Klasická, relativistická, kvantová a statistická fyzika, jaro 2021

P. A. M. Dirac

> The physicist, in his study of natural phenomena, has two methods of making progress: (1) the method of experiment and observation, and (2) the method of mathematical reasoning. The former is just the collection of selected data; the latter enables one to infer results about experiments that have not been performed. There is no logical reason why the second method should be possible at all, but one has found in practice that it does work and meets with reasonable success. This must be ascribed to some mathematical quality in Nature, a quality which the casual observer of Nature would not suspect, but which nevertheless plays an important role in Nature's scheme.

Z přednášky "The relation between Mathematics and Physics".

P. A. M. Dirac

> One might describe the mathematical quality in Nature by saying that the universe is so constituted that mathematics is a useful took in its description. However, recent advances in physical science show that this statement of the case is too trivial. The connection between mathematics and the description of the universe goes far deeper than this, and one can get an appreciation of it only from a thorough examination of the various facts that make it up. The

Z přednášky “The relation between Mathematics and Physics”.

P. A. M. Dirac

Let us take as our starting-point that scheme of physical science which was generally accepted in the last century - the mechanistic scheme. This considers the whole universe to be a dynamical system (of course an extremely complicated dynamical system), subject to laws of motion which are essentially of the Newtonian type. The role of mathematics in this scheme is to represent the laws of motion by equations, and to obtain solutions of the equations referring to observed conditions.

The dominating idea in this application of mathematics to physics is that the equations representing the laws of motion should be of a simple form. The whole success of the scheme is due to the fact that equations of simple form do seem to work. The physicist is

Citáty z přednášky "The relation between Mathematics and Physics".

P. A. M. Dirac

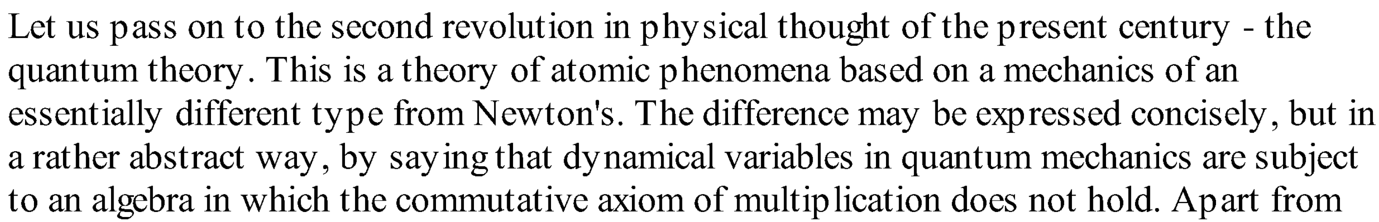
> The discovery of the theory of relativity made it necessary to modify the principle of simplicity. Presumably one of the fundamental laws of motion is the law of gravitation which, according to Newton, is represented by a very simple equation, but, according to Einstein, needs the development of an elaborate technique before its equation can even be

> What makes the theory of relativity so acceptable to physicists in spite of its going against the principle of simplicity is its great mathematical beauty. This is a quality which cannot be defined, any more than beauty in art can be defined, but which people who study mathematics usually have no difficulty in appreciating. The theory of relativity introduced

> We now see that we have to change the principle of simplicity into a principle of mathematical beauty. The research worker, in his efforts to express the fundamental laws of Nature in mathematical form, should strive mainly for mathematical beauty. He should still

Citáty z přednášky "The relation between Mathematics and Physics".

P. A. M. Dirac



Let us pass on to the second revolution in physical thought of the present century - the quantum theory. This is a theory of atomic phenomena based on a mechanics of an essentially different type from Newton's. The difference may be expressed concisely, but in a rather abstract way, by saying that dynamical variables in quantum mechanics are subject to an algebra in which the commutative axiom of multiplication does not hold. Apart from

Z přednášky “The relation between Mathematics and Physics”.

P. A. M. Dirac

Quantum mechanics requires the introduction into physical theory of a vast new domain of pure mathematics - the whole domain connected with non-commutative multiplication. This, coming on top of the introduction of new geometries by the theory of relativity, indicates a trend which we may expect to continue. We may expect that in the future further big domains of pure mathematics will have to be brought in to deal with the advances in fundamental physics.

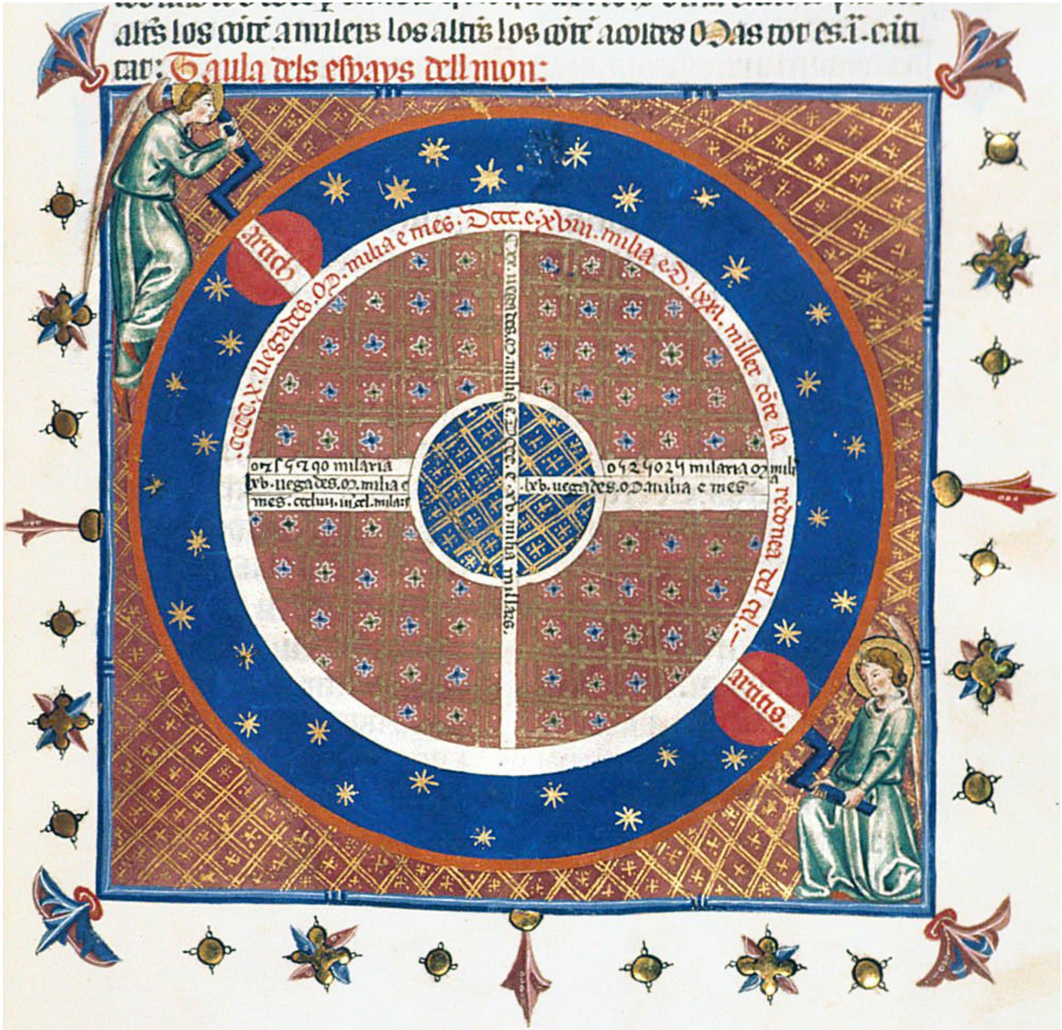
Pure mathematics and physics are becoming ever more closely connected, though their methods remain different. One may describe the situation by saying that the mathematician plays a game in which he himself invents the rules while the physicist plays a game in which the rules are provided by Nature, but as time goes on it becomes increasingly evident that the rules which the mathematician finds interesting are the same as those which Nature has chosen. It is difficult to predict what the result of all this will be. Possibly, the two subjects

Citáty z přednášky "The relation between Mathematics and Physics".

Osnova

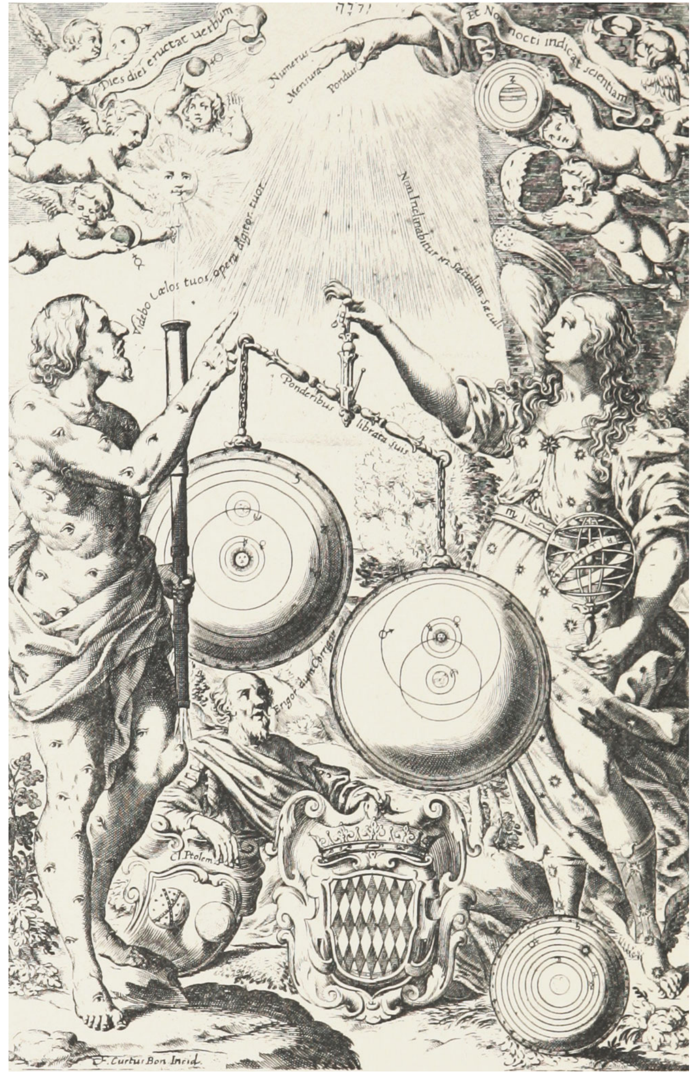
1. **Uvedení do scény klasické fyziky, základní zákony a rovnice klasické mechaniky, variační princip v klasické mechanice.**
2. **Newtonův gravitační zákon - objev, Cavendishovo ,,vážení Země", význam. Ilustrace: slapové jevy.**
3. **Koncept pole, gravitační a elektromagnetické pole. Ilustrace: elektromagnetická indukce a elektromagnetické záření.**
4. **Základní ideje speciální teorie relativity. Ilustrace: experimentální pozorování ,,paradoxu dvojčat", role teorie relativity v systému GPS.**
5. **Zákony zachování a Einsteinův vztah mezi hmotností a energií. Ilustrace: jaderné přeměny.**
6. **Základní ideje obecné teorie relativity, zakřivený prostoročas. Ilustrace: nedávné experimenty prokazující existenci gravitačních vln.**
7. **Základní ideje kvantové teorie. Ilustrace: dvojštěrbinové experimenty, fundamentální experimenty, za které byla udělena N. cena v r. 2012.**
8. **Elementární částice - od atomu k Higgsovu bosonu. Ilustrace: nedávné experimenty prokazující existenci Higgsova bosonu.**
9. **Soustava jednotek SI - historie, nové definice využívající fundamentální konstanty.**
10. **Makroskopické kvantové jevy. Ilustrace: kvantový Hallův jev, experimenty s Bose-Einsteinovými kondenzáty a se supravodiči.**

Andělé udržující v pohybu nebeské sféry.



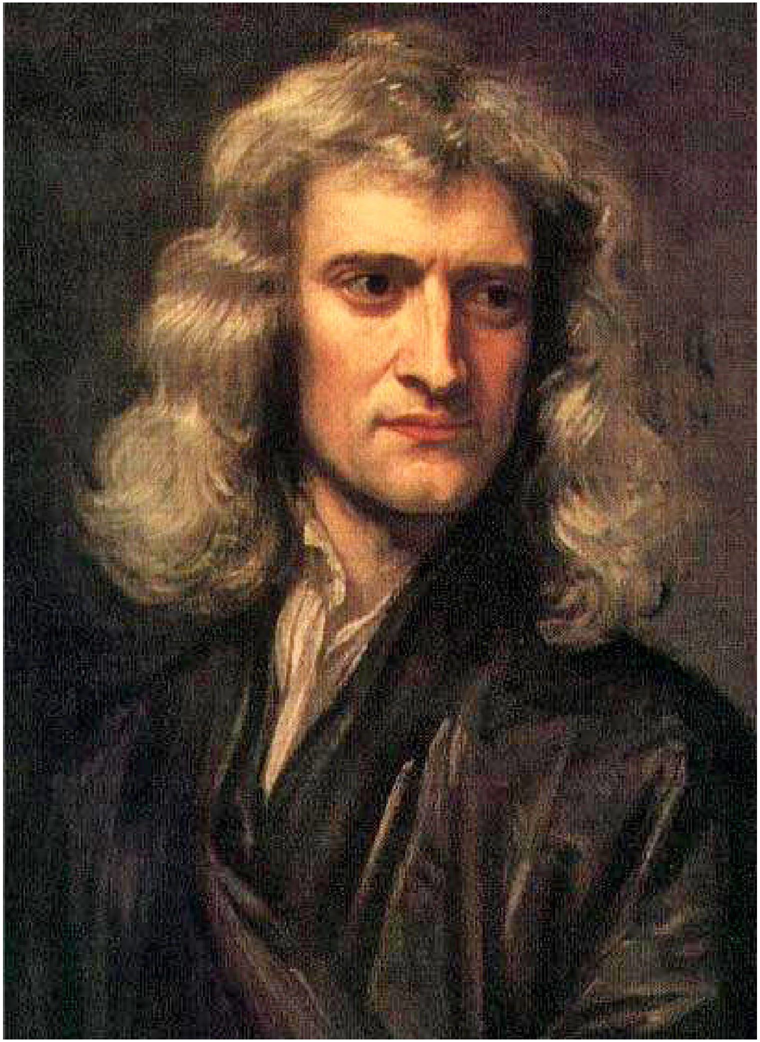
Magdeburgské polokoule (1660).

Alegorie z r. 1651.

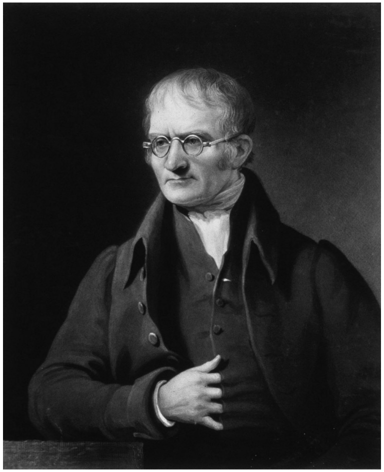


Alegorické znázornění porovnávání tří modelů: Koperníkova, Tychonova a Ptolemaiova.

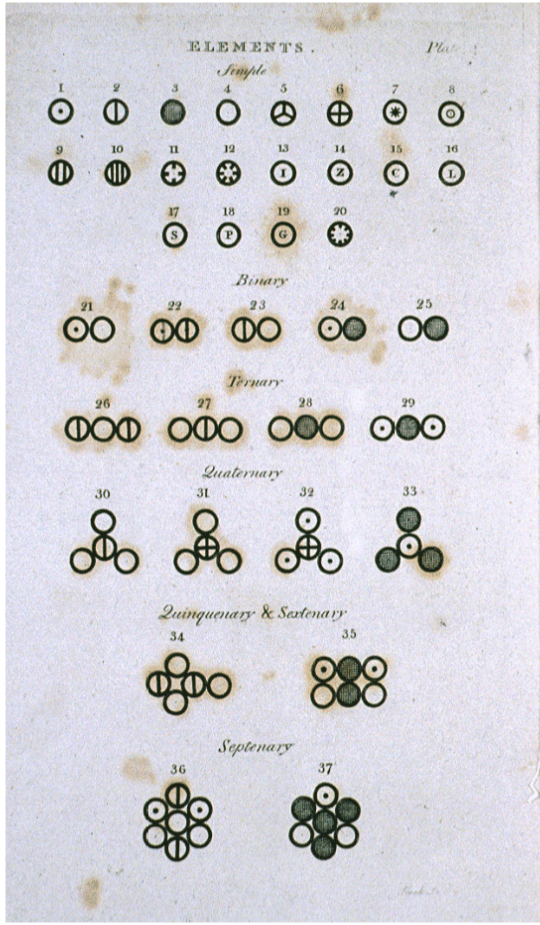
Isaac Newton (1642-1727).

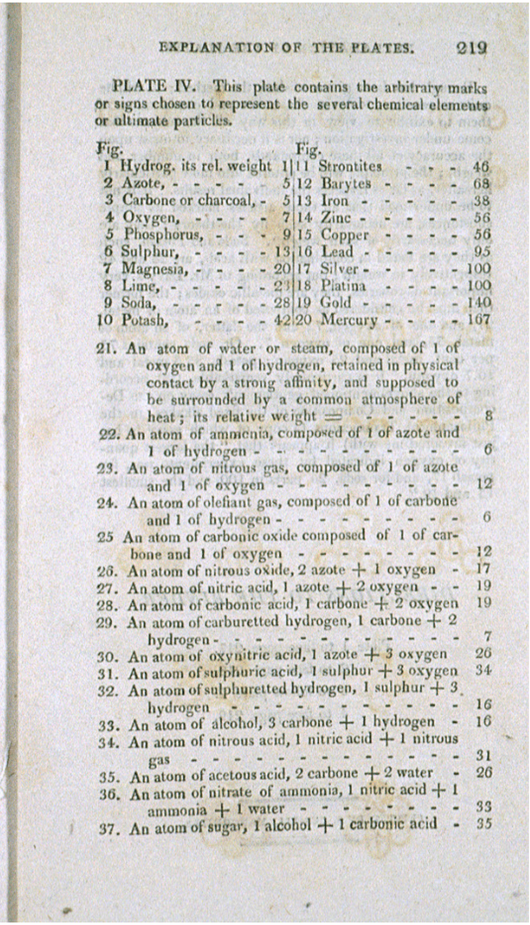


Dalton, prvky, atomy



John Dalton (1766-1844)





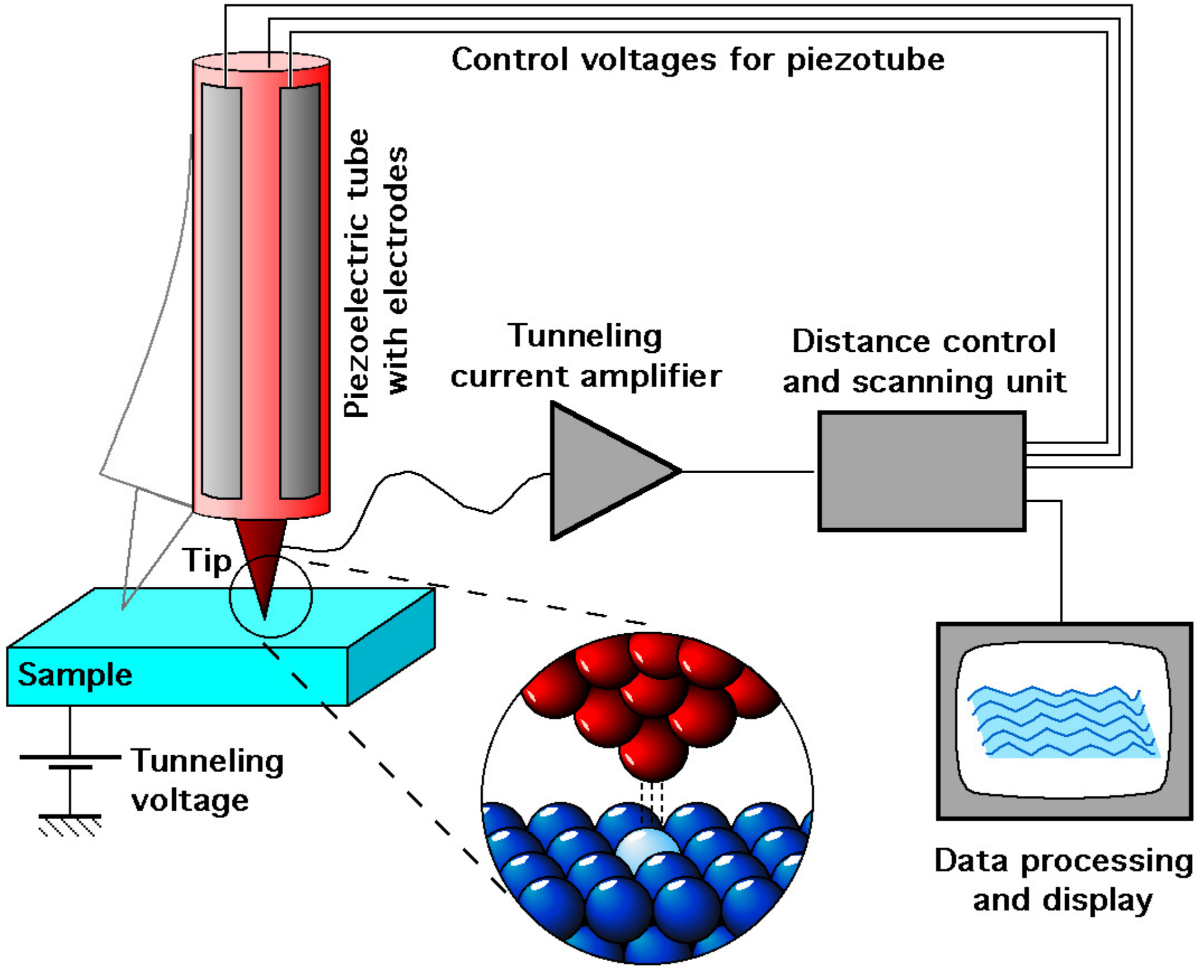
EXPLANATION OF THE PLATES. 219

PLATE IV. This plate contains the arbitrary marks or signs chosen to represent the several chemical elements or ultimate particles.

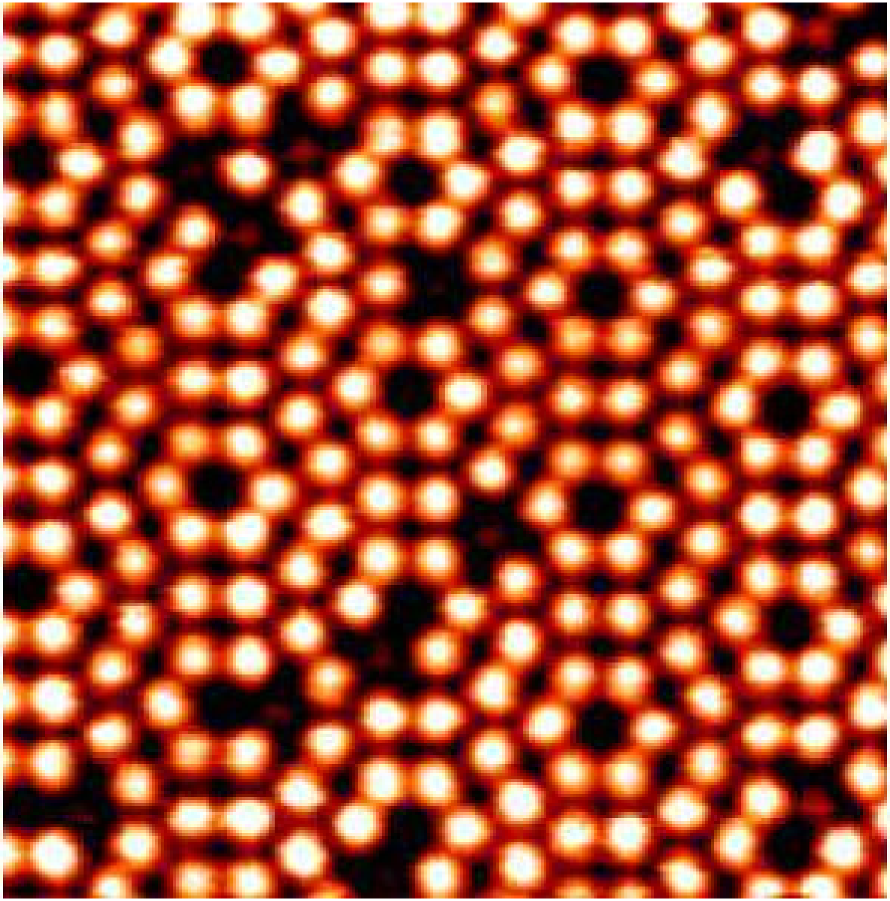
Fig.			Fig.		
1	Hydrog. its rel. weight	1	11	Strontites	46
2	Azote,	5	12	Barytes	68
3	Carbone or charcoal,	5	13	Iron	38
4	Oxygen,	7	14	Zinc	56
5	Phosphorus,	9	15	Copper	56
6	Sulphur,	13	16	Lead	95
7	Magnesia,	20	17	Silver	100
8	Lime,	23	18	Platina	100
9	Soda,	28	19	Gold	140
10	Potash,	42	20	Mercury	167

21. An atom of water or steam, composed of 1 of oxygen and 1 of hydrogen, retained in physical contact by a strong affinity, and supposed to be surrounded by a common atmosphere of heat; its relative weight = - - - - - - 8
22. An atom of ammonia, composed of 1 of azote and 1 of hydrogen - - - - - - - - - - - 6
23. An atom of nitrous gas, composed of 1 of azote and 1 of oxygen - - - - - - - - - - 12
24. An atom of olefiant gas, composed of 1 of carbone and 1 of hydrogen - - - - - - - - - 6
25 An atom of carbonic oxide composed of 1 of carbone and 1 of oxygen - - - - - - - - 12
26. An atom of nitrous oxide, 2 azote + 1 oxygen - 17
27. An atom of nitric acid, 1 azote + 2 oxygen - - 19
28. An atom of carbonic acid, 1 carbone + 2 oxygen 19
29. An atom of carburetted hydrogen, 1 carbone + 2 hydrogen - - - - - - - - - - - - 7
30. An atom of oxynitric acid, 1 azote + 3 oxygen 26
31. An atom of sulphuric acid, 1 sulphur + 3 oxygen 34
32. An atom of sulphuretted hydrogen, 1 sulphur + 3 hydrogen - - - - - - - - - - - - 16
33. An atom of alcohol, 3 carbone + 1 hydrogen - 16
34. An atom of nitrous acid, 1 nitric acid + 1 nitrous gas - - - - - - - - - - - - - - 31
35. An atom of acetous acid, 2 carbone + 2 water - 26
36. An atom of nitrate of ammonia, 1 nitric acid + 1 ammonia + 1 water - - - - - - - - 33
37. An atom of sugar, 1 alcohol + 1 carbonic acid - 35

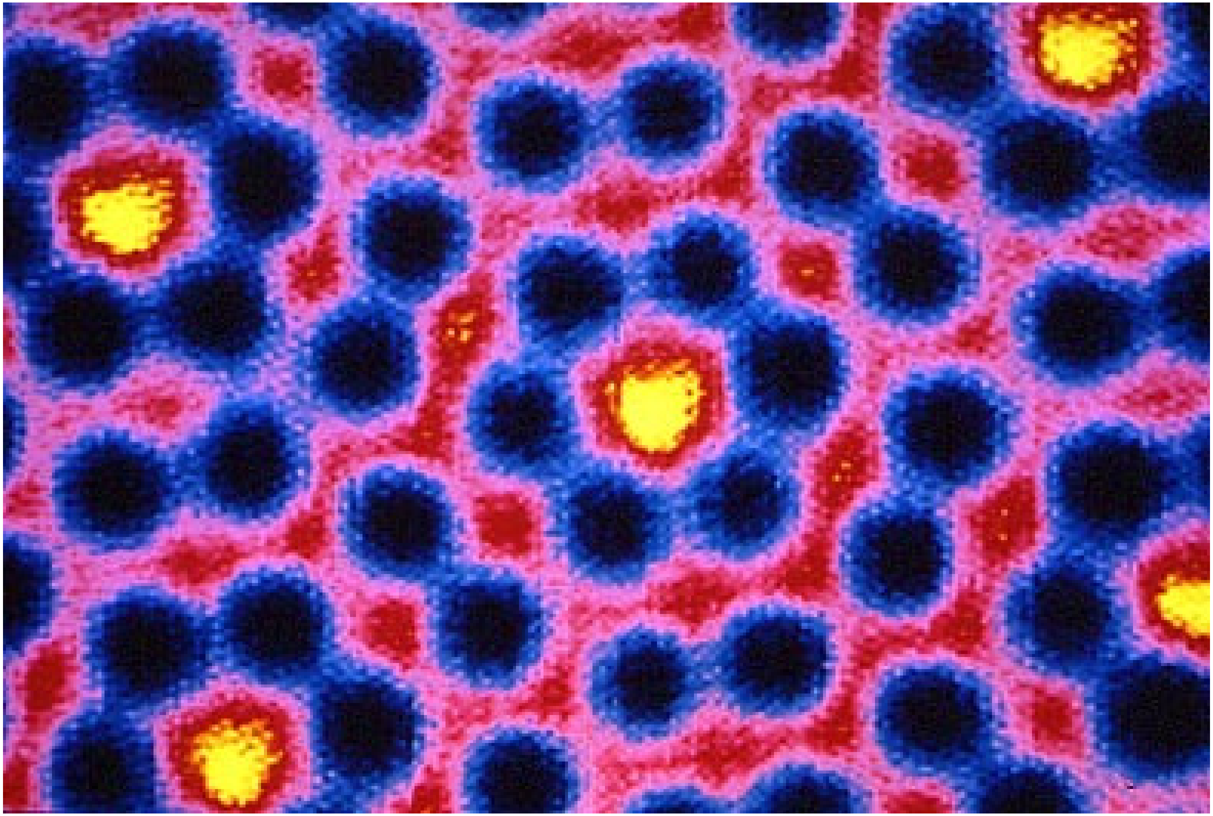
Princip skenovacího tunelového mikroskopu (STM)



Snímek povrchu Si získaný s pomocí STM.



Snímek povrchu Si získaný s pomocí STM, zvětšení 20 krát 10^6.



Atomy Xe na niklovém povrchu.