Quartz crystals. Space group $P3_121$.

Among many discourses by Lord Rayleigh, there are two devoted to argon, which he had discovered with William Ramsay. There are also some commemorative lectures: on the life and work of Faraday, James Joule, Heinrich Hertz, Lord Kelvin.

Happily, in their printed form these discourses are all of moderate length, and may be read easily. Every reader will skip some and read many others, and it is difficult to imagine anyone truly concerned with the physical sciences—past or present—who will not find these volumes truly fascinating. Each reader will end up with favorite discourses. Both of mine occur in volume 7, and both were given in 1910. One of these is Lord Rayleigh on "Colours of sea and sky," the other J. J. Thomson's "The dynamics of a golf ball," a stunning display of the general physics of motion of a spinning object.

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Symmetry of Crystals

E. S. Fedorov. D. Harker, K. Harker, trans.

315 pp. American Crystallographic Association, 1971. $10.00 for ACA members; $25 for non-members

For the last several years I have expressed regret to my colleagues that there has not been available (even in Russian) an edition of the *Collected Works of Fedorov*. Nor have there been translations of the most important works of this ingenious crystallographer, except for those published in German by E. S. Fedorov himself. In 1949, A. V. Shybnikov and I. I. Shafranovskii edited a collection of reprints and translations (from German into Russian) of five important papers. These five papers have now been superbly translated into English by David and Katherine Harker.

The first paper deals with "Basic formulas of analytical geometry in an improved form." Here Fedorov defines the coordinates of a point by the perpendicular projections of that point onto the axes of coordinates. This procedure has the advantage that the coordinate of a point on one axis does not vary with the inclination of the other axes. The positions of points related by rotation axes can be presented in a convenient form.

In the second paper, "Symmetry of finite figures," symmetry operations are used and classified: rotation about axes, reflections through planes and combined rotation-reflection operations (instead of rotation-inversion). Each symmetry class is represented by a set of three equations defining the three coordinates of all the symmetrically related points.

The third paper, "The symmetry of regular systems of figures," is the most important one; it gives the derivation of all 230 space groups. Again, each possible combination of operations (translation, screw-rotation and glide-reflection are added) is expressed by a set of three equations. Each triplet of equations gives the coordiantes of an

infinite set of equivalent points (in German: *regelmassiges Punktsystem*). Contrary to general opinion it is quite evident that Fedorov derived the space groups primarily by combining all possible symmetry elements in all possible ways, that is, in principle the same manner as Schoenflies, and not by space division.

In monograph 4, "Comparison of the crystallographic results of Schoenflies with mine," Fedorov showed complete coincidence of the number and types of his "regular systems of figures" with Schoenflies's "space groups," which is to be considered as a proof of the correctness of both derivations (1890–91). The last monograph, "A theory of the structure of crystals," deals with space partitioning into parallelohedra and stereohedra. As Fedorov pointed out later (1900) all space groups can be derived in this way, except 06-$P4_332$ and 07-$P4_12$ (compare my note in *Science* **174**, 52, 1971.) There are still some unsolved interesting problems in this field (see also the Introduction by D. Harker and my thesis "Homogene Raumteilung und Kristallstruktur", E. T. H. Zurich, 1935).

The project of this translation was sponsored by the National Science Foundation and the American Crystallographic Association Monograph Fund. All crystallographers not familiar with the Russian language must be extremely grateful to the translators and institutions that enabled the excellent production of this most important historical document, which may be still stimulating for modern scientists.

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Atomic-Absorption Spectrochemical Analysis

B. V. L'vov

324 pp. American Elsevier, New York, 1971. $43.00

This treatment of atomic absorption spectroscopy is an extremely readable yet comprehensive reference work on the theory, instrumentation, and application of the technique for chemical analysis. The wealth of experimental detail contained on its 324 pages will make it indispensible to any chemist who is concerned with inorganic analysis.

The book is an English-language edition of the Russian version published in 1965. It differs from its Russian counterpart in that many of the chapters have been revised and rewritten to reflect the new developments in the field. Treated are such topics as source lamps; the effects of filler gases and current on lamp emission, stability, and life; optics; modulation of beams; errors in measurements; atomization techniques; flames and burner designs; effects of solvents on the process and sensitivities. A separate chapter on the use of the graphite cuvette, which was developed by L'vov, makes many details on this important method available for the first time in English.

The chapter on special applications provides suggestions for further research in the vacuum-ultraviolet region and provides some data on the possibilities of isotope analysis.

The intriguing point of view presented by L'vov at the conclusion of the book is the prospect that it may be possible to achieve some analyses without the use of standards. He demonstrates the potential by calculating absolute oscillator strengths for some of the common metals using the graphite cuvette. With this approach many of the uncertainties in temperature gradients, effective sample path length, and sample-vapor inhomogeneity are reduced to tractable and calculable levels.

There are only two points of criticism that I would make of the book. The first is the price. It will necessarily limit its audience. The second is the impression that L'vov gives in advocating atomic absorption as the ideal approach for the analysis of ultrapure materials. The atomic-absorption approach, utilizing the graphite cuvette, is quite sensitive, but other companion techniques should also be used in establishing which impurities are to be examined. On the positive side, however, few techniques permit the sensitivities down to the 10^{-10} to 10^{-13}-gram level that appear to be possible with the graphite cuvette and a 3×10^{-14}-gram detection limit claimed for cadmium must indeed be a record.

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Relativity Reexamined

L. Brillouin

111 pp. Academic, New York, 1970. $6.75

In his book, *Relativity Reexamined*, Leon Brillouin attempts to find inconsistencies in Einstein's theories and to set up countertheories. Such programs are of value, particularly as a means to clarify one's understanding of the theories examined. Previous at-