# Solid state physics in crystallography

## S07-01

## Discovery of the wave nature of crystals

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The derivation of characteristic angles of crystals, determining their shape, was and still is an unsolvable problem of modern physics. This means that the nature of the formation of the definite geometrical configuration of facets in the crystals is not properly understood so far. Actually, untill now the characteristic angles of crystals are determined only experimentally, because none of the modern physical theories, including quantum mechanics, adhering to the Standard Model (SM) [1], is unable, in principle, directly derive them. So that the above problem still remains one of the most important unsolved problems of theoretical quantum chemistry and crystal chemistry, which are based on abstract-mathematical postulates of quantum mechanics being its fundamental concepts.

In contrast to the SM, the Wave Model (WM) that we develop have solved this problem. In the framework of the WM, there were revealed the wave shell-nodal structure of the atoms, the main role of the specific spatial arrangement of the nodes and internodal strong bonds in the atoms at the formation of chemical bonds, secondary role of electrons at this (which define the strenght of chemical bonds but not their directions), the nature of symmetry and periodicity in the properties and structure of atoms, and much more (see, for example, Ref. [2]). It is therefore not suprising that the WM led us also to the right theoretical solution concerning characteristic angles of crystals, stipulating their shape.

Obviously, since, in accordance with the WM, we recognize the wave nature of all objects and phenomena in Nature, including atoms, hence, the wave origin of natural crystalline formations, consisting of atoms, also did not cause our doubts. Therefore, we began seeking the characteristic angles of crystals in solutions of the general („classical”) wave equation, $\Delta\hat{\Psi} - \frac{1}{c^2}\frac{\partial^2\hat{\Psi}}{\partial t^2} = 0$, as this equation is applicable to the description of all wave objects and processes. Our expectations were fully met [3]. Indeed, as we found out, the angles that determine the position of the planes of the faces in crystals, are really contained in the well-known particular solutions of the mentioned above wave equation, moreover, in the same its solutions that define the shell-nodal structure of the atoms. The experimentally data confirmed, convincingly enough, the validity of this discovery, which we intend to discuss at the conference.

**References**

[1] G. P. Shpenkov, "*Some Words about Fundamental Problems of Physics*: *Constructive Analysis"*, LAMBERT Academic Publishing, pages116 (2012).

[2] G. P. Shpenkov, *An Elucidation of the Nature of the Periodic Law*, Chapter 7 in "*The Mathematics of the Periodic Table*", edited by Rouvray D. H. and King R. B., Nova Science Publishers, NY, 119-160, 2006.

[3] [5] G. P. Shpenkov, DIALECTICAL VIEW OF THE WORLD, *The Wave Model* (*Selected Lectures*), Vol. 6 Topical Issues (2015), Supplementary Data, I. *The wave nature of minerals*, pages -130-155; http://shpenkov.com/pdf/Vol.6.TopicalIssues.pdf

**TABLE**

Characteristic angles of crystals of natural minerals (fragment of Table 2, taken from [3]).

| Characteristic angles of $\tilde{\Theta}_{l,m}(\theta)$ (***theoretical*** values first calculated and published by L. Kreidik and G. Shpenkov [2-4]) | The angles of crystal minerals (***measured*** by R. Haüy [5], N. Kokscharov [6, 7], and others [8-23]) |
|---|---|
| $\boxed{\tilde{\Theta}_{2,0}(\theta)=\cos^2\theta-1/3}$ | |
| **a) Zeros:** | |
| $O_1(2,0)=\arccos\sqrt{\frac{1}{3}}=54^\circ\,44'\,8.''20$ | $54^\circ\,44'\,8.''20$ |
| $O_2(2,0)=\arccos\left(-\sqrt{\frac{1}{3}}\right)=125^\circ\,15'\,51.''80$ | $125^\circ 15' 52''$ [5: Part I, Vol. III, p.364, 1853] |
| **b) Sectors:** | |
| $2O_1(2,0)=109^\circ\,28'\,16.''40$ | Haüy: $109^\circ 28' 16''$ [5: p.29; 1*] |
| $O_2(2,0)-O_1(2,0)=70^\circ\,31'\,43.''60$ | Haüy: $70^\circ 31' 44''$ [5: p.29; 1*] |
| $2(O_2(2,0)-O_1(2,0))=141^\circ\,03'\,27.''20$ | $141^\circ\,03'$ [6: Part. III, Vol. VII, p.26, 1844] |
| **c) Extremes:** $\theta_1(2,0)=0^\circ$, $\theta_2(2,0)=90^\circ$, and $\theta_3(2,0)=180^\circ$ | characteristic angles of crystals |
| $\boxed{\tilde{\Theta}_{2,1}=\cos\theta\sin\theta}$ | |
| **Zeros** and **extremes** of $45^\circ$ and $90^\circ$ | characteristic angles of crystals |

$$\boxed{\tilde{\Theta}_{3,0} = \cos\theta(\cos^2\theta - 3/5)}$$

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**a) Zeros:**

$O_1(3,0) = \arccos\left(\sqrt{\frac{3}{5}}\right) = 39^\circ\, 13'\, 53.''47$ Haüy: $39^\circ 13' 53''$ [5: p.85; 2*]

$O_2(3,0) = 90^\circ$ ,

$O_3(3,0) = \arccos\left(-\sqrt{\frac{3}{5}}\right) = 140^\circ\, 46'\, 06.''53$ Haüy: $140^\circ 46' 07''$ [5: p.86; 2*]

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$$\boxed{\Theta_{6,5}(\theta) = \sin^5\theta\cos\theta}$$

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http://shpenkov.com/pdf/CrystalsNature.pdf