Illusztrációk az *Általános Kémia* előadáshoz

A modern kémia megszületése

A modern kémia a 18. sz. második felében, s a 19. sz. elején alakul ki, de kezdetei már a 17. sz.-ban láthatók

Robert Boyle (1627–1691) was born at Lismore Castle, Munster, Ireland, the fourteenth child of the Earl of Cork. As a young man of means, he was tutored at home and on the Continent. He spent the later years of the English Civil Wars at Oxford, reading and experimenting with his assistants and colleagues. This group was committed to the New Philosophy, which valued observation and experiment at least as much as logical thinking in formulating accurate scientific understanding. At the time of the restoration of the British monarchy in 1660, Boyle played a key role in founding the Royal Society **to nurture this new view of science.**

Although Boyle's chief scientific interest was chemistry, his first published scientific work, *New Experiments Physico-Mechanicall, Touching the Spring of the Air and its Effects* (1660), concerned the physical nature of air, as displayed in a brilliant series of experiments in which he used an air pump to create a vacuum. The second edition of this work, published in 1662, delineated the quantitative relationship that Boyle derived from experimental values, later known as "Boyle's law": that the volume of a gas varies inversely with pressure.

Robert Boyle at the age of thirty-seven, with his air pump in the background.

François Diodati reengraved this image from an engraving by William Faithorne, *Opera varia* (1680)

Courtesy Edgar Fahs Smith Memorial Collection, Dept. of Special Collections, University of Pennsylvania Library.

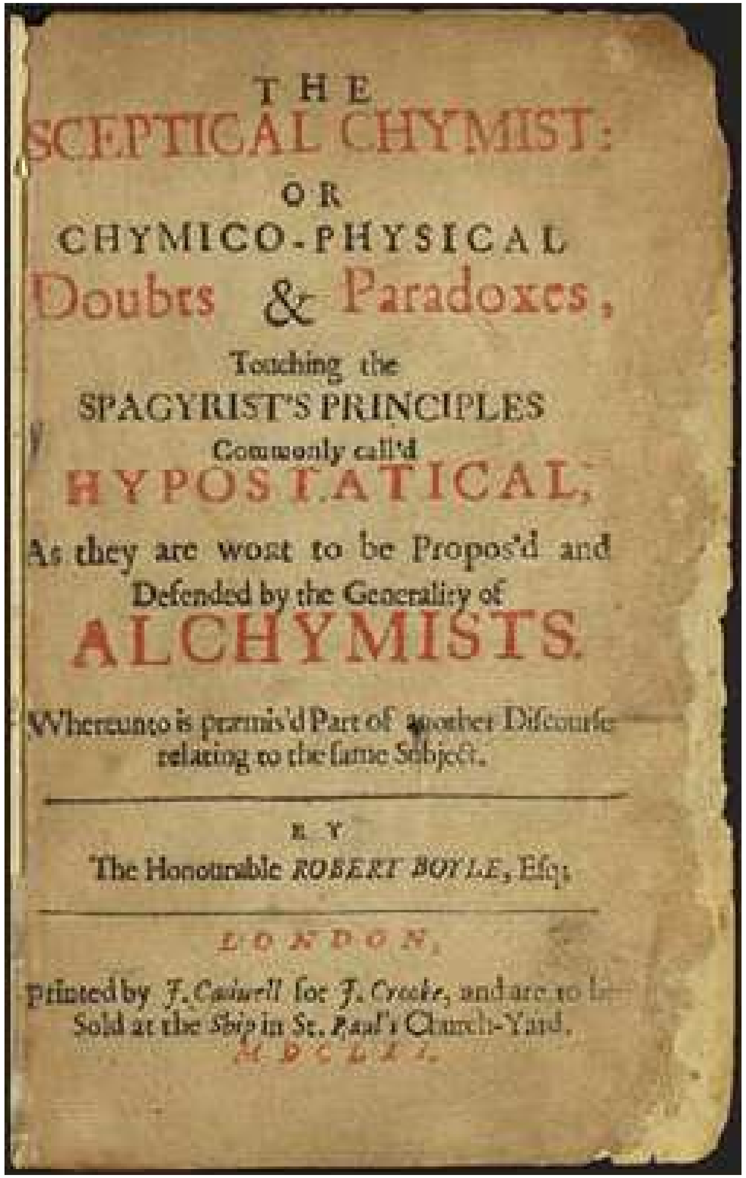
Robert Boyle (25 January 1627 – 31 December 1691) was a natural philosopher, chemist, physicist, inventor, and gentleman scientist, also noted for his writings in theology. He is best known for the formulation of Boyle's law.[2] Although his research and personal philosophy clearly has its roots in the alchemical tradition, he is largely regarded today as the first modern chemist, and therefore one of the founders of modern chemistry. Among his works, *The Sceptical Chymist* is seen as a cornerstone book in the field of chemistry.

Boyle was an advocate of corpuscularism, a form of atomism that was slowly displacing Aristotelian and Paracelsian views of the world. Instead of defining physical reality and analyzing change in terms of Aristotelian substance and form and the classical four elements of earth, air, fire, and water—or the three Paracelsian elements of salt, sulfur, and mercury—corpuscularism discussed reality and change in terms of particles and their motion. Boyle believed that chemical experiments could demonstrate the truth of the corpuscularian philosophy. In this context he defined the term *element* in *Sceptical Chymist* (1661): " . . . certain primitive and simple, or perfectly unmingled bodies; which not being made of any other bodies, or of one another, are the ingredients of which all those called perfectly mixt bodies are immediately compounded**, and into which they are ultimately resolved."**

Robert Boyle:
*The **Skeptical** Chemist, 1661 (!)*

"Én megpróbáltam a kémiát más szempontok szerint művelni, nem úgy, ahogy az eddigi kémikusok tették, hanem ahogy egy tudóshoz illik." ....

"Bár viselnék az emberek inkább a tudományok előrehaladását szívükön, mint önző érdeküket, akkor könnyen belátnák, hogy nagyobb szolgálatot tennének a világnak, ha minden erejüket kísérletek végzésére és megfigyelések gyűjtésére fordítanák, ahelyett hogy kísérleti alapozás nélküli elméleteket állítanának fel. "



THE

SCEPTICAL CHYMIST:

OR

CHYMICO-PHYSICAL

Doubts & Paradoxes,

Touching the

SPAGYRIST'S PRINCIPLES

Commonly call'd

HYPOSTATICAL;

As they are wont to be Propos'd and Defended by the Generality of

ALCHYMISTS.

Whereunto is præmis'd Part of another Discourse relating to the same Subject.

BY

The Honourable *ROBERT BOYLE*, Esq;

LONDON,

Printed by *J. Cadwell* for *J. Crooke*, and are to be Sold at the *Ship* in St. *Paul's* Church-Yard.

MDCLXI.

Priestley

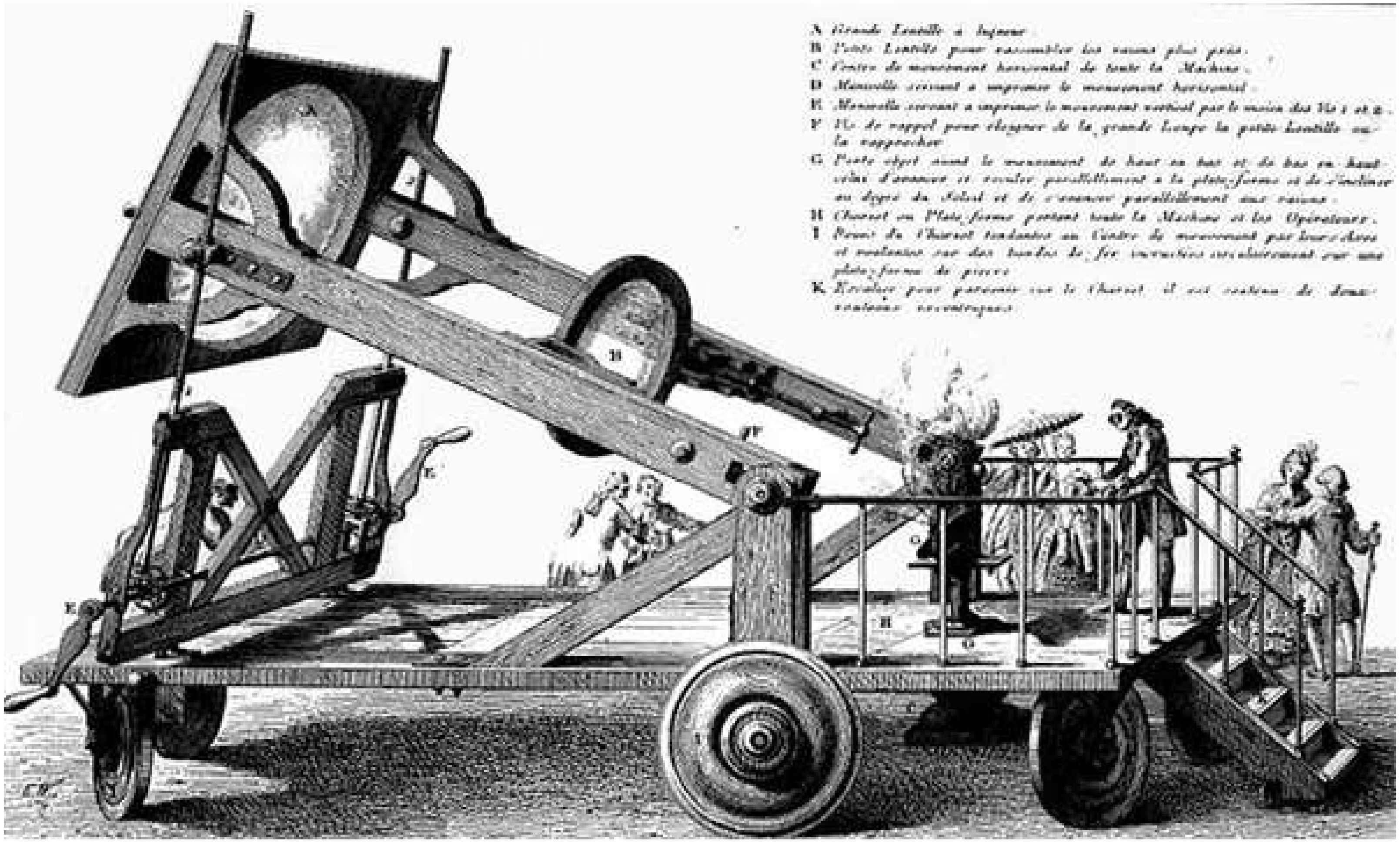
Joseph Priestley (13 March 1733 (Old Style) – 6 February 1804) was an 18th-century English theologian, Dissenting clergyman, natural philosopher, educator, and political theorist who published over 150 works. He is usually credited with the discovery of oxygen, having isolated it in its gaseous state, although Carl Wilhelm Scheele and Antoine Lavoisier also have a claim to the discovery.[2] During his lifetime, Priestley's considerable scientific reputation rested on his invention of soda water, his writings on electricity, and his discovery of several "airs" (gases), the most famous being what Priestley dubbed "dephlogisticated air" (oxygen). However, Priestley's determination to defend phlogiston theory and to reject what would become the Chemical Revolution eventually left him isolated within the scientific community.

Mikhail Lomonosov (1711-1765), a polymath and writer of Imperial Russia
Polymath : polihisztor.

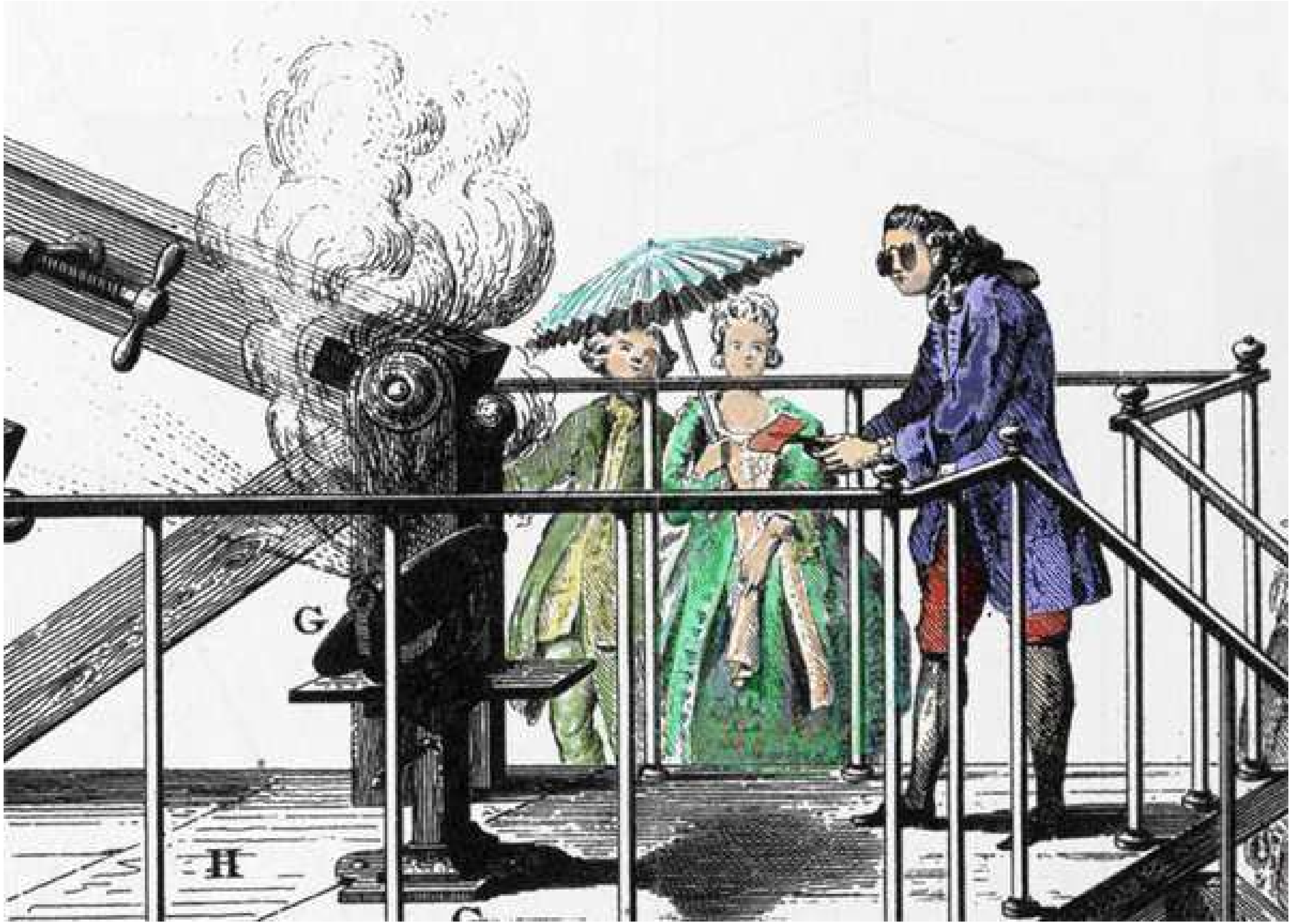
Lomonosov, 1753:
“Today I made an experiment in hermetic glass vessels in order to determine whether the mass of metals increases from the action of pure heat. The experiment demonstrated that the famous Robert Boyle was deluded, for without access of air from outside, the mass of the burnt metal remains the same."

Lavoisier

The Burning lenses



Calcination of a piece of metal with the burning lenses



Joseph Louis Proust
(1754 – 1826)
Állandó súlyviszonyok törvénye

John Dalton
(1766 – 1844)
Többszörös súlyviszonyok törvénye

Amedeo Avogadro.

Joseph Louis Gay-Lussac's law of combining volumes (1808) (when two gases react, the volumes of the reactants and products—if gases—are in whole number ratios) tended to support Dalton's atomic theory. Dalton did not in fact accept Gay-Lussac's work, but the Italian chemist **Amedeo Avogadro** (1776–1856) saw it as the key to a better understanding of molecular constituency.

In 1811 **Avogadro** hypothesized that equal volumes of gases at the same temperature and pressure contain equal numbers of molecules. From this hypothesis it followed that relative molecular weights of any two gases are the same as the ratio of the densities of the two gases under the same conditions of temperature and pressure. Avogadro also astutely reasoned that simple gases were not formed of solitary atoms but were instead *compound* molecules of two or more atoms. (Avogadro did not actually use the word *atom*; at the time the words *atom* and *molecule* were used almost interchangeably. He talked about three kinds of "molecules," including an "elementary molecule"—what we would call an atom.) Thus Avogadro was able to overcome the difficulty that Dalton and others had encountered when **Gay-Lussac reported that above 100ºC the volume of water vapor was twice the volume of the oxygen used to form it. According to Avogadro, the molecule of oxygen had split into two atoms** in the course of forming water vapor.

Curiously, Avogadro's hypothesis was neglected for half a century after it was first published. Many reasons for this neglect have been cited, including some theoretical problems, such as Jöns Jakob Berzelius's "dualism," which asserted that compounds are held together by the attraction of positive and negative electrical charges, making it inconceivable that a molecule composed of two electrically similar atoms—as in oxygen—could exist. In addition, Avogadro was not part of an active community of chemists: the Italy of his day was far from the centers of chemistry in France, Germany, England, and Sweden, where Berzelius was based.

Avogadro was a native of Turin, where his father, Count Filippo Avogadro, was a lawyer and government leader in the Piedmont (Italy was then still divided into independent countries). Avogadro succeeded to his father's title, earned degrees in law, and began to practice as an ecclesiastical lawyer. After obtaining his formal degrees, he took private lessons in mathematics and sciences, including chemistry. For much of his career as a chemist he held the chair of physical chemistry at the University of Turin.

Avogadro EREDETI CIKKÉBŐL! : http://web.lemoyne.edu/~giunta/avogadro.html

Essay on a Manner of Determining the Relative Masses of the Elementary Molecules of Bodies, and the Proportions in Which They Enter into These Compounds
Journal de Physique **73**, 58-76 (1811) [Alembic Club Reprint No. 4] **I.** ***(fordítás franciából)***

M. Gay-Lussac has shown in an interesting Memoir (Mémoires de la Société d'Arcueil, Tome II.) that gases always unite in a very simple proportion by volume, and that when the result of the union is a gas, its volume also is very simply related to those of its components. But the quantitative proportions of substances in compounds seem only to depend on the relative number of molecules which combine, and on the number of composite molecules which result. It must then be admitted that very simple relations also exist between the volumes of gaseous substances and the numbers of simple or compound molecules which form them. *Kiemeles FG:* ***The first hypothesis to present itself in this connection, and apparently even the only admissible one, is the supposition that the number of integral molecules in any gases is always the same for equal volumes, or always proportional to the volumes*.** Indeed, if we were to suppose that the number of molecules contained in a given volume were different for different gases, it would scarcely be possible to conceive that the law regulating the distance of molecules could give in all cases relations as simple as those which the facts just detailed compel us to acknowledge between the volume and the number of molecules. On the other hand, it is very well conceivable that the molecules of gases being at such a distance that their mutual attraction cannot be exercised, their varying attraction for caloric may be limited to condensing the atmosphere formed by this fluid having any greater extent in the one case than in the other, and, consequently, without the distance between the molecules varying; or, in other words, without the number of molecules contained in a given volume being different. Dalton, it is true, has proposed a hypothesis directly opposed to this, namely that the quantity of caloric is always the same for the molecules of all bodies whatsoever in the gaseous state, and that the greater or less attraction for caloric only results in producing a greater or less condensation of this quantity around the molecules, and thus varying the distance between the molecules themselves. But in our present ignorance of the manner in which this attraction of the molecules for caloric is exerted, there is nothing to decide us *à priori* in favour of the one of these hypotheses rather than the other; and we should rather be inclined to adopt a neutral hypothesis, which would make the distance between the molecules and the quantities of caloric vary according to unknown laws, were it not that the hypothesis we have just proposed is based on that simplicity of relation between the volumes of gases on combination, which would appear to be otherwise inexplicable.

Az atomot a 19. sz. végéig oszthatatlannak, az anyag végső építőkövének gondolták

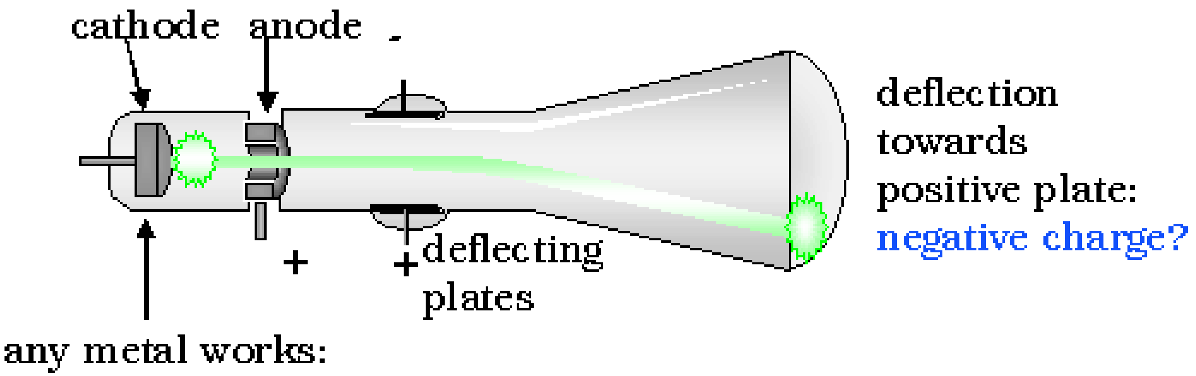
Maxwell, around 1875, describing atoms:

"foundation stones of the material universe ... unbroken and unworn. They continue to this day as they were created—perfect in number and measure and weigth."

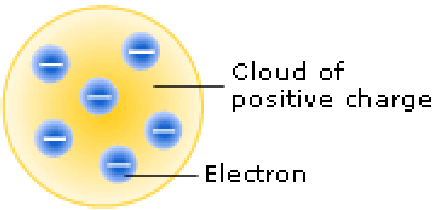
(*Scientific American*, Aug. 1997, p. 73.)

Az atom mai fogalmának kialakulása

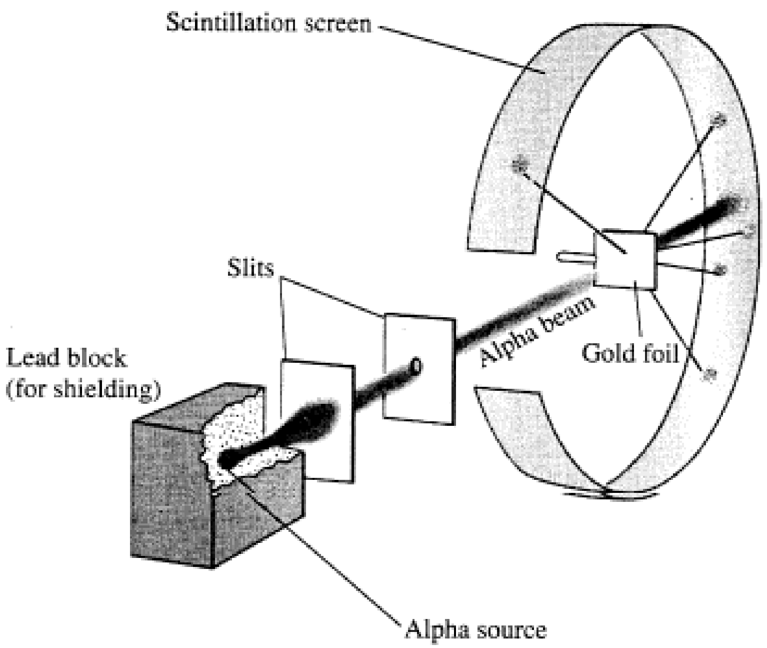
Feltörik a diót
Az első csapás az oszthatatlan atomra:
J.J. Thomson, 1897: az elektron felfedezése

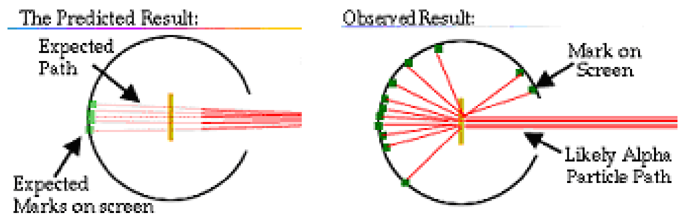


A pudding-modell:



Rutherford, 1911: az atommag



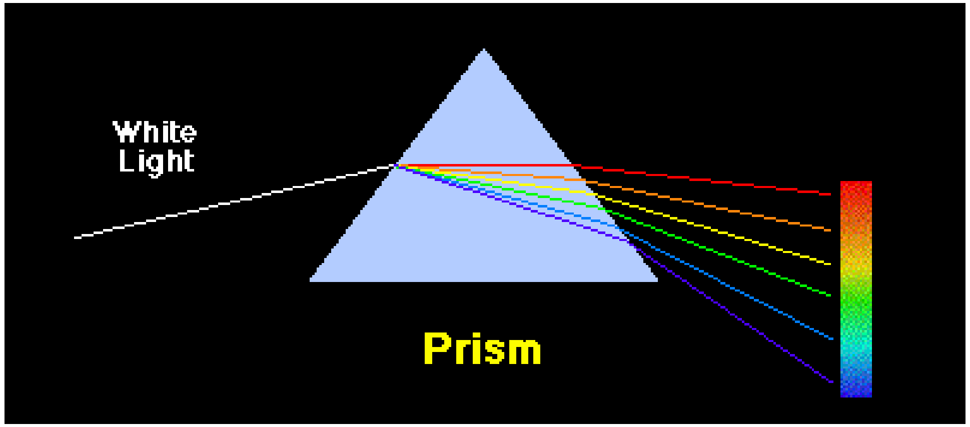


A kvantumosság megjelenése a fizikában:

1. a H-atom színképe,
2. feketetest-sugárzás,
3. fotoelektromos effektus

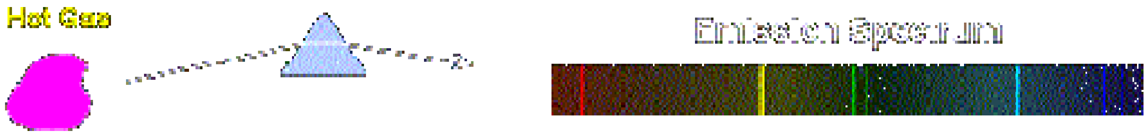
Színképek

A spektroszkópia alapja: a fényt komponenseire bontjuk

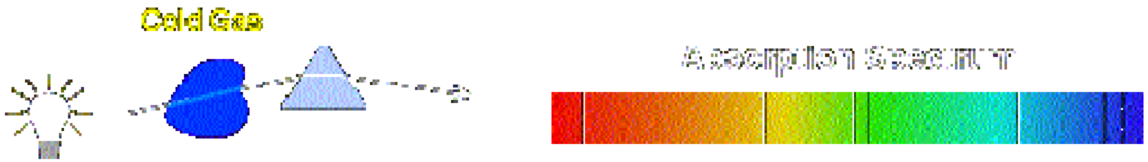


Folytonos spektrum

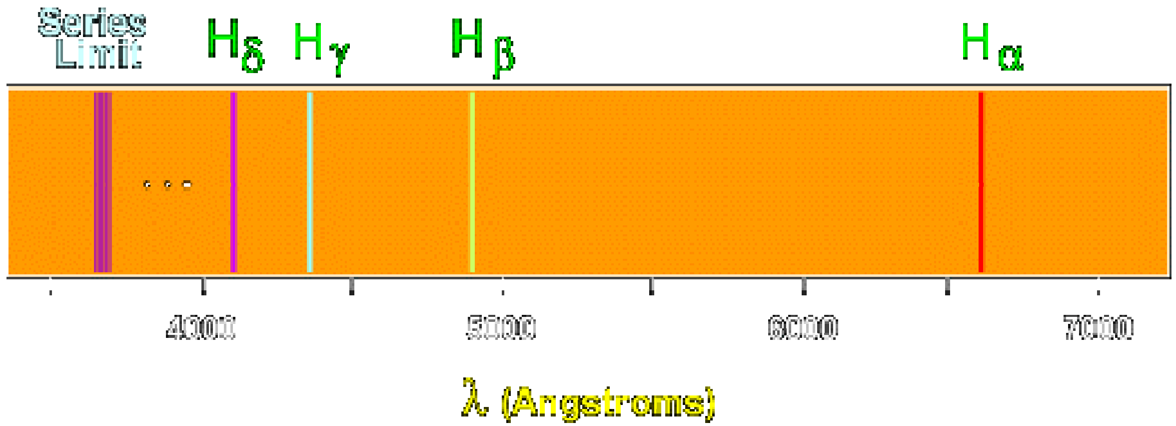
Vonalas emissziós sp.



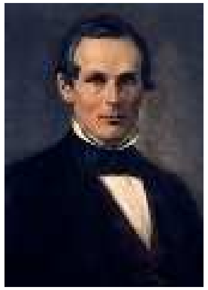
Vonalas abszorpciós sp.



Angstrom svéd (asztro)fizikus:
az atomos hidrogén spektruma a látható fény tartományában



Négy vonalat észlelt: 410 nm, 434 nm, 486 nm, and 656 nm.



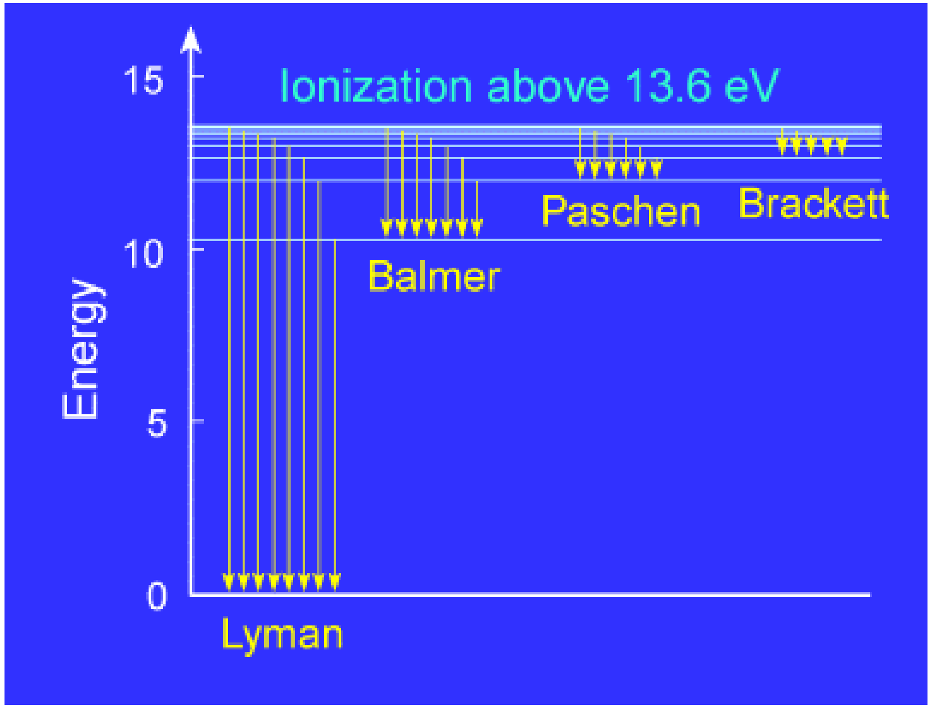
Anders Ångström (1817-1874)
One of the leading founders of the science of spectroscopy. He was a pioneer, in 1853, to observe and study **the spectrum of hydrogen which was the foundation for Balmer´s formula.**
After leaving the observatory for the professorship in physics at Uppsala university (1858-1874) he continued his spectral research.

Balmer (matematikatanár): a H-atom spektrumvonalaira egyszerű képletet talált

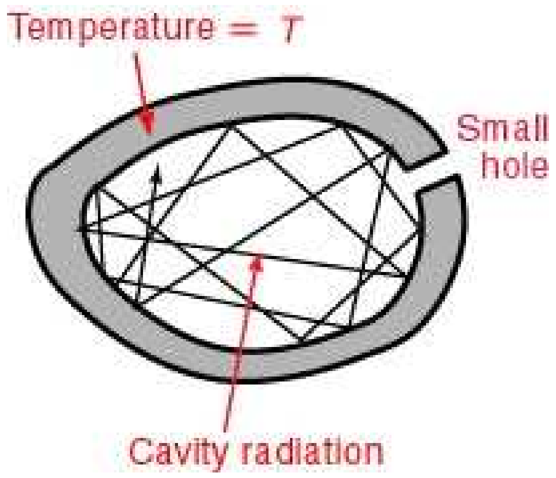
$$1/\lambda = \text{const.}\ (1/2^2 - 1/n^2)$$

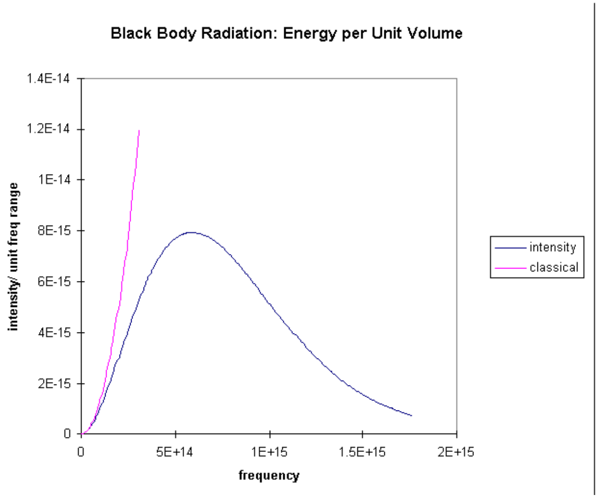
ahol n = 3,4,5,6

A teljesebb spektrum:



A fekete-test sugárzása





Egy példa: a kozmikus háttér spektruma egy *blackbody* spektrum, ahol a hőmérséklet, T_B = *2.725 K*

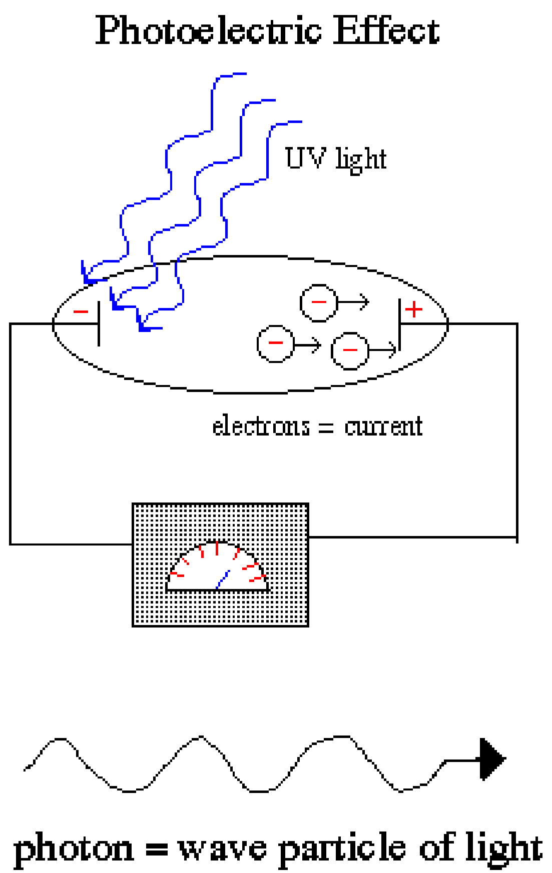
Cosmic Microwave Background The CMB has the spectrum of a blackbody. A blackbody spectrum is produced by an isothermal, opaque and non-reflecting object. Usually a cavity with a small hole is used in the laboratory to make an opaque and non-reflective object. Radiation that enters the cavity through the hole will have to bounce off many walls before it returns to the outside, so even if the walls are only somewhat dark, the hole will appear to be completely black. …. A simple *gedanken* experiment shows that the spectrum emitted by a blackbody can only **depend on its temperature T.**

A fotoelektromos effektus

(2005: Einstein-év)

A foton energiája kvantált

$E = h\nu$



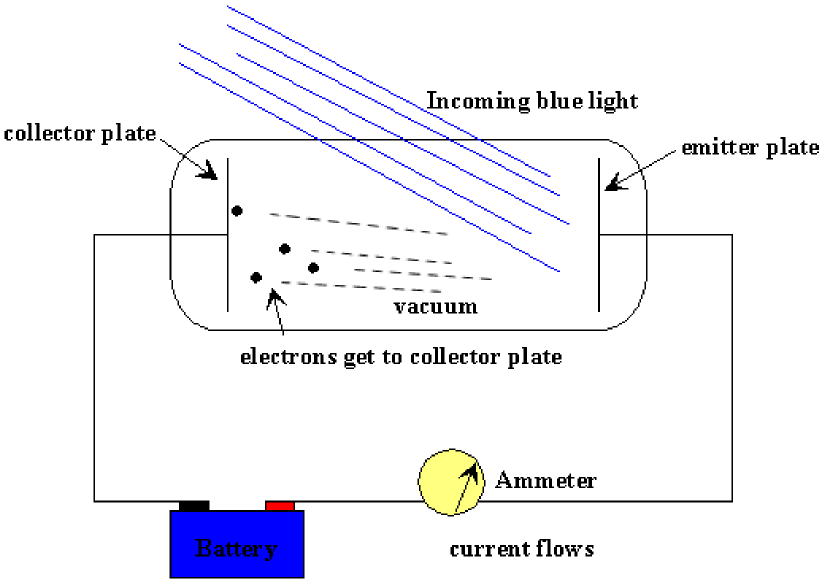
Mi a rossz a rajzon?

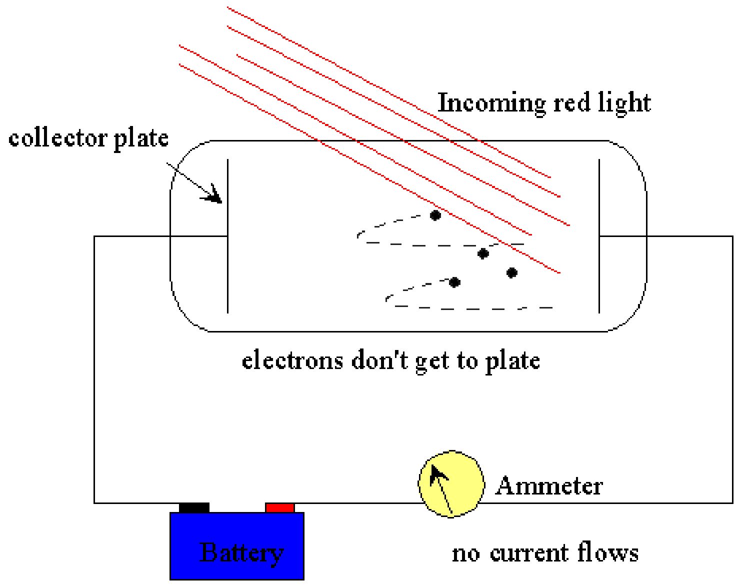
Hiányzik a feszültségforrás

***cf.* következő oldal**

Az eredeti kísérlet picit más volt, a kollektoron taszító, negatív feszültség

In 1902, Lenard studied how the energy of the emitted photoelectrons varied with the intensity of the light. ... To measure the energy of the ejected electrons, Lenard charged the collector plate negatively, to repel the electrons coming towards it. Thus, only electrons ejected with enough kinetic energy to get up this potential hill would contribute to the current. Lenard discovered that there was a well defined minimum voltage that stopped any electrons getting through, we'll call it V_{stop}. To his surprise, he found that V_{stop} did not depend at all on the intensity of the light! Doubling the light intensity doubled the *number* of electrons emitted, but did not affect the *energies* of the emitted electrons.





Philipp Lenard

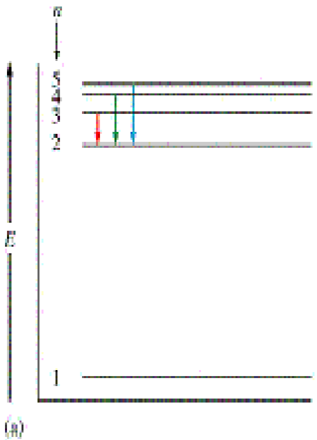
The Nobel Prize in Physics 1905

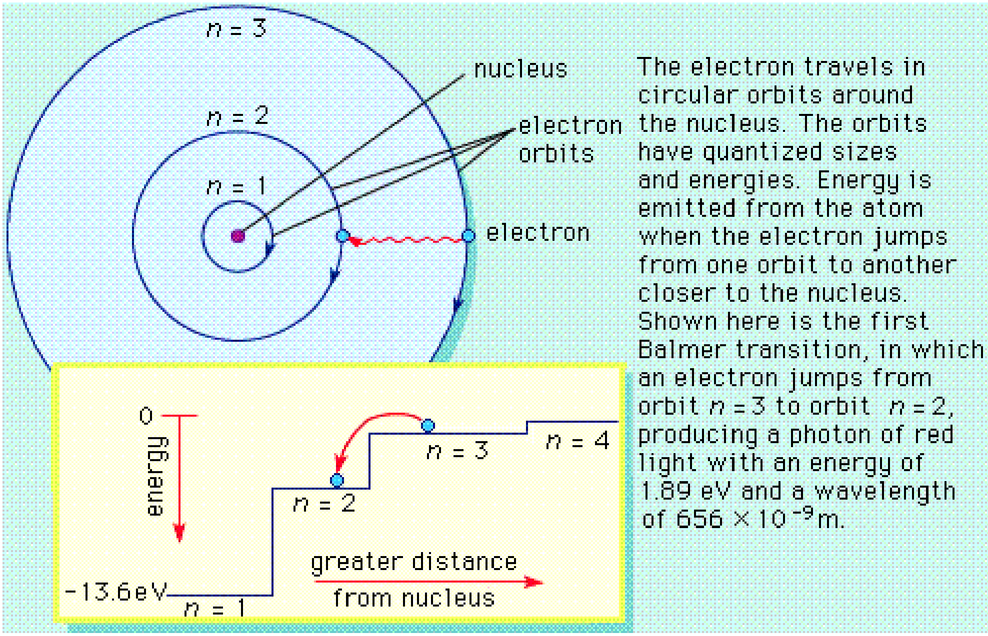
Biography

Lénárd Fülöp ?

Philipp von Lenard was born at **Pozsony**[1] (Pressburg) in Austria-Hungary on June 7, 1862. His family had originally come from the Tyrol. He studied physics successively at Budapest, Vienna, Berlin and Heidelberg under Bunsen, Helmholtz, Königsberger and Quincke and in 1886 took his Ph.D. at Heidelberg.

A Bohr-modell, 1913:





Heisenberg és Bohr

A Coulomb-törvény, skaláris formában:
$F = k_c\, q_1 q_2 / r^2$

$k_c = 1/(4\pi\varepsilon)$ ahol ε a vakuum *permittivitása*.

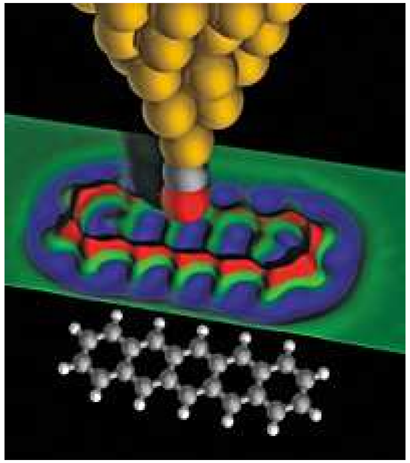
$\varepsilon = 8.854 \times 10^{-12}\ C^2 N^{-1} m^{-2}$.

Az atomokról (és molekulákról) ma már nagyon pontos, de alapvetően indirekt, közvetett információnk van.
Néhány módszer azonban már tényleg szinte közvetlenül látja az atomokat,
pl. az *Atomic Force Microscope*, felületek vizsgálatára

August 31, 2009

Molecule's Atoms, Bonds Visualized

High-resolution AFM technique makes even hydrogen atom positions visible



By functionalizing an atomic force microscope tip, researchers have greatly enhanced the resolution of atomic force microscopy (AFM), making it possible to view the entire structure of a single molecule. Physicist Leo Gross of IBM Research, in Rüschlikon, Switzerland, and coworkers accomplished the feat on the aromatic compound pentacene (*Science* **2009,** *325*, 1110).

Az AFM felbontását úgy növelték, hogy egy CO molekulát kapcsoltak az arany tű csúcsára..

Close Approach.
In this depiction, an **AFM tip (gold) with a CO terminus** (C is gray, O is red) traces an image (blue, red, and green surface) of atoms and bonds in pentacene (C is gray, H is white).

Az anyag kettős természete: hullám és részecske

The Nobel Prize in Physics 1929

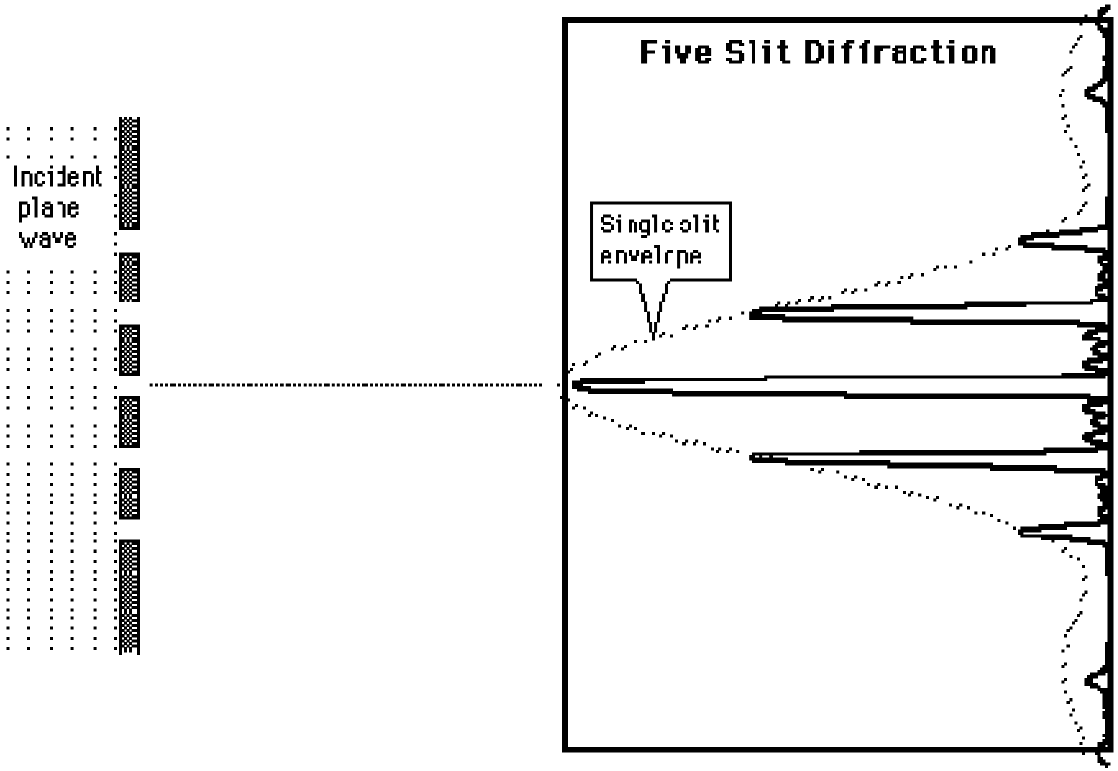
"for his discovery of the wave nature of electrons"

$$\lambda = h/p$$

Prince Louis-Victor Pierre Raymond de Broglie
b. 1892,d. 1987

In 1924 at the Faculty of Sciences at Paris University he delivered a thesis *Recherches sur la Théorie des Quanta* (Researches on the quantum theory), which gained him his doctor's degree.

A hullámtermészet lényege: **Interferencia-diffrakció**

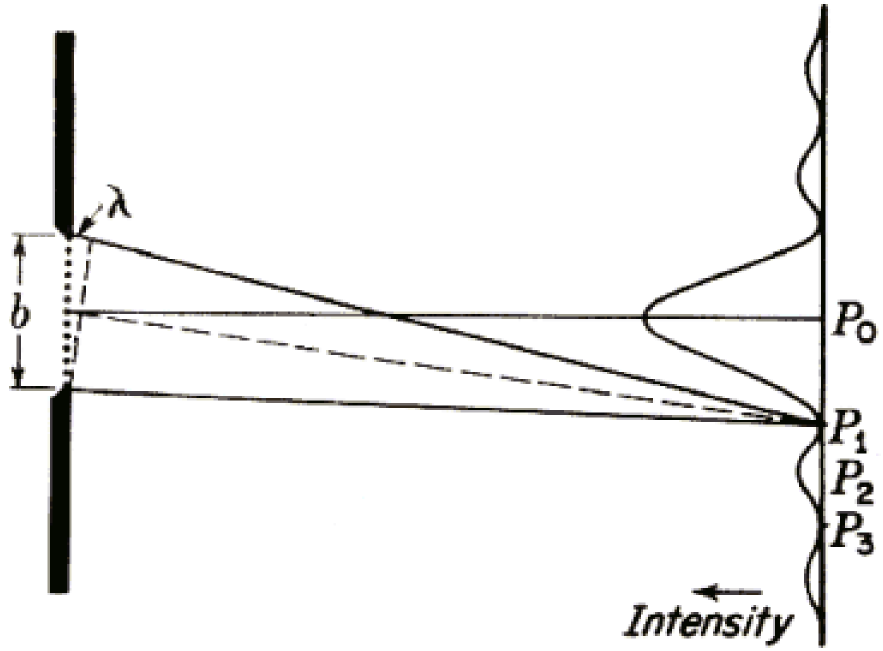


Megjegyzés: **EGYETLEN rés is már diffrakciót ad (Fraunhofer)**

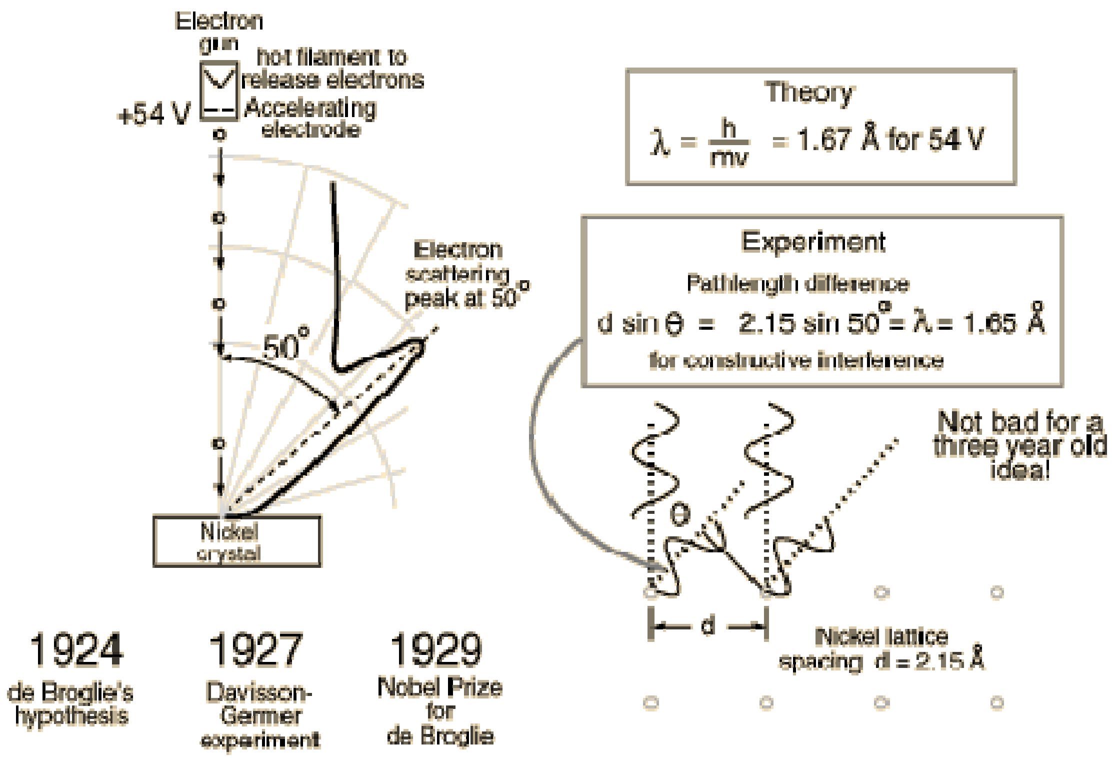
http://www.micrographia.com/tutoria/micbasic/micbpt06/micb0600.htm

Kiemelés FG. Consider a subject under a brightfield microscope which has a pattern of detail in which very small opaque objects are separated from one another by a distance equal to their own diameter. The diagram below represents the **diffraction which occurs at a single narrow slit**, and is used here to illustrate what happens when light passes through the space separating the opaque objects of the above example.

* *Given the approximation that the wavefront of light arriving at this slit from a very distant point source is planar, Huyghens' principle states that along the imaginary line b which represents the wavefront momentarily present between the edges of the slit, each point on b could itself be considered a secondary source of wavelets which radiate from that point. This provides a basis for determining the distribution of the light energy passing through the slit, which, due to interference between the rays, is neither even nor random.*



Az elektronhullám kísérleti igazolása:
Davisson és Germer, 1927



Davisson és Germer, az eredeti cikk

Second Series *December, 1927* *Vol. 30, No. 6*

THE

PHYSICAL REVIEW

DIFFRACTION OF ELECTRONS BY A CRYSTAL OF NICKEL

BY C. DAVISSON AND L. H. GERMER

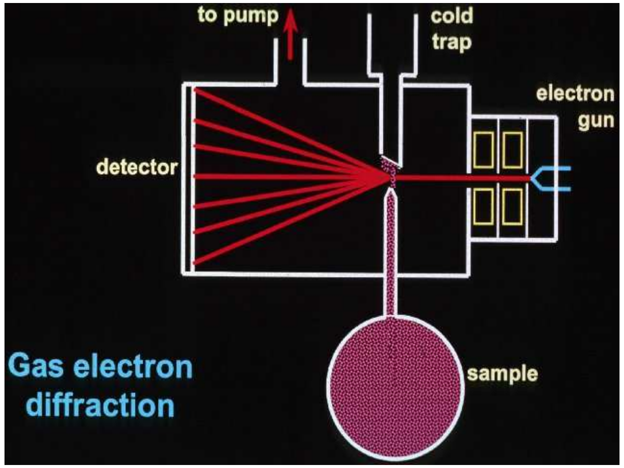
ABSTRACT

The intensity of scattering of a homogeneous beam of electrons of adjustable speed incident upon a single crystal of nickel has been measured as a function of direction. The crystal is cut parallel to a set of its {111}-planes and bombardment is at normal incidence. The distribution in latitude and azimuth has been determined for such scattered electrons as have lost little or none of their incident energy.

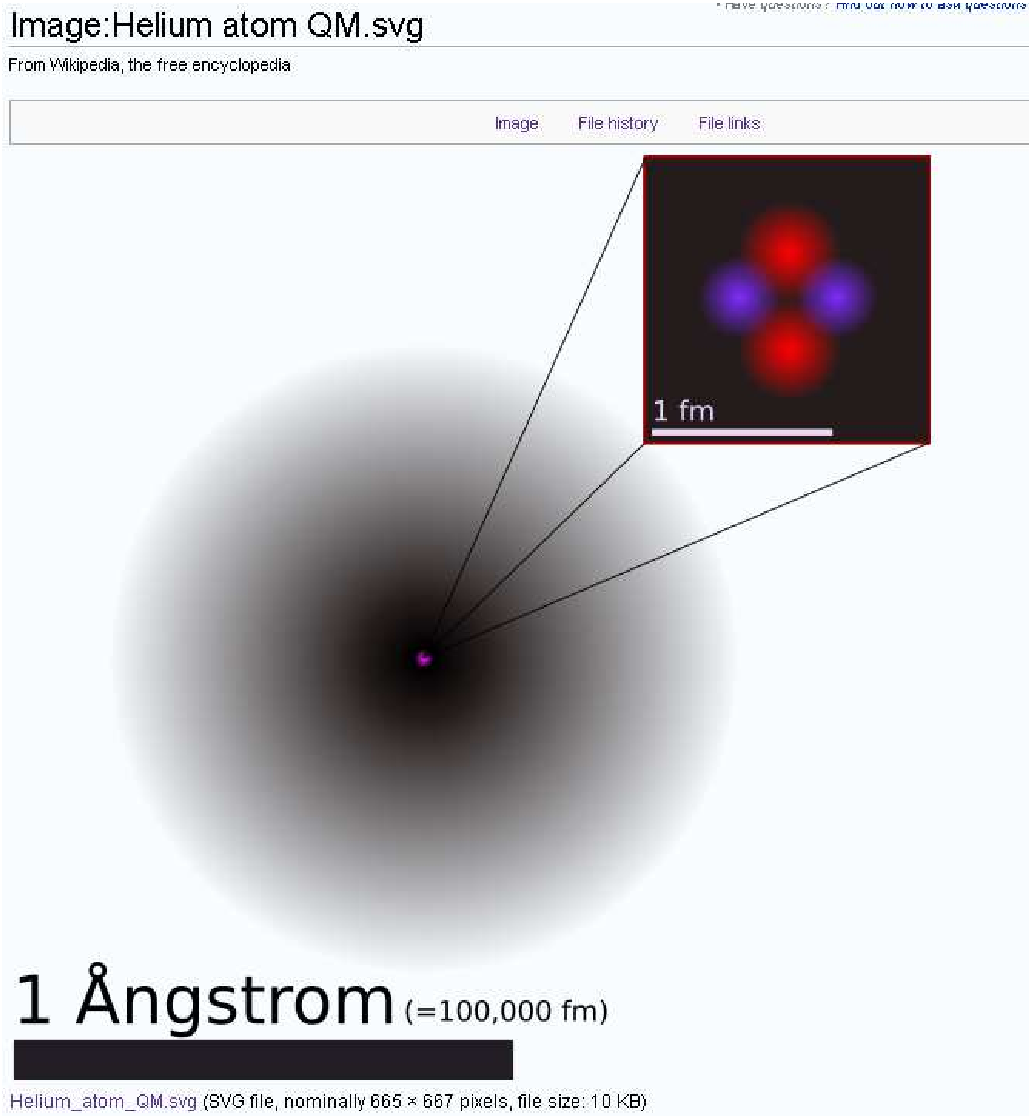
Electron beams resulting from diffraction by a nickel crystal.—Electrons of the above class are scattered in all directions at all speeds of bombardment, but at and near critical speeds sets of three or of six sharply defined beams of electrons issue from the crystal in its principal azimuths. Thirty such sets of beams have been ob-

Az elektron hullámtermészetét ma a gyakorlatban is kihasználjuk, pl.:

Molekulák geometriájának meghatározása
gáz-elektrondiffrakciós *módszerrel*



A modern atomkép:



Megj.: persze valójában a mag is **gömb**szimmetrikus

A H-atom kvantummechanikai leírása

Kvantumszámok:

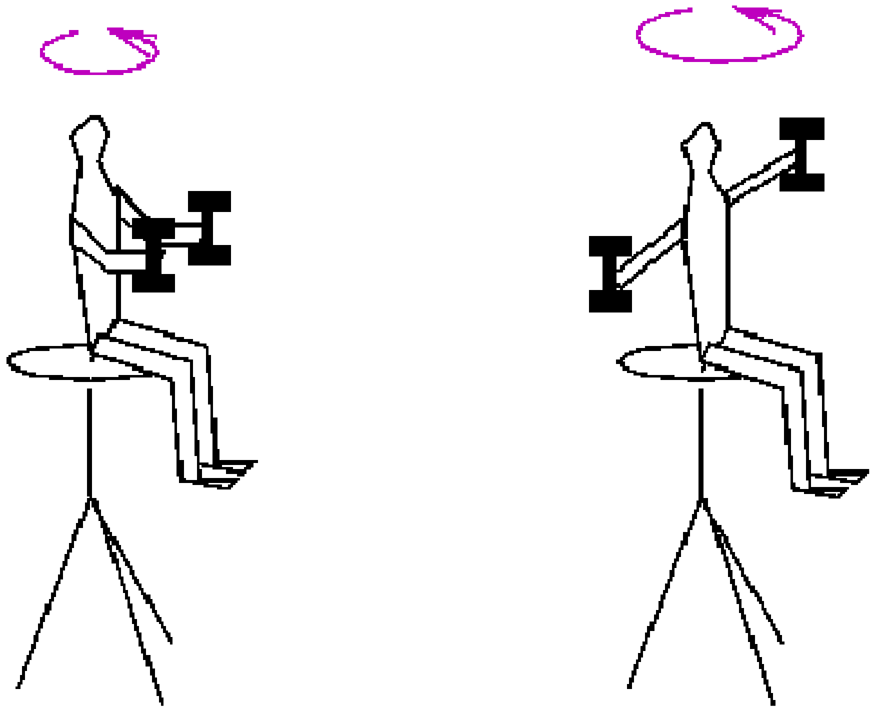
n - energia

l – az impulzusmometetum nagysága

m - az impulzusmometum z-komponense

Az impulzusmomentum: $\underline{L} = \underline{r} \times \underline{p}$

avagy: $\underline{L} = I\underline{\omega}$; $I = mr^2$ tehetetlenségi nyomaték, ω a szögsebesség vektor

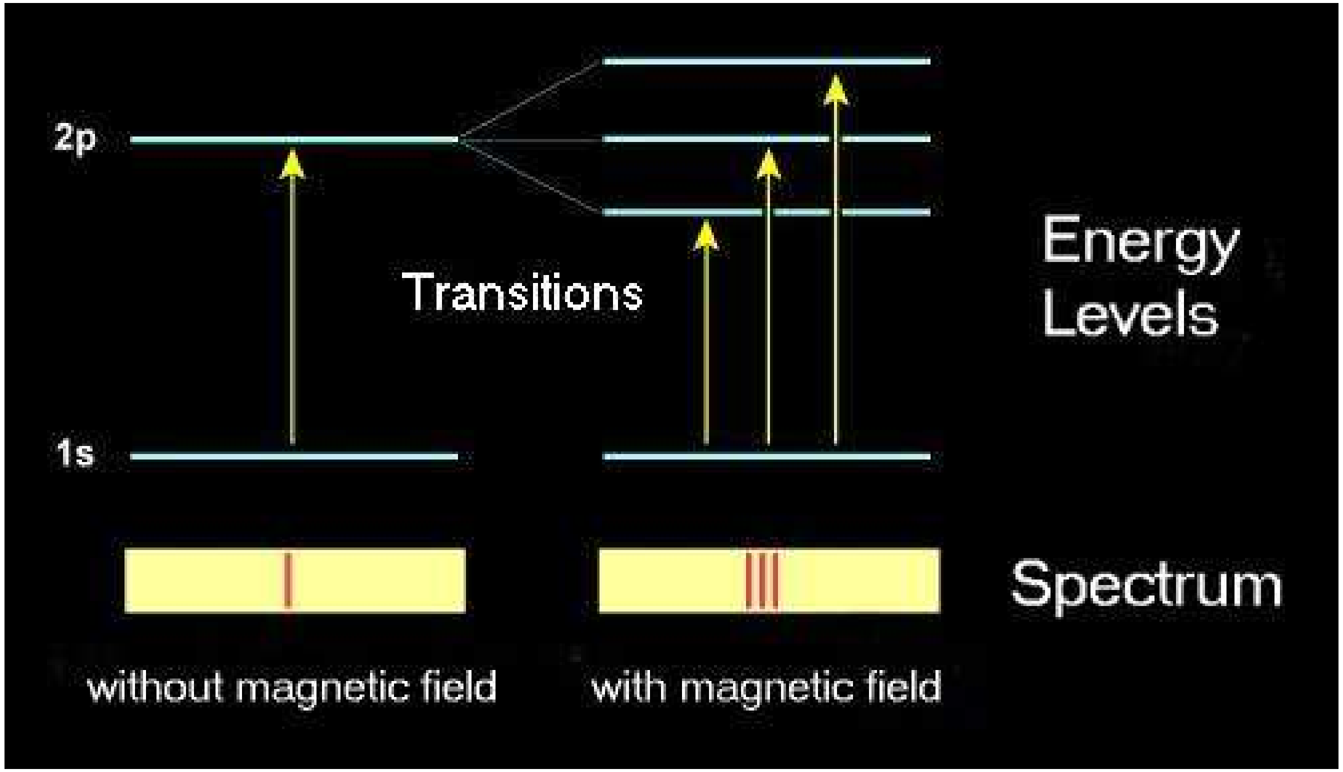


Sasha Cohen

Vajon tudja-e, hogy mindez csak impulzusmometum kérdése

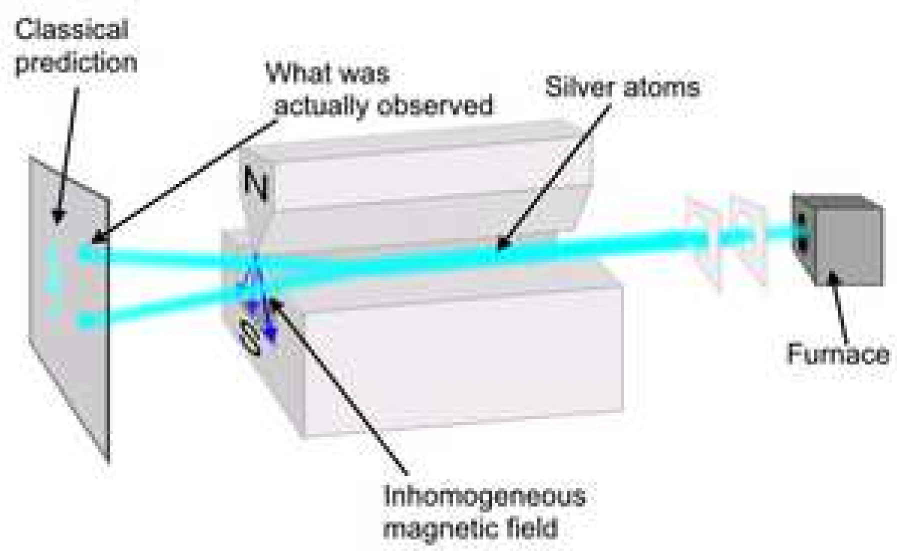
Ha nem figyelünk az impulzusmomentum megőrzésére ...

Hol jelentkezik az **m** kvantumszám, miért **mágneses** kv.sz.?
Ha egy töltött részecskének impulzusmomentuma van, az egyben **mágneses momentumot** is jelent.
A kis elemi mágneses külső mágneses térben különböző irányú lehet, a z-komponenst méri m.
Külső mágneses térben *az energiaszintek* **m** *szerint felhasadnak*. 2p : l =1, m =-1,0,1



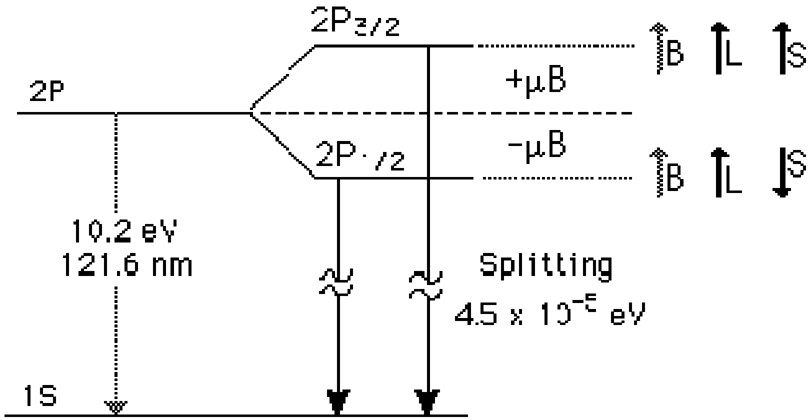
Elektronspin:
a pályamozgástól függetlenül, az elektronnak **saját, belső** impulzumomentuma is van!

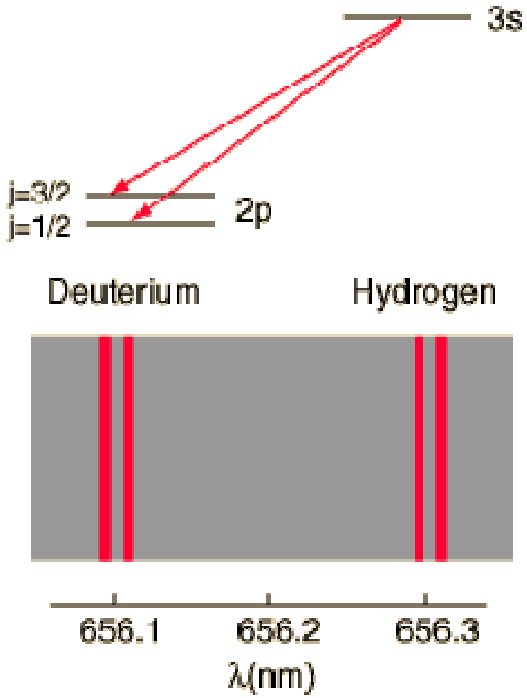
A Stern-Gerlach kísérlet, 1922.



[A ‘klasszikus’ várakozás: ha szabadon forogna a tér minden irányában a mágneses momentum, z-vetülete statisztikusan, folytonosan változna, s ezzel az eltérülés is.]

Az elektronspin a hidrogénspektrum finomszerkezetében
is világosan megmutatkozik (spin-pálya kölcsönhatás)

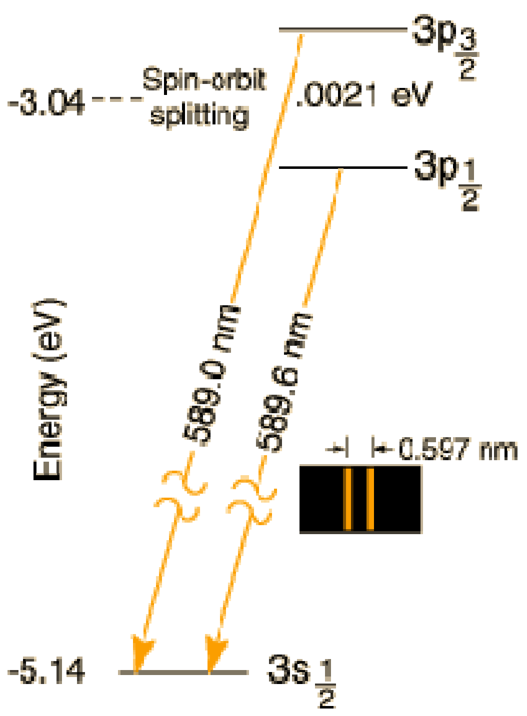


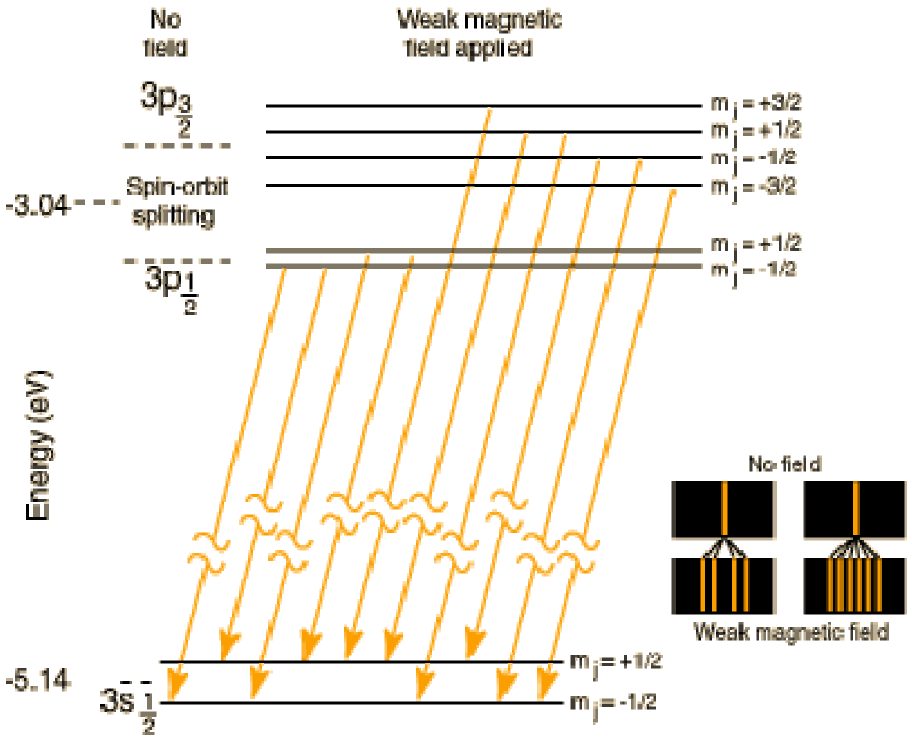


Egy speciális példa a Zeeman-effektusra (unicorn.ps.uci.edu/.../Sodium/sodium.html): a Na-dublett továbbhasadása mágneses térben

Sodium Spectrum

The sodium spectrum is dominated by the bright doublet known as the Sodium D-lines at 588.9950 and 589.5924 nanometers. From the energy level diagram it can be seen that these lines are emitted in a transition from the 3p to the 3s levels. The line at 589.0 has twice the intensity of the line at 589.6 nm. Taking the range from 400-700nm as the nominal visible range, the strongest visible line other than the D-lines is the line at 568.8205 which has an intensity about 0.7% of that of the strongest line. All other lines are a factor of two or more fainter than that one, so for most practical purposes, all the light from luminous sodium comes from the D-lines.





H-atom: **az elektron tartózkodási valószínűsége**

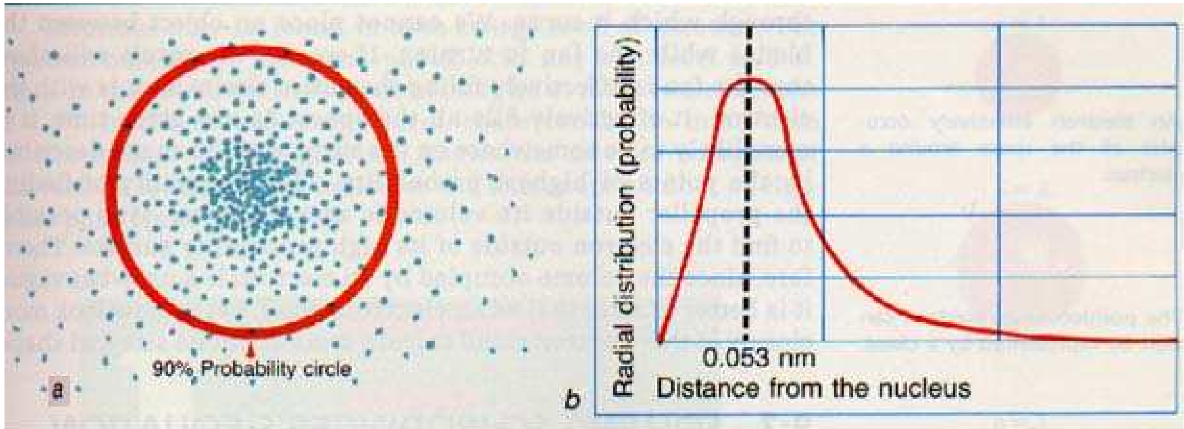
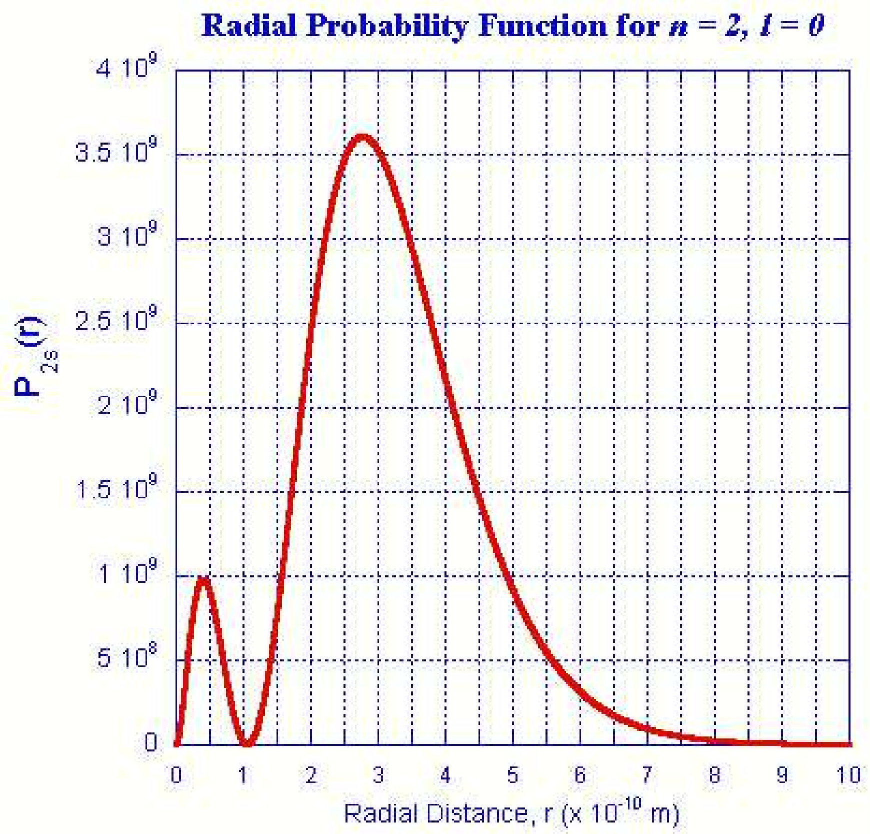
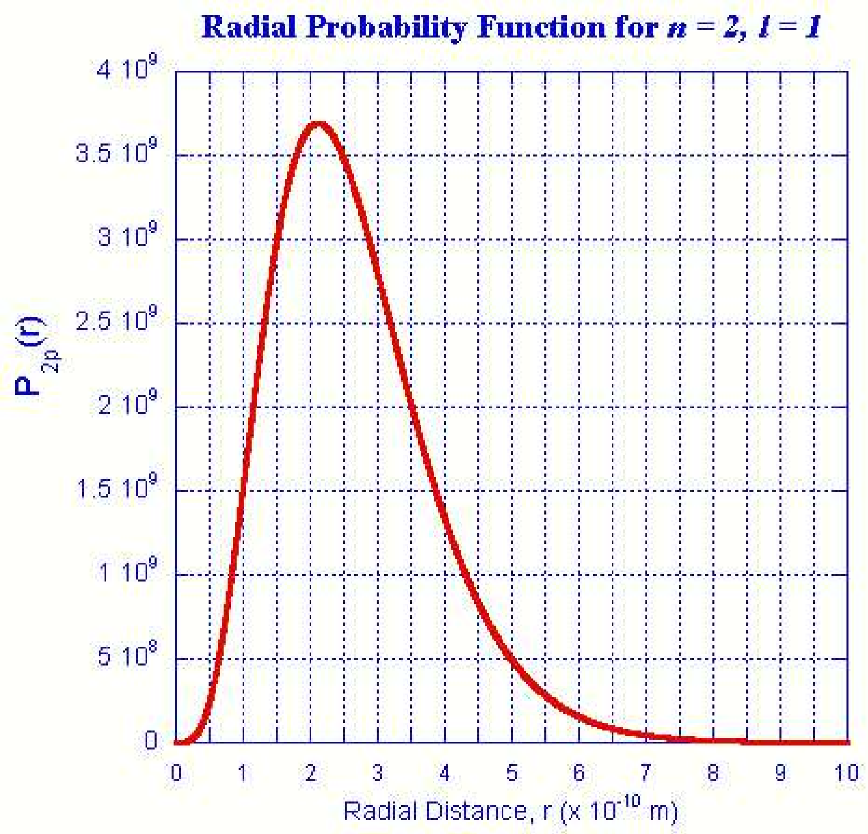


FIGURE 9-4. Probability plots for a hydrogen electron are shown in (a). Note the area represented by 90% probability. The point of highest probability for a hydrogen electron occurs at about 0.053 nm from the nucleus (b).

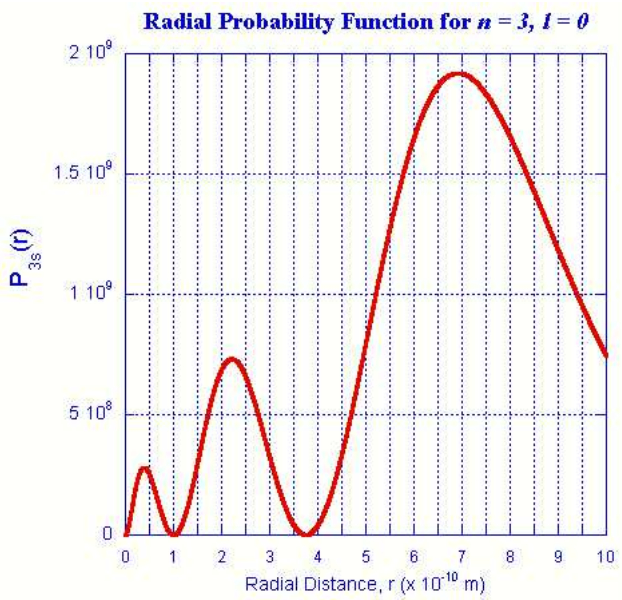
2s

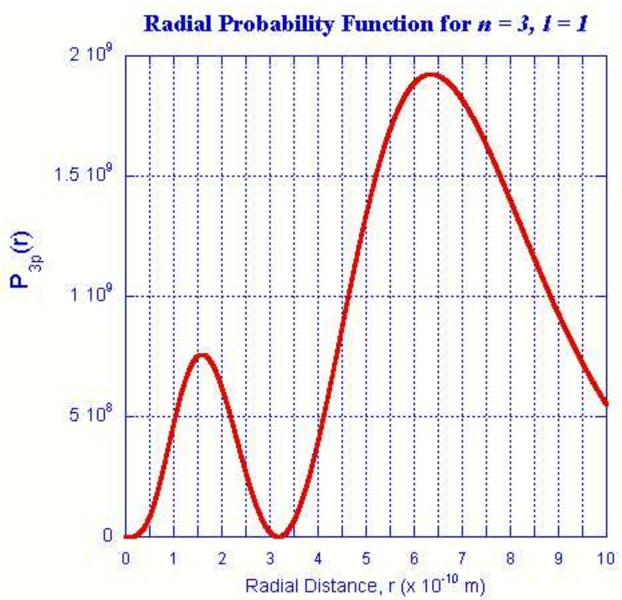

Radial Probability Function for n = 2, l = 0
P2s(r)
4 10^9
3.5 10^9
3 10^9
2.5 10^9
2 10^9
1.5 10^9
1 10^9
5 10^8
0
0 1 2 3 4 5 6 7 8 9 10
Radial Distance, r (x 10^-10 m)

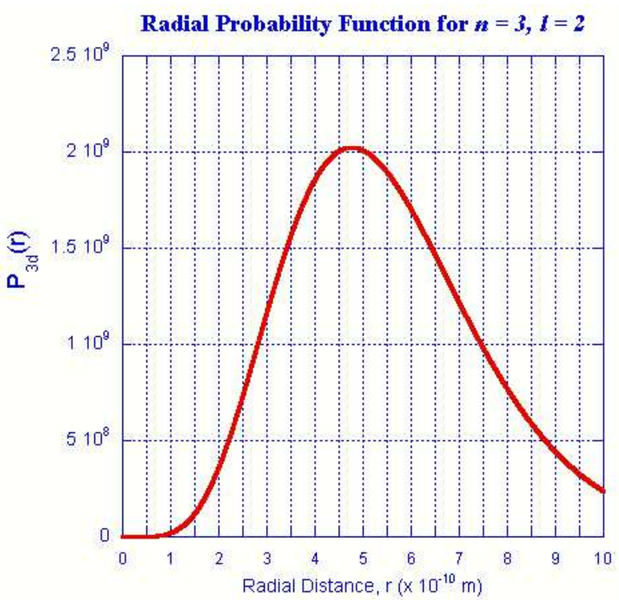
2p


Radial Probability Function for n = 2, l = 1
P2p(r)
4 10^9
3.5 10^9
3 10^9
2.5 10^9
2 10^9
1.5 10^9
1 10^9
5 10^8
0
0 1 2 3 4 5 6 7 8 9 10
Radial Distance, r (x 10^-10 m)

3s, 3p, 3d.
Figyeljük a csomófelületek számát!

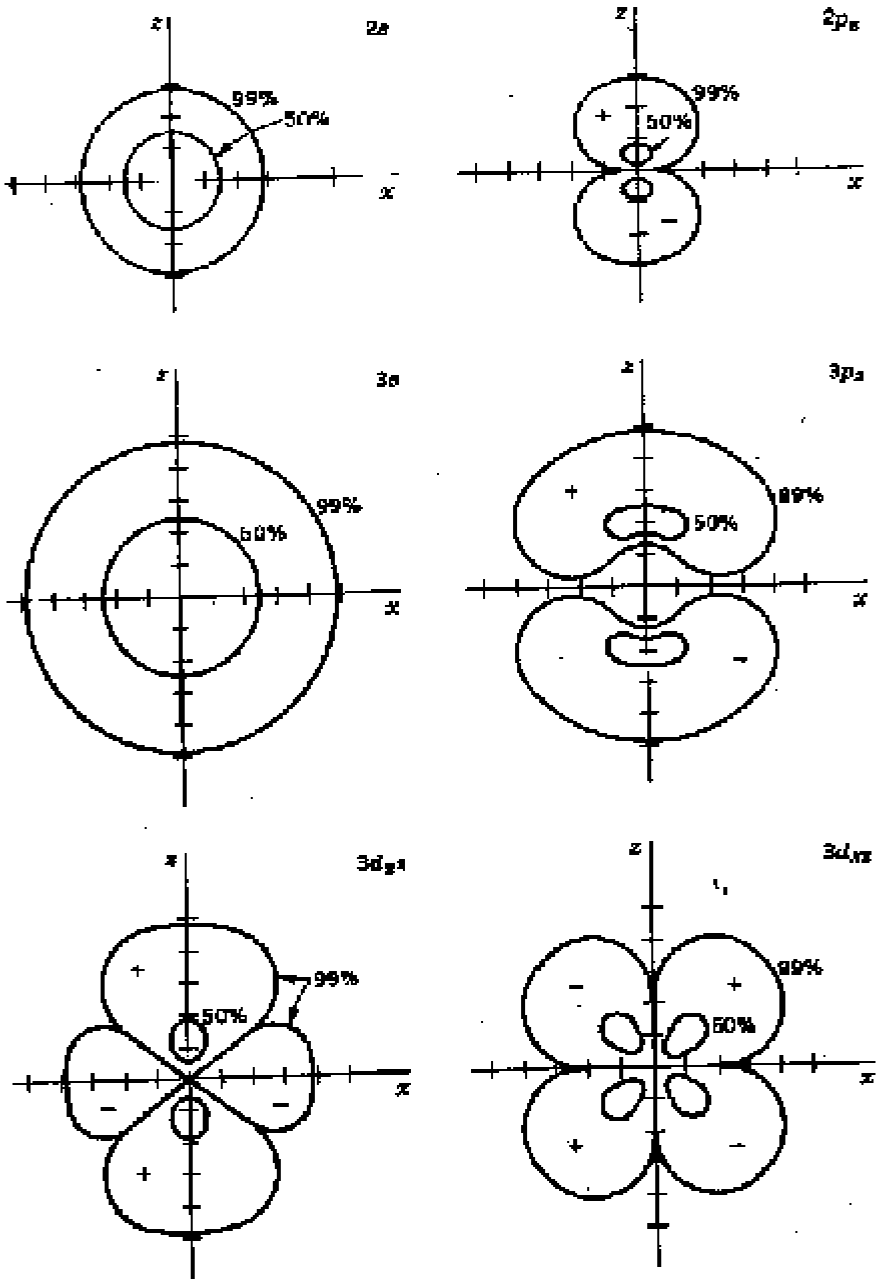




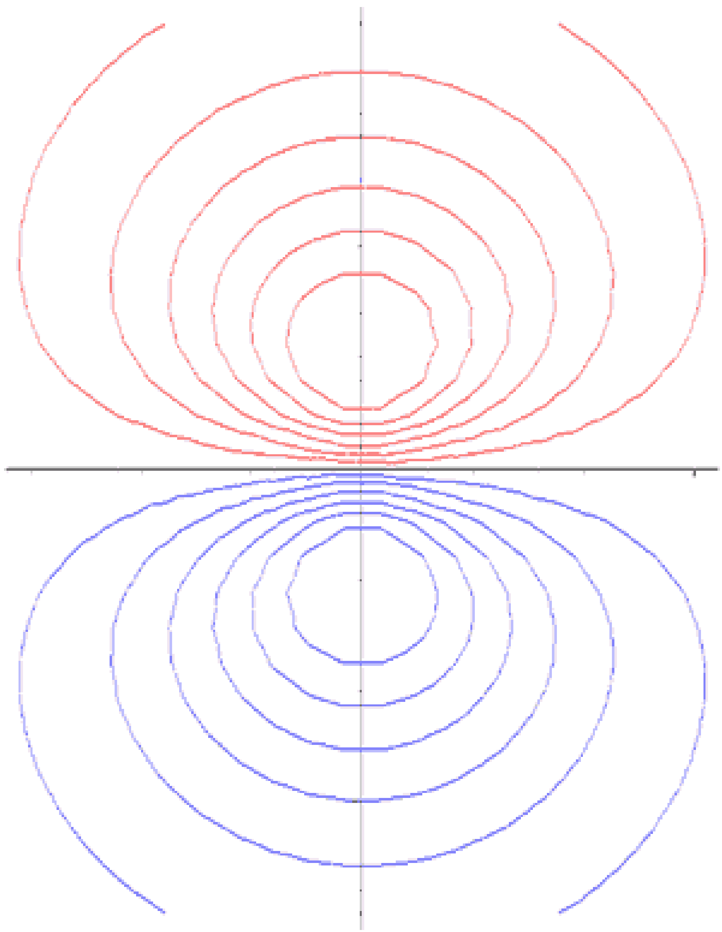


Szintvonalak

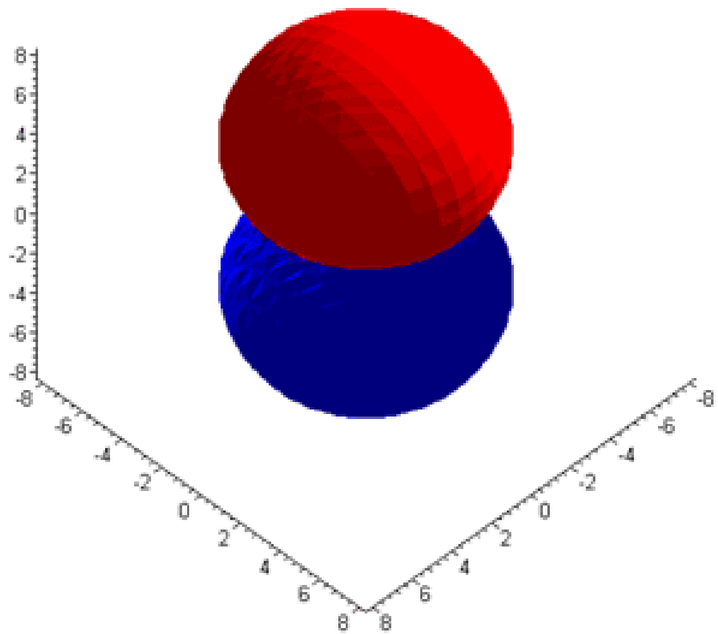
(Offenhartz, p90, scannned)



Contour plot of the $2p_z$ wave function of the hydrogen atom.
The xz-plane is taken for the cross section.

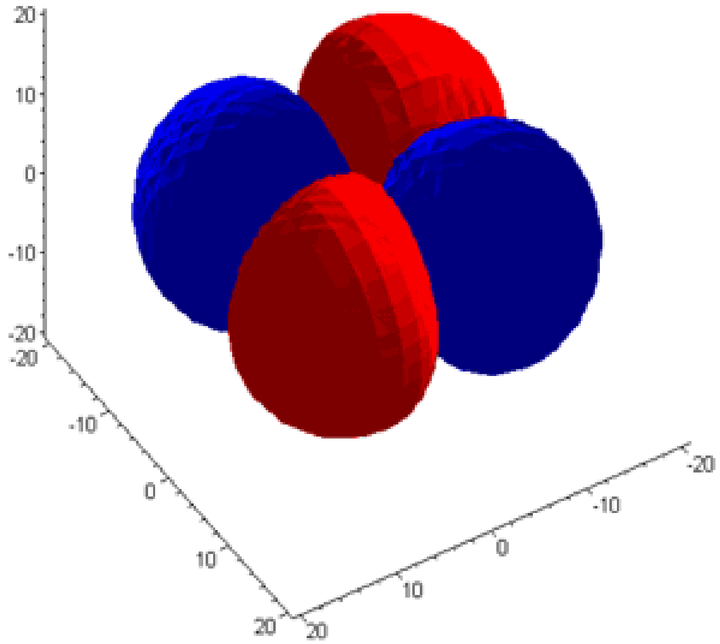


Isosurface of the $2p_z$ wave function of the hydrogen atom.

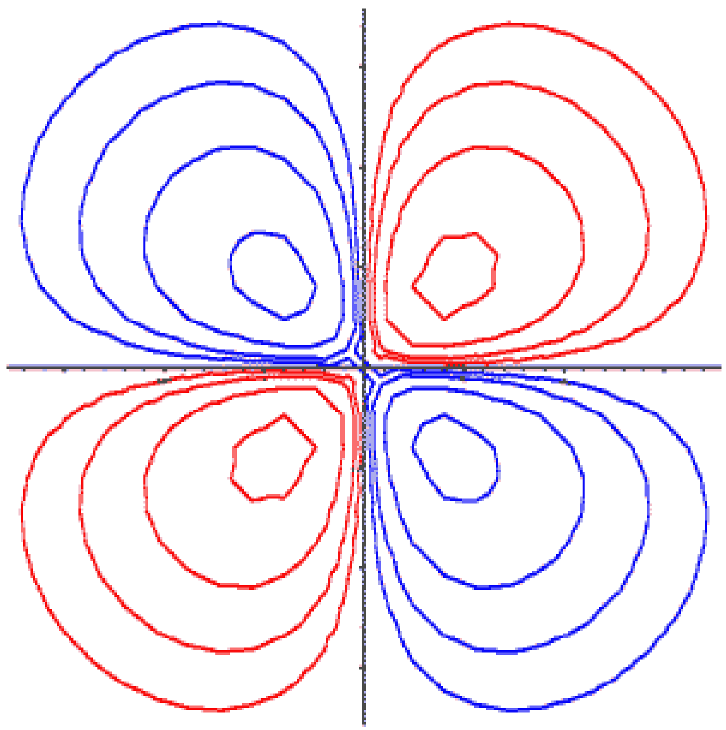


http://www.catalysis.nl/~chembond/notes/Hatom/Hatom3.html

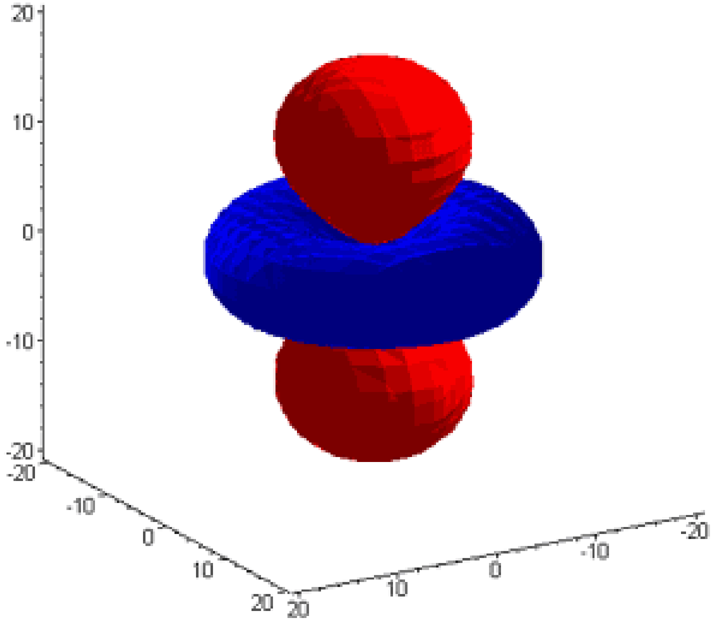
Isosurface of the $3d_{xy}$ wave function of the hydrogen atom.



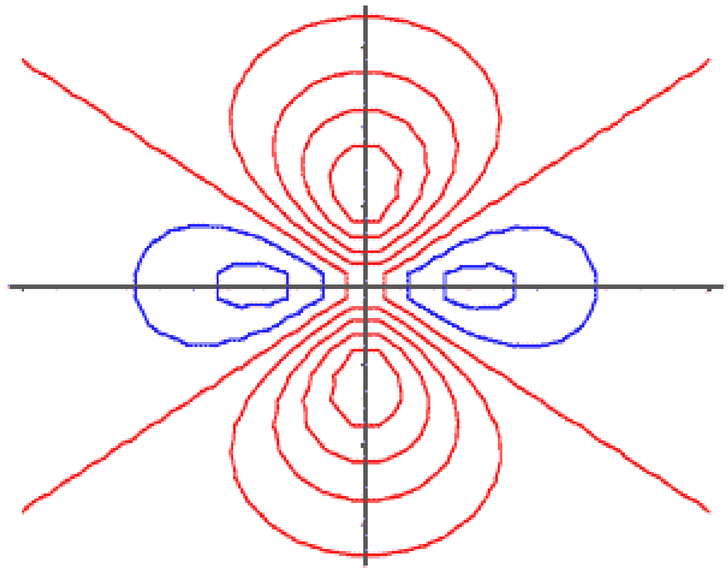
Contour plot The xy-plane is taken for the cross section.



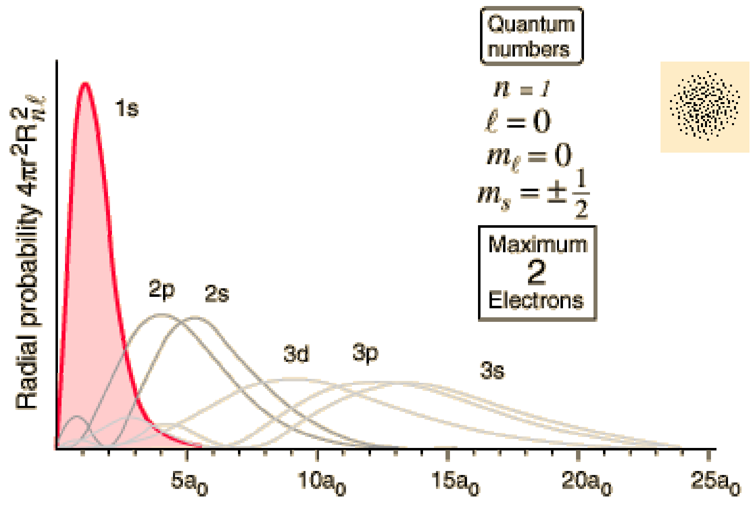
Isosurface of the $3d_{z^2}$ wave function of the hydrogen atom.

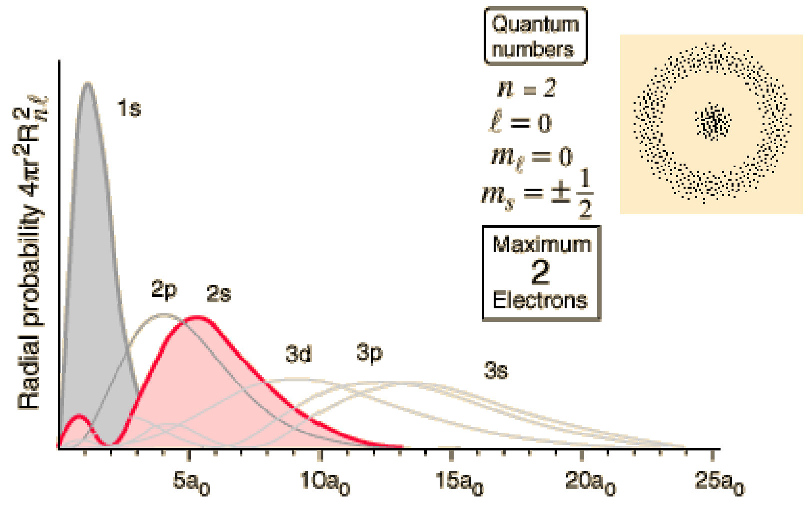


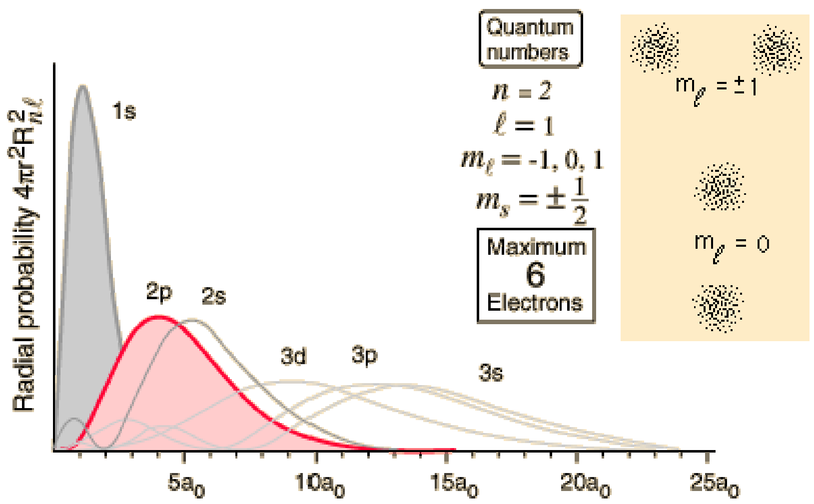
Contour plot of the $3d_{z^2}$ wave function of the hydrogen atom. The xz-plane is taken for the cross section.

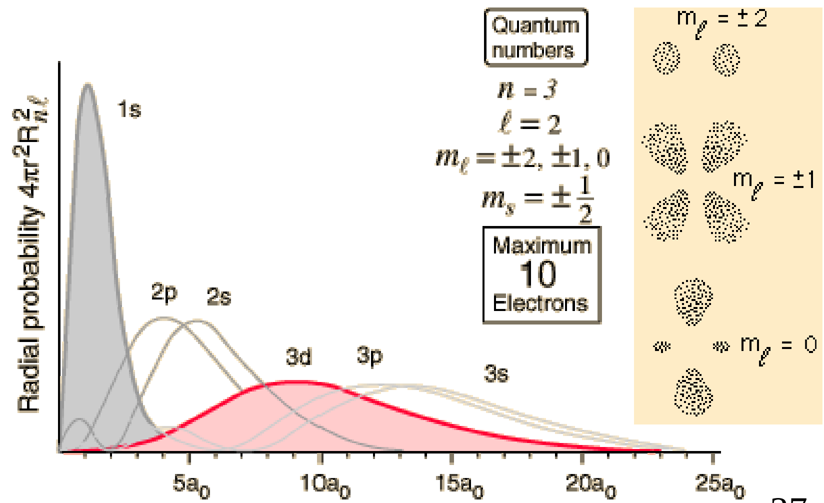


Mégegyszer együtt: radiális eloszlás és el. sűrűség



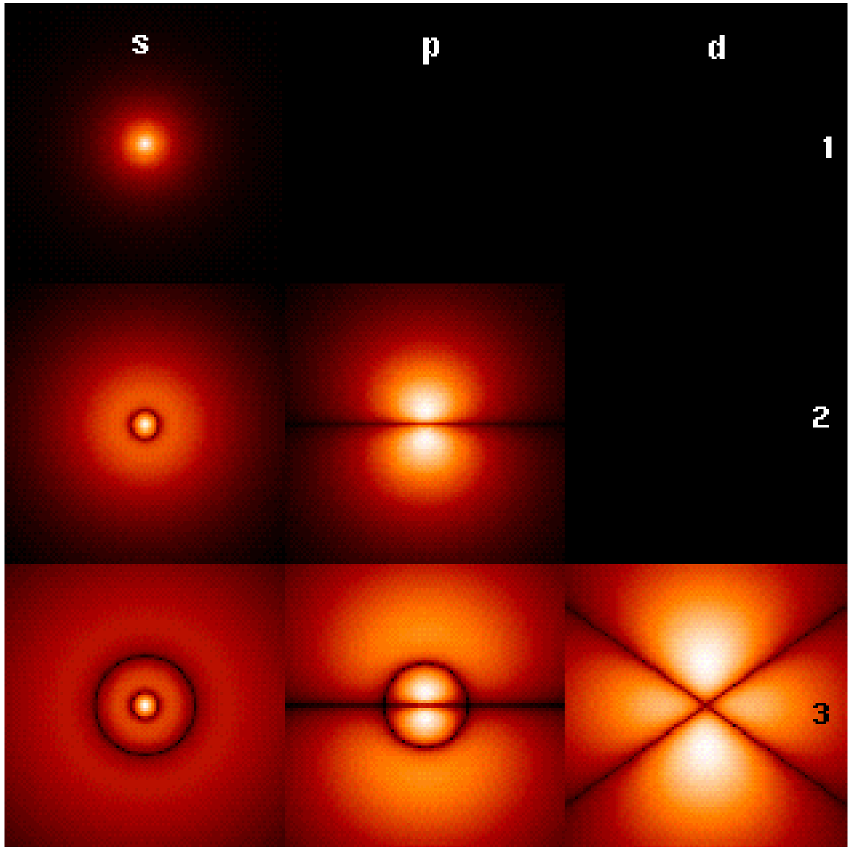






A H-atom pályái
Ábrázolva valójában Ψ négyzete, vagyis az elektronsűrűség)

http://en.wikipedia.org/wiki/Hydrogen_atom



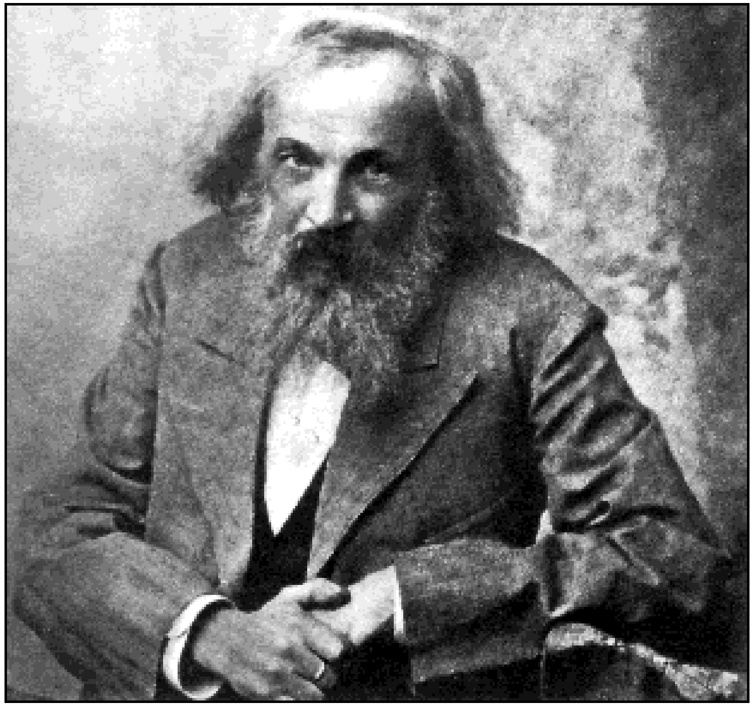
A periódusos rendszer

TABELLE II

Reihen	Gruppe I. — R^2O	Gruppe II. — RO	Gruppe III. — R^2O^3	Gruppe IV. RH^4 RO^2	Gruppe V. RH^3 R^2O^5	Gruppe VI. RH^2 RO^3	Gruppe VII. RH R^2O^7	Gruppe VIII. — RO^4
1	H = 1							
2	Li = 7	Be = 9,4	B = 11	C = 12	N = 14	O = 16	F = 19	
3	Na = 23	Mg = 24	Al = 27,3	Si = 28	P = 31	S = 32	Cl = 35,5	
4	K = 39	Ca = 40	— = 44	Ti = 48	V = 51	Cr = 52	Mn = 55	Fe = 56, Co = 59, Ni = 59, Cu = 63.
5	(Cu = 63)	Zn = 65	— = 68	— = 72	As = 75	Se = 78	Br = 80	
6	Rb = 85	Sr = 87	?Yt = 88	Zr = 90	Nb = 94	Mo = 96	— = 100	Ru = 104, Rh = 104, Pd = 106, Ag = 108.
7	(Ag = 108)	Cd = 112	In = 113	Sn = 118	Sb = 122	Te = 125	J = 127	
8	Cs = 133	Ba = 137	?Di = 138	?Ce = 140	—	—	—	— — — —
9	(—)	—	—	—	—	—	—	
10	—	—	?Er = 178	?La = 180	Ta = 182	W = 184	—	Os = 195, Ir = 197, Pt = 198, Au = 199.
11	(Au = 199)	Hg = 200	Tl = 204	Pb = 207	Bi = 208	—	—	
12	—	—	—	Th = 231	—	U = 240	—	— — — —

Figure 2.5 Dmitri Mendeleev's 1872 periodic table. The spaces marked with blank lines represent elements that Mendeleev deduced existed but were unknown at the time, so he left places for them in the table. The symbols at the top of the columns (e.g., R^2O and RH^4) are molecular formulas written in the style of the 19th century.

Mengyelejev



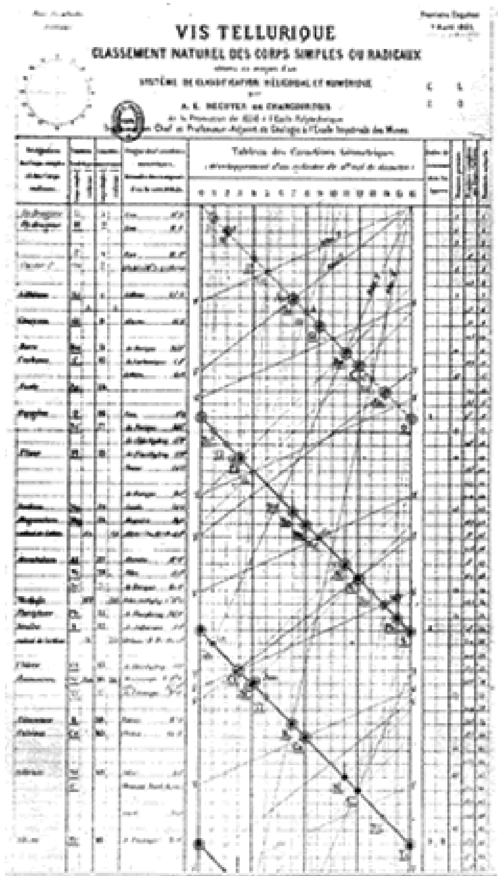
Tellur és jód helyet cserél ......

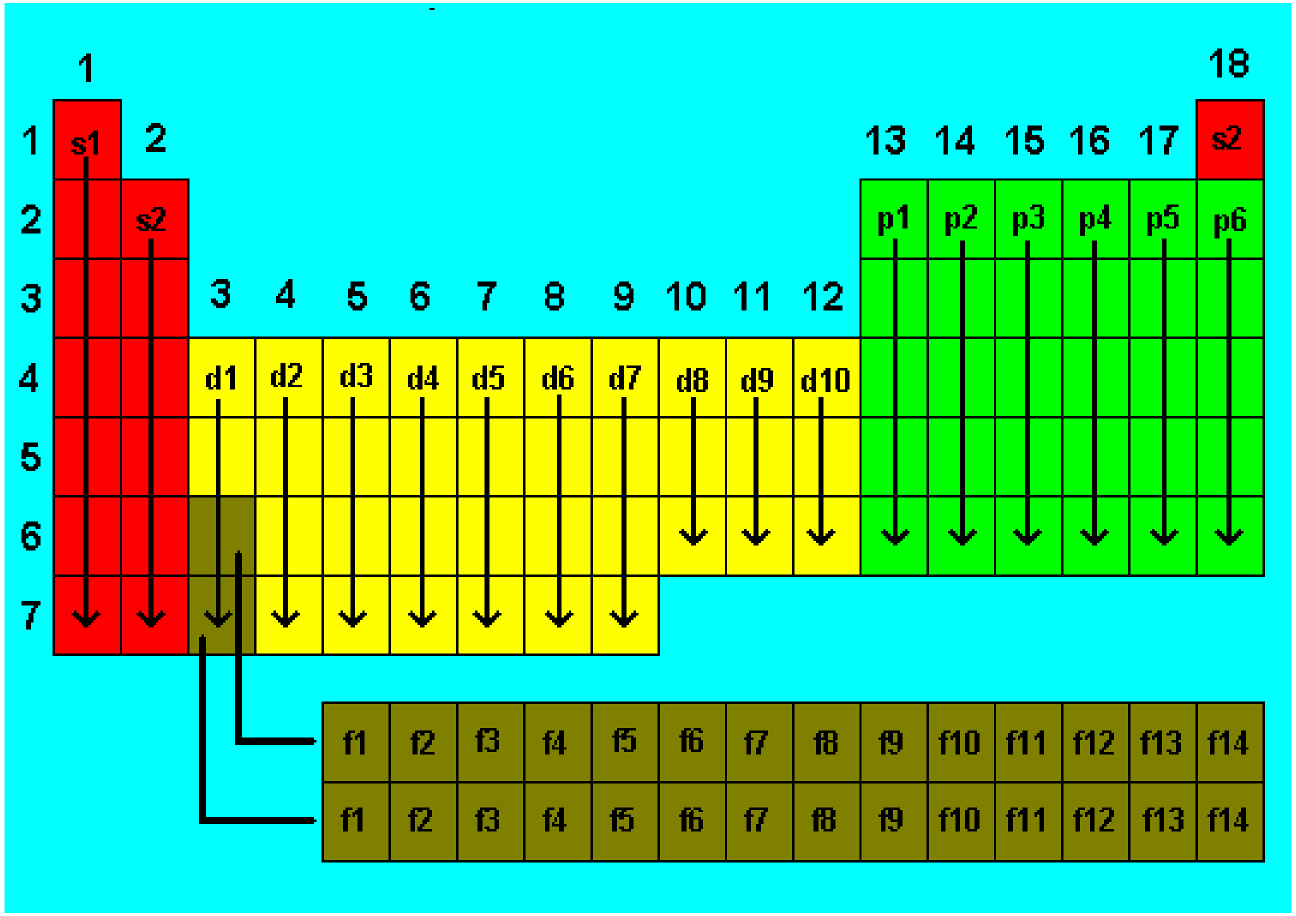
Sztori: a tellúr magyar "kapcsolata":
Tellurium was discovered in a certain gold ore from Transsylvania. This ore, known as "Faczebajer weißes blättriges Golderz" (white leafy gold ore from Faczebaja) or "antimonalischer Goldkies" (antimonic gold pyrite), was according to professor Anton von Rupprecht "Spießglaskönig" (*argent molybdique*), containing native Antimony (note). The same ore was analyzed by by Franz Joseph **Müller** Freiherr von Reichenstein (1742-1825) (note), chief inspector of mines in Transsylvania, he concluded in 1782 that the ore did not contain Antimony, but that it was Bismuth sulphide (note). A year later he reported that this was erroneous and that the ore contained mainly gold and an unknown metal very similar to Antimony (note). However, Müller was not able to identify this metal. He gave it the name aurum paradoxium or metallum problematicum because it did not show the properties predicted for the Antimony he was expecting.

Magyarosan:
Müller Ferenc (?)

Az új eredmények mindig már ott „lógnak a levegőben”;
A periodikusság felismerése Mengyelejev előtt: Elemek egy hengeren
190 éve született Alexandre Émile Béguyer de Chancourtois
.... 1820. január 20-án született Párizsban. A francia geológus,

Két évvel az első nemzetközi vegyészkonferencia után, **1862**-ben Chancourtois az atomsúlyok szerint sorba rendezett elemek neveit egy **henger palástjára** írta fel spirális alakban.




1
18
1
s1
2
13
14
15
16
17
s2
2
s2
p1
p2
p3
p4
p5
p6
3
3
4
5
6
7
8
9
10
11
12
4
d1
d2
d3
d4
d5
d6
d7
d8
d9
d10
5
6
7
f1
f2
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f11
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f13
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f14

Melyik a legnagyobb rendszámú atom?
A 118-ast már évekkel ezelőtt jelentette a Lawrence Livermore Lab., de bizonytalan volt. Most megerősítették (?).
(Előtte levők közül van 112, 114, 116).

Chem. Eng. News
October 17, 2006
Transactinides

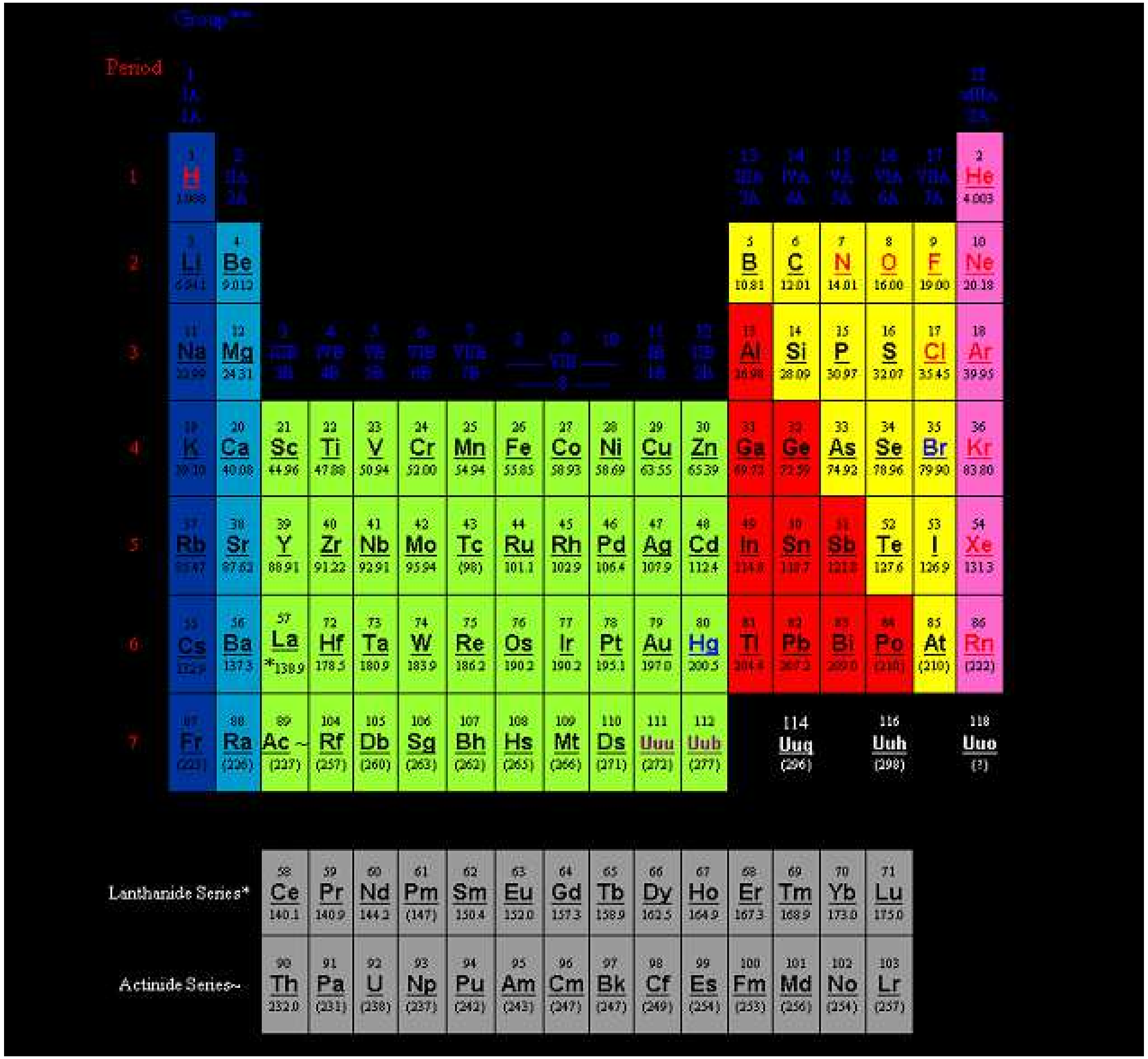
Element 118 Detected, With Confidence

High-energy experiments yield three atoms of superheavy nuclide

Mitch Jacoby

An experiment begun in 2002 has produced three atoms of the heaviest superheavy element yet—element 118—according to a team of researchers from Russia and the U.S. On the basis of the number of protons in its nucleus, **the new element belongs just below radon** in the periodic table.
Scientists at the Joint Institute for Nuclear Research in Dubna, working with colleagues from Lawrence Livermore National Laboratory in California, bombarded a target enriched in californium (^{249}Cf, containing 98 protons) with an energetic beam of calcium ions (^{48}Ca, with 20 protons). After thousands of hours of bombardment, the team claims to have detected three series of correlated nuclear events that signify the creation and nearly instantaneous demise of three atoms of element 118. The results have been published in *Physical Review C* (**2006**, *74*, 044602) and were announced on Oct. 16 in a telephone press briefing by members of the Livermore group.

A legnagyobb elemek …. Állítólag a 118-as is biztos már
Forrás: Los Alamos Natl. Lab.



Nagy rendszámú, új elemek elnevezése:

Periodic Table: IUPAC Naming
At Chemical Elements.com

55 Cs 132.9	56 Ba 137.3	57 La *138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 190.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.5	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac ~ (227)	104 Rf (257)	105 Db (260)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (271)	111 Uuu (272)	112 Uub (277)		114 Uuq (296)		116 Uuh (298)		118 Uuo (?)

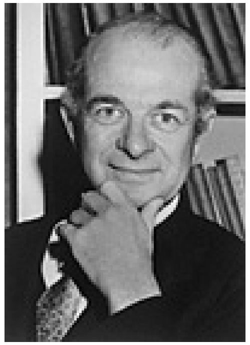
Due to disputes over the discovery of some of the heavier elements, the International Union for Pure and Applied Chemistry (IUPAC) has devised a systematic naming scheme,

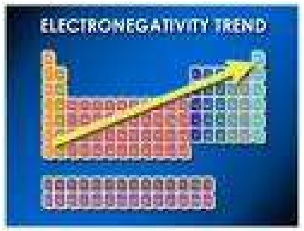
Number	**Name**	**Number**	**Name**
0	nil	5	pent
1	un	6	hex
2	bi	7	sept
3	tri	8	oct
4	quad	9	enn

1. The element's atomic number is examined and broken down into individual numbers. For example, the hypothetical element numbered 119 would be separated into *1-1-9*.
2. The element's numbers are replaced by the Latin and Greek naming system, as shown in this table:
Using the previous example, 1-1-9 would change to *Un un enn*.
3. All the roots are put together, and -ium is added to the end. If *bi* or *tri*, occur before -ium, the *i* is dropped. If *enn* occurs before nil, the last *n* is dropped. Using the same example, *Un un enn* becomes *Ununennium*.
4. The symbol is the first letter of all the Greek and Latin parts that make up the element's name. Thus, the symbol for *Ununennium* is Uue.

Pauling az elektronegativitás mellett a kémia számos területén úttörő volt

Linus Carl Pauling





The Nobel Prize in Chemistry 1954

(Később Béke-Nobel-díjat is kapott)

"for his research into the nature of the chemical bond and its application to the elucidation of the structure of complex substances"

USA

California Institute of Technology (Caltech)
Pasadena, CA, USA

b. 1901
d. 1994

Pauling eredeti cikke az elektronegativitásról:
J. Am. Chem. Soc. 54, 3570-3582 (1932).

Elve: ‘normális’ esetben – tiszta kovalens kötés - a kötésenergia additív lenne . Az eltérés (kötéserősödés) a kötés ionos jellegéből fakad, ami a két atom elektronegativitás-különbségének lehet a mértéke

3570 LINUS PAULING Vol. 54

[CONTRIBUTION FROM THE GATES CHEMICAL LABORATORY, CALIFORNIA INSTITUTE OF TECHNOLOGY, No. 326]

THE NATURE OF THE CHEMICAL BOND. IV. THE ENERGY OF SINGLE BONDS AND THE RELATIVE ELECTRONEGATIVITY OF ATOMS

BY LINUS PAULING

RECEIVED MAY 18, 1932 PUBLISHED SEPTEMBER 5, 1932

Recent developments in the application of the quantum mechanics to problems of molecular structure[1] have indicated that the properties of a bond between two atoms often are determined mainly by one single-electron orbital wave function for each atom, and are not strongly affected by the

The Additivity of the Energies of Normal Covalent Bonds. The Hydrogen Halides and the Halogen Halides.—It is found that there exists a convincing body of empirical evidence in support of the postulate[5] that *the energies of normal covalent bonds are additive;* that is

$$A:B = {}^1/_2\,\{A:A + B:B\}$$

where the symbol A:B means the energy of the normal covalent bond

We accordingly write

$$\Delta_{A:B} = (x_A - x_B)^2 \qquad (1)$$

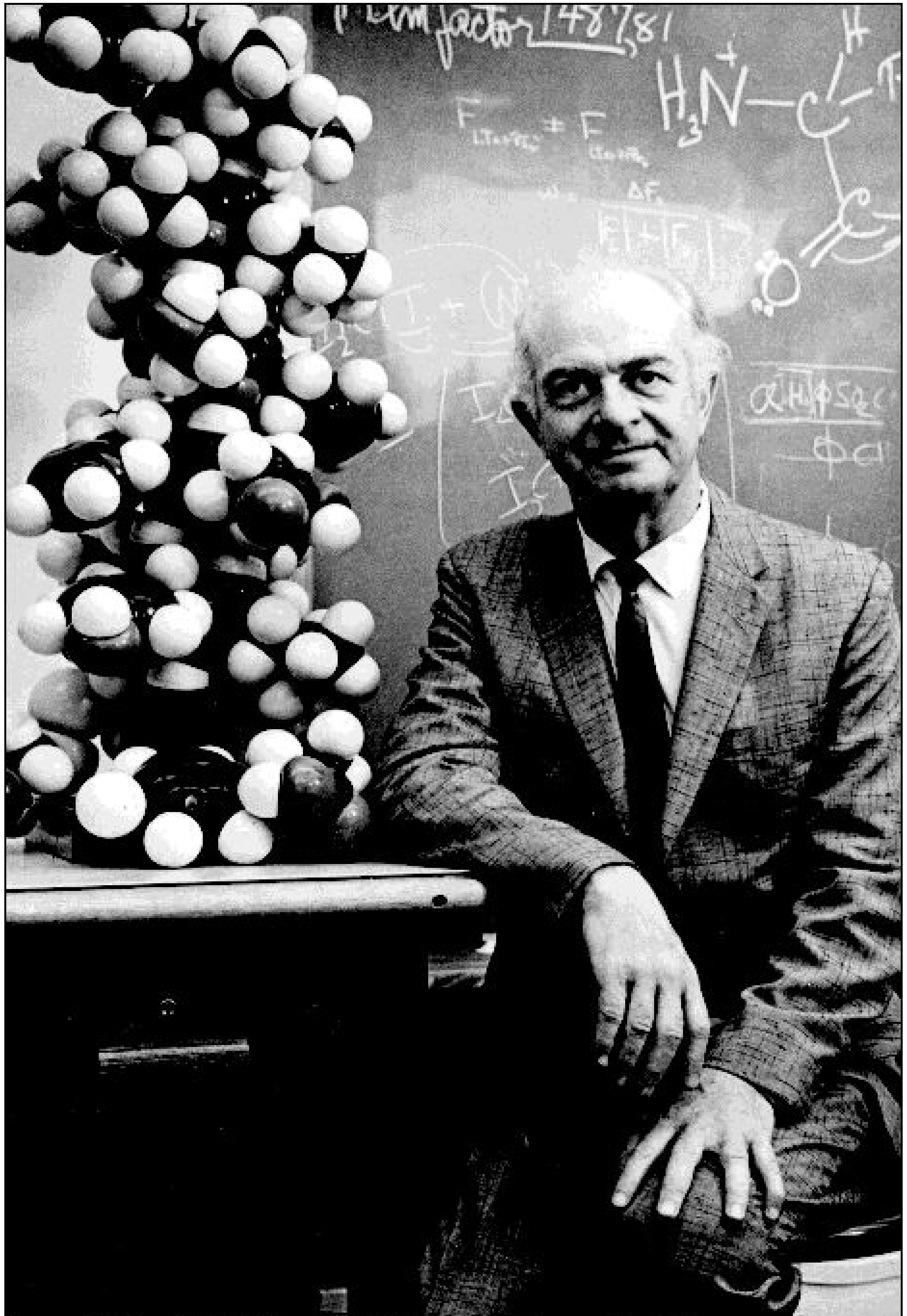
with Δ measured in volt-electrons, and construct the scale shown in Figs. 3

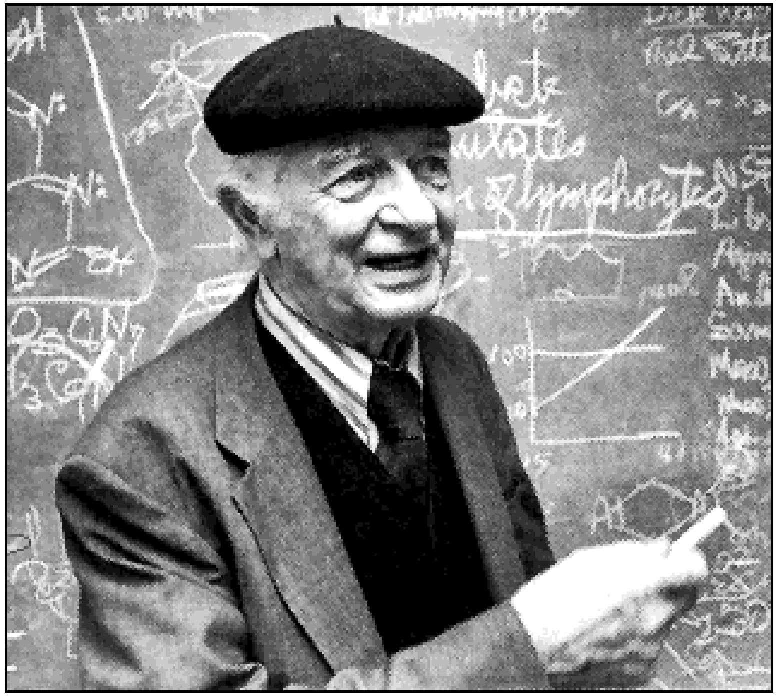
Az eredeti cikkben még a hidrogén nulla, s a fluor 2

TABLE III

COÖRDINATES OF ELEMENTS ON THE ELECTRONEGATIVITY SCALE

H	0.00	Br	0.75
P	.10	Cl	.94
I	.40	N	.95
S	.43	O	1.40
C	.55	F	2.00





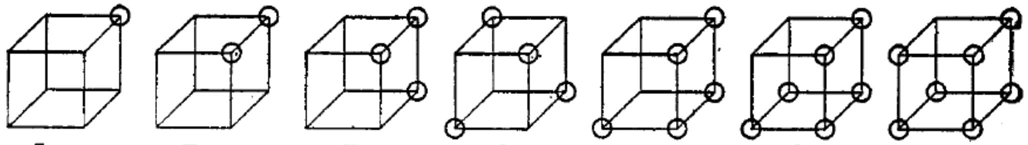
Szinte hihetetlen: Lewis a kémiai kötésről a kvantummechanika *előtt* már olyan képet alkotott, mely ma is jól használható (v.ö.: a Bohr-elmélet is csak 3 éve, 1913-ban született!)

Lewis 1916(!)-os cikkéből (The Atom and the Molecule)

JACS, vol. 38, pp. 762-786

The Cubical Atom.

A number of years ago, to account for the striking fact which has become known as Abegg's law of valence and countervalence, and according to which the total difference between the maximum negative and positive valences or polar numbers of an element is frequently eight and is in no case more than eight, I designed what may be called the theory of the cubical atom. This theory, while it has become familiar to a number of my colleagues, has never been published, partly because it was in many respects incomplete. Although many of these elements of incompleteness remain, and although the theory lacks to-day much of the novelty which it originally possessed, it seems to me more probable intrinsically than some of the other theories of atomic structure which have been proposed, and I cannot discuss more fully the nature of the differences between polar and nonpolar compounds without a brief discussion of this theory.



Li Be B C N O F

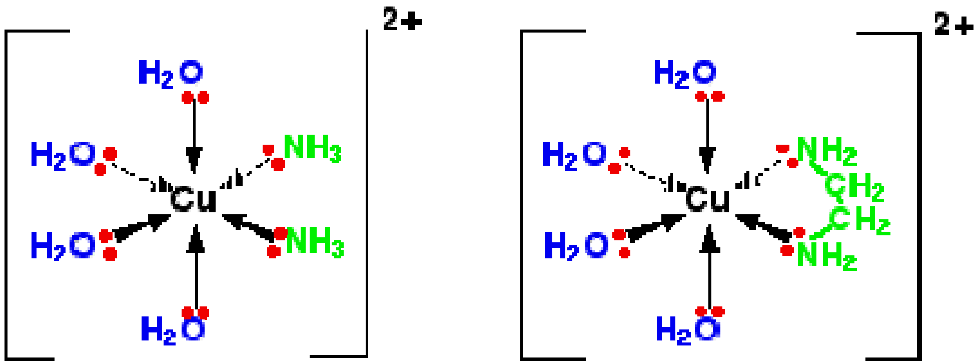
Fig. 2.

The pictures of atomic structure which are reproduced in Fig. 2,[1] and in which the circles represent the electrons in the outer shell of the

a körök jelölik az elektronokat

Komplexek - koordinációs vegyületek

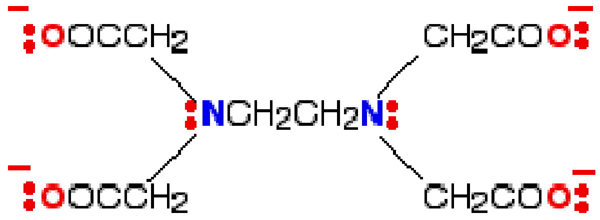
A datív kötés egyik formája



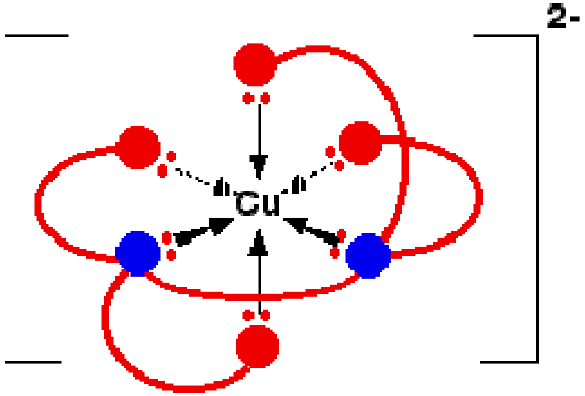
Színek .....

hydrated ion	$Fe_{(II)}$ $[Fe(H_2O)_6]^{2+}$ pale green soln	$Fe_{(III)}$ $[Fe(H_2O)_6]^{3+}$ yellow/brown soln	$Co_{(II)}$ $[Co(H_2O)_6]^{2+}$ pink soln	$Cu_{(II)}$ $[Cu(H_2O)_6]^{2+}$ blue soln	$Al_{(III)}$ $[Al(H_2O)_6]^{3+}$ colourless soln	$Cr_{(III)}$ $[Cr(H_2O)_6]^{3+}$ green soln
OH^- little	$[Fe(H_2O)_4(OH)_2]$ dark green ppt	$[Fe(H_2O)_3(OH)_3]$ brown ppt	$[Co(H_2O)_4(OH)_2]$ blue/green ppt	$[Cu(H_2O)_4(OH)_2]$ blue ppt	$[Al(H_2O)_3(OH)_3]$ white ppt	$[Cr(H_2O)_3(OH)_3]$ green ppt
OH^- excess	$[Fe(H_2O)_4(OH)_2]$ dark green ppt	$[Fe(H_2O)_3(OH)_3]$ brown ppt	$[Co(H_2O)_4(OH)_2]$ blue/green ppt	$[Cu(H_2O)_4(OH)_2]$ blue ppt	$[Al(OH)_4]^-$ colourless soln	$[Cr(OH)_6]^{3-}$ green soln
NH_3 little	$[Fe(H_2O)_4(OH)_2]$ dark green ppt	$[Fe(H_2O)_3(OH)_3]$ brown ppt	$[Co(H_2O)_4(OH)_2]$ blue/green ppt	$[Cu(H_2O)_4(OH)_2]$ blue ppt	$[Al(H_2O)_3(OH)_3]$ white ppt	$[Cr(H_2O)_3(OH)_3]$ green ppt
NH_3 excess	$[Fe(H_2O)_4(OH)_2]$ dark green ppt	$[Fe(H_2O)_3(OH)_3]$ brown ppt	$[Co(NH_3)_6]^{2+}$ straw coloured soln	$[Cu(NH_3)_4(H_2O)_2]^{2+}$ deep blue soln	$[Al(H_2O)_3(OH)_3]$ white ppt	$[Cr(NH_3)_6]^{3+}$ green soln
CO_3^{2-}	$FeCO_3$ dark green ppt	$[Fe(H_2O)_3(OH)_3]$ brown ppt + bubbles	$CoCO_3$ blue/green ppt	$CuCO_3$ turquoise ppt	$[Al(H_2O)_3(OH)_3]$ white ppt + bubbles	$[Cr(H_2O)_3(OH)_3]$ green ppt + bubbles

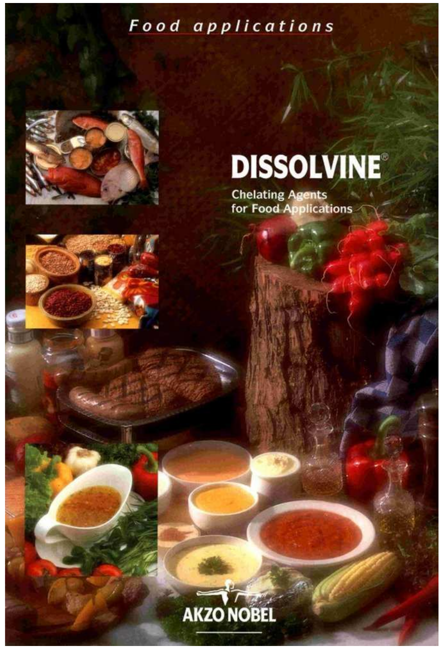
Többfogú ligandumok
Sztár az EDTA



the EDTA^{4-} ion

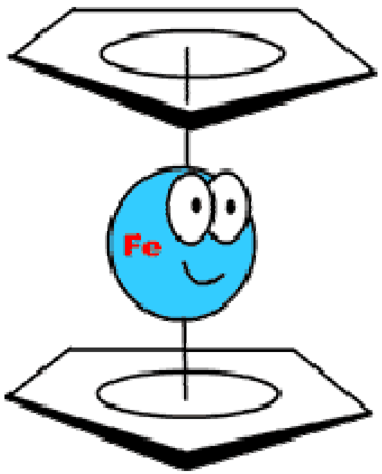


the [Cu(EDTA)]$^{2-}$ ion

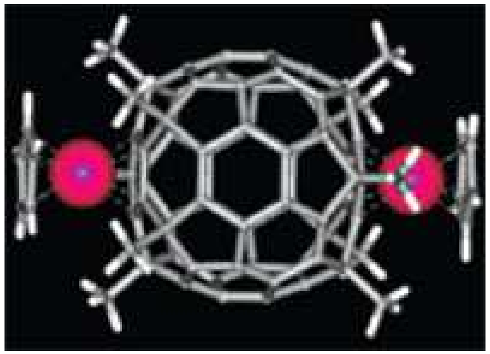


Különlegesebb komplexek: ferrocén és rokonok

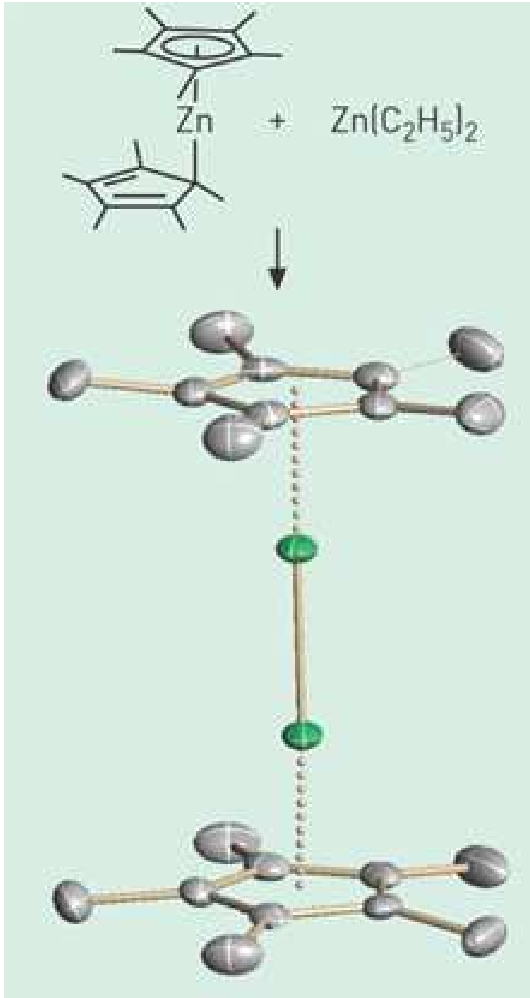
ferrocén



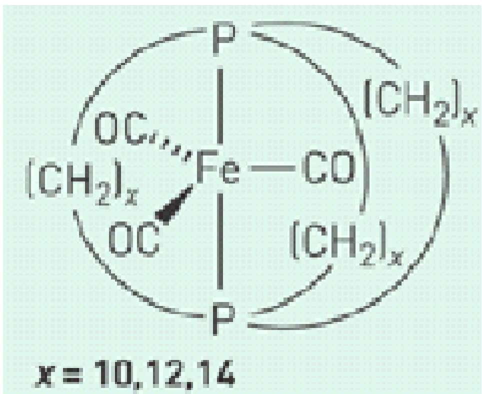
Ferrocén és buckyball



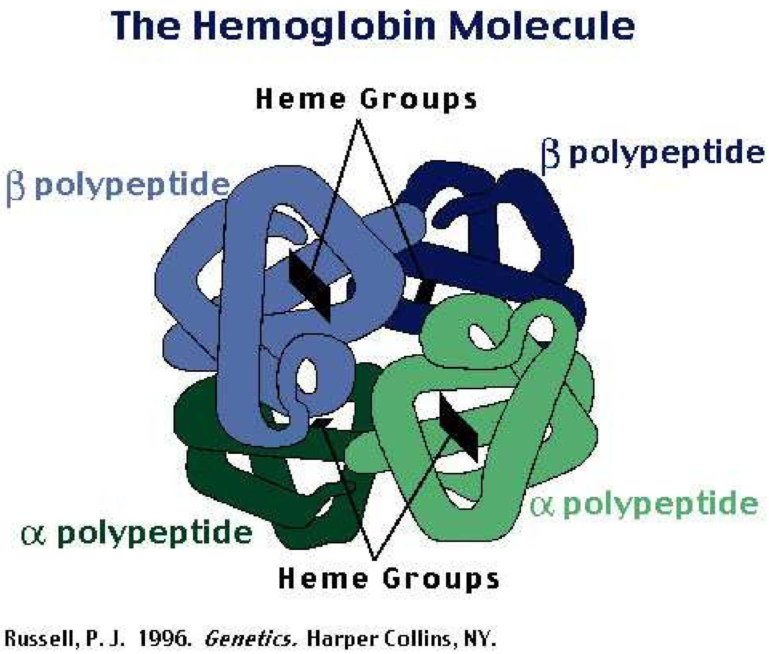
Zn-Zn kötés ....



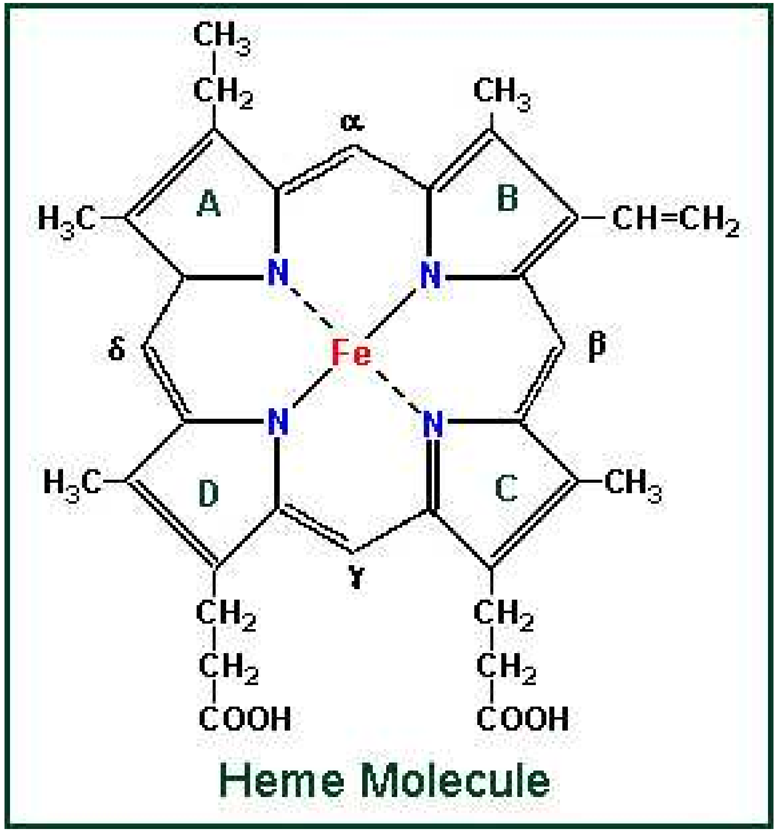
„Érdekesség:
Molekuláris giroszkóp"



Komplexek a természetben:



A *heme* molekula:



Művészet direkt és átvitt értelemben: