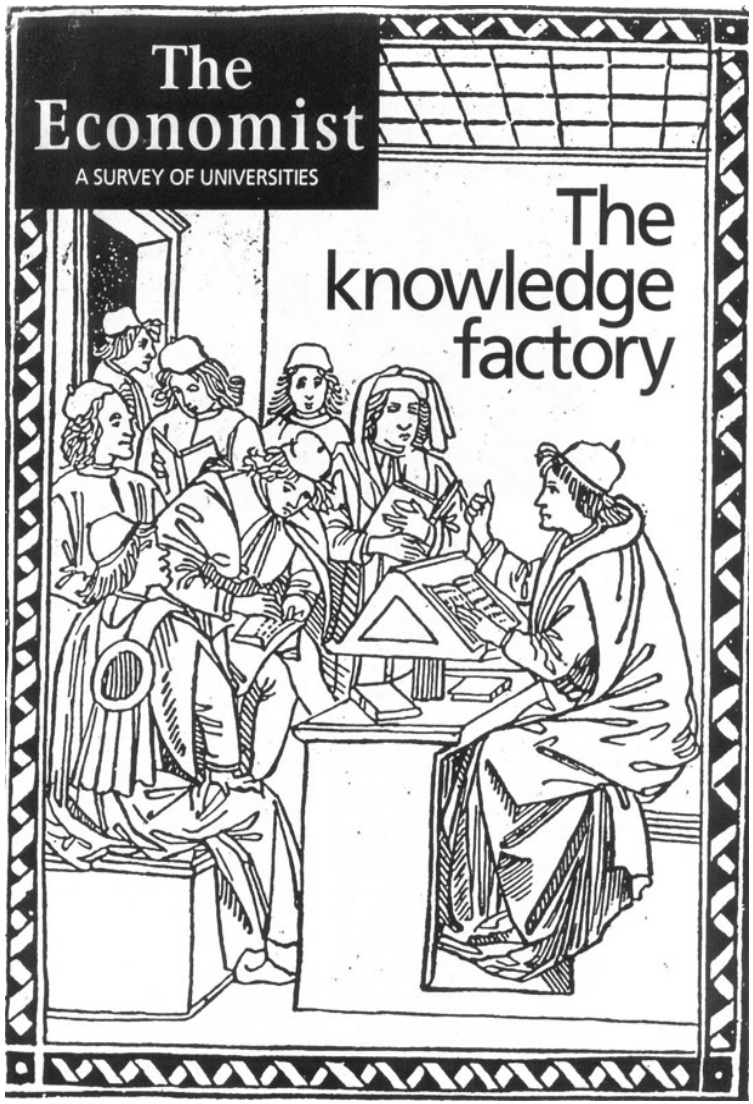
The Humboldtian doctrine

Wilhelm von Humboldt

1767-1835, German linguist.
Founder of the Berlin University in 1811.
Minister of Education.

Humboldt-doctrine:
University education should be based on scientific research.

(Brother of famous geographic explorer Alexander von Humboldt)



The University time line

Before 1800:

- theology, rhetoric, humanities
- medicine, astronomy

1800-century:

- research and teaching (Humboldt)
- order of natural systems
- biology, geography

1900-1950:

- scientific breakthroughs (physics, chemistry, bioscience)
- university available for all

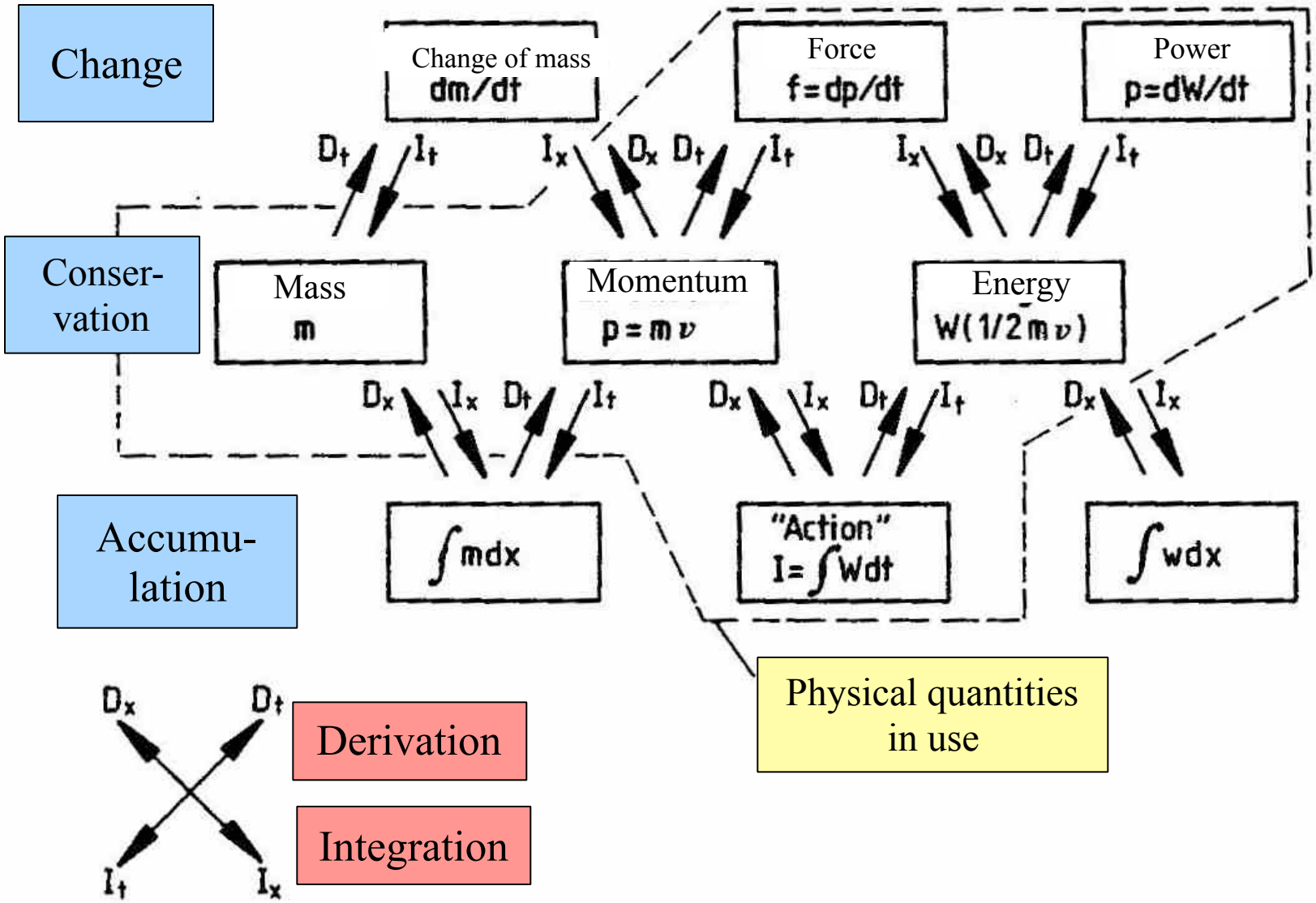
After the 50ies:

- research becomes a substantial economic factor

Great Minds providing Scientific Strength

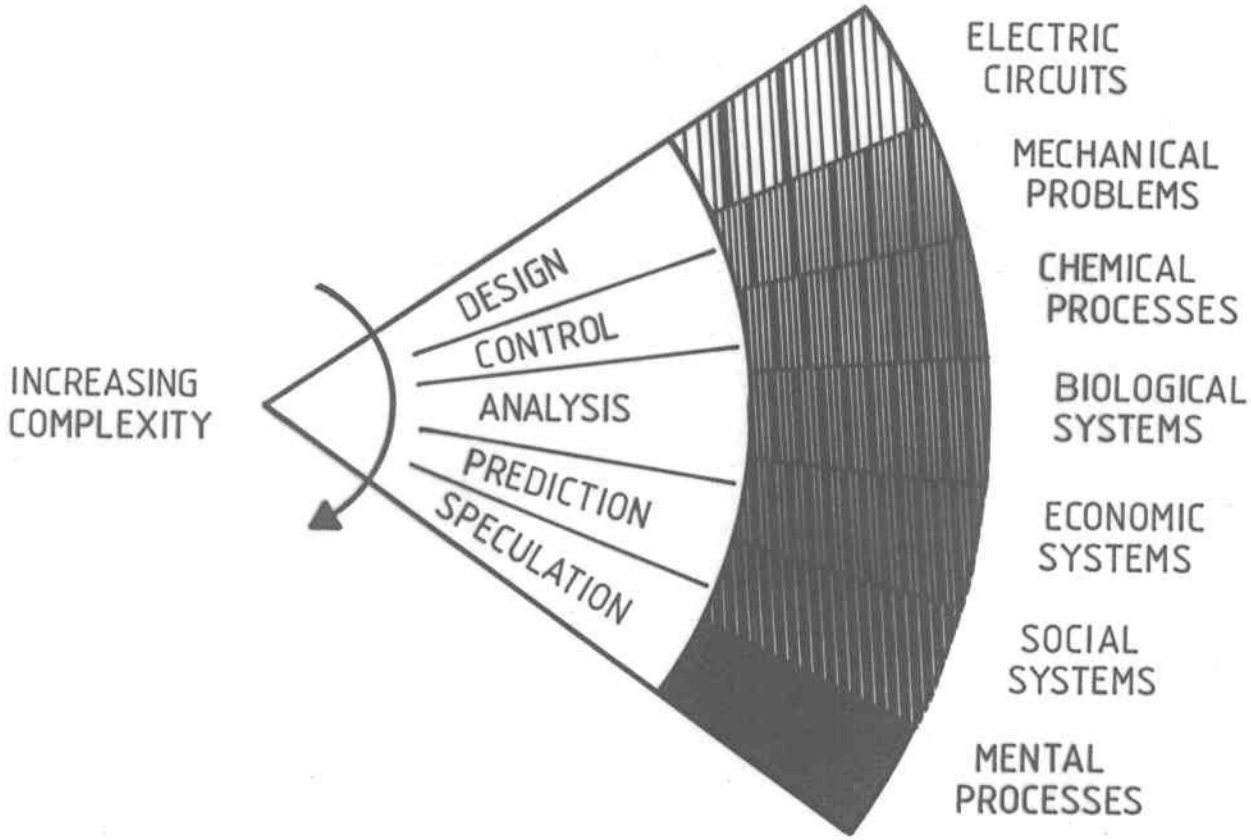
Century Country	1600	1700	1800	Early1900	Character-istics
Great Britain	**Gilbert Newton Locke**	**Davy Dalton Cavendish**	**Faraday Kelvin Joule Maxwell Rayleigh**	**Thomson Dirac Rutherford Chadwick**	Empiric method Scientific communication
France	**Pascal Descartes**	**Laplace Lagrange Legendre Coulombe Buffon d'Alembert**	**Ampere Poincare Galois Bequerel**	**Curie Neel deBroglie**	Mathematics Analytical models
Germany Austria	**Kepler**	**Leibniz Kant**	**Humboldt Hertz Gauss Helmholtz Weber Bolzmann**	**Planck Einstein Heisenberg Pauli Schrödinger**	Theoretical strength Experimentation
USA		**Franklin**	**Henry Gibbs Michelson Millikan**	**Compton Anderson Lawrence Bardeen Faynman Bethe**	Practical (inventions) Funded research
Italy	**Galilei**	**Galvani Volta**	**Marconi**	**Fermi**	Pragmatic & empiric experimentation
Netherlands	**Huygens Leeuwenhoek**		**van der Vaals Lorentz**	**Onnes G't Hooft**	Mathem theory Applied physics
Denmark	**Tycho Brahe Rømer**		**Ørstedt**	**Bohr**	Natural science physics
Sweden		**Linne Polhem Celcius**	**Gadolin Berzelius**	**Arrhenius**	Geology Chemistry

Physics and higher mathematics

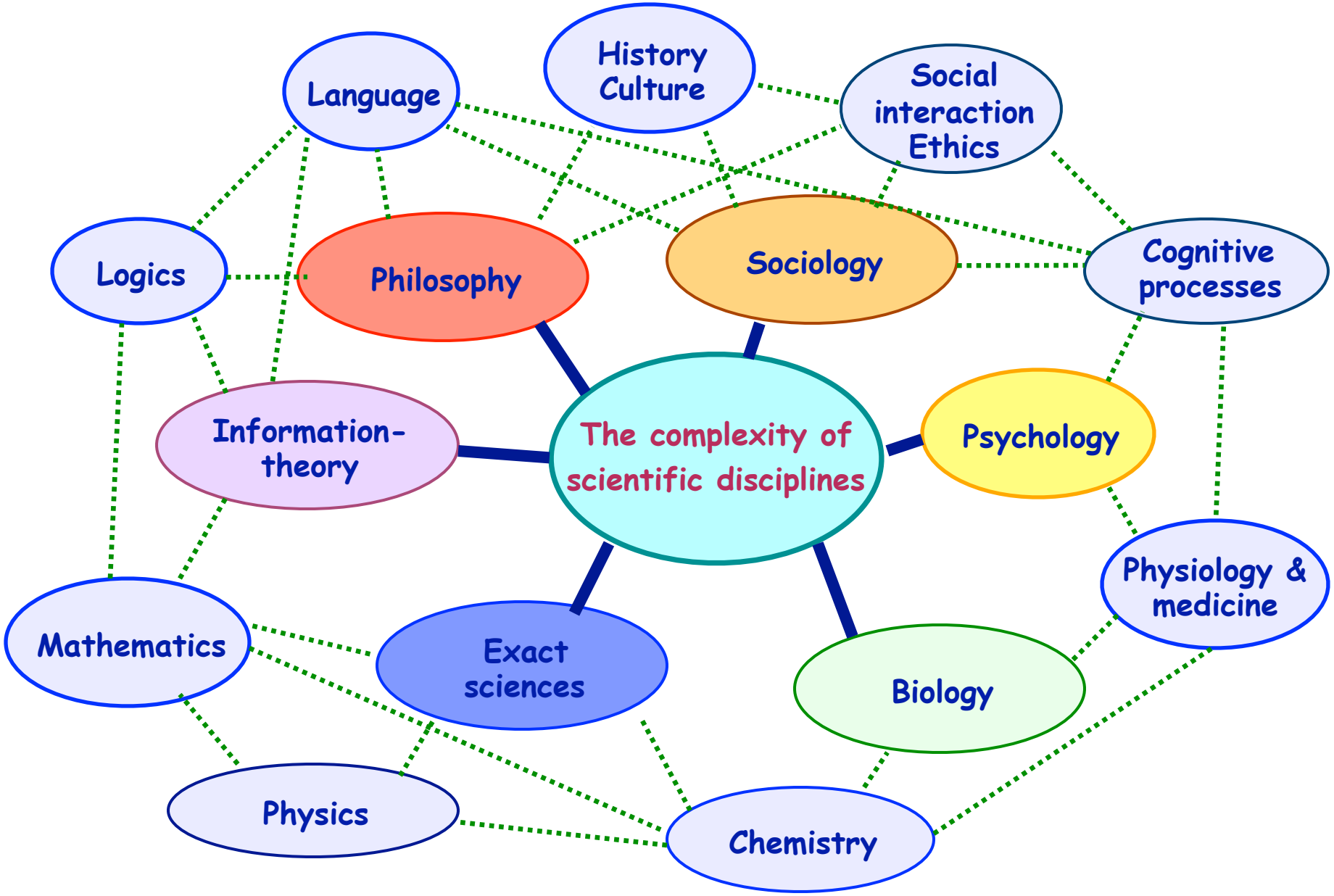


Source: J-T Eriksson

The hierarchy of complexity



COURTESY :
WALTER KARPLUS


Language
History
Culture
Social
interaction
Ethics
Logics
Philosophy
Sociology
Cognitive
processes
Information-
theory
The complexity of
scientific disciplines
Psychology
Physiology &
medicine
Mathematics
Exact
sciences
Biology
Physics
Chemistry

The big questions

In science

1. What are the forces behind the expanding Universe?
2. Why dosen't relativity work on the atomic scale?
3. Is there a mentally comprehensible "theory of everything"?
4. Can we build computable models of how DNA, RNA, proteins, etc. interacts?
5. Can consciousness be explained rationally?

In life

1. Can conflicts be prevented before becoming global catastrophes?
2. Can the population growth be controlled?
3. How to establish democratic rule in totalitarian regions?
4. How to manage world economy?
5. What measures should be taken to secure a sustainable environment?