Symmetry: Culture and Science
Vol. 9, No. 1, 77-112, 1998

SYMMETRO-GRAPHY

SYMMETRY: A BIBLIOGRAPHY OF INTERDISCIPLINARY BOOKS[1]

University-textbooks, scholarly monographs, popular-scientific works

Dénes Nagy

This bibliography includes
- about 600 books, plus their additional editions, close to 1,000 items (collections of papers by different authors, abstracts and proceedings of meetings, booklets shorter than 50 pages, and manuscripts are not considered),
- on symmetry (they refer to this term or its derivatives, including antisymmetry, asymmetry, dissymmetry, *directly in their titles),*
- in 25 languages (Bulgarian, Catalan, Chinese, Czech, Danish, Dutch, English, French, German, Greek, Hungarian, Italian, Japanese, Lithuanian, Norwegian, Polish, Portuguese, Rumanian, Russian, Serbo-Croatian, Slovakian, Spanish, Swedish, Turkish, Ukrainian),
- from all of the continents (from Brazil to Mongolia, from Mexico to Australia, from Norway to Mozambique),
- with the full bibliographic description of each book (Bulgarian, Chinese, Greek, Japanese, Russian, and Ukrainian names and titles are romanized), and
- with translations of all book-titles that have no English versions.

The books are classified according to a system that was developed for this purpose. Since the "linear" classification of interdisciplinary books is impossible, there are cross-references among sections.

INTRODUCTION

As it is emphasized in the heading, all of the listed books are on symmetry (*antisymmetry, asymmetry, dissymmetry*, and other derivatives): they refer to this fact directly in their titles. Since the expression *symmetry* became an international word, its adapted versions, with minor phonetic changes, are available in many languages. In the case of Far Eastern books those are considered that use

- the Chinese term *duìchèn* (modern Mandarin reading, Pinyin [sound assembly] system of romanization; which is *tui ch'eng* according to the earlier Wade-Giles romanization)[2,3], or

---

[1] Originally published in *Visual Mathematics*, http://www.mi.sanu.ac.yu/vismath, http://members.tripod.com/vismath.

[2] Its adopted Korean version *tae-ch'ing* (McCune-Reischauer system of romanization).

[3] Its adopted Japanese version *taishou* (revised Hepburn system of romanization).

- the Japanese *shinmetorii* (the adopted international word, which development has no Chinese or Korean equivalent).

The cited Chinese term, which is written in two characters, is related to objects facing each other to form a pair (bilateral symmetry), but its meaning can be extended to the case of rotational symmetry. Still, it is more specific than the Western "symmetry". Perhaps this observation also contributed to the fact that in modern Japanese both terms are used: *taishou* (adopted from China and written in Sino-Japanese *kanji* characters) and *shinmetorii* (adopted from Western languages and written in the *katakana* phonetic syllabary).

Note the following important conventions:

(1) Books without reference to symmetry (or its derivatives) in the title → not listed.

Unfortunately there are many books of this category which deal with symmetry-related topics. Obviously, the exclusion of these books has some disadvantages, but

- it was necessary to limit the scopes of this bibliography,
- there are some good bibliographies on polyhedra, proportions, rhythm, tilings and patterns, respectively, which are available for further reference.

Bibliography of bibliographies (or comprehensive lists of references) of some symmetry-related fields

(a) Polyhedra

Cromwell, P. (1997) *Polyhedra, Cambridge* [England]: Cambridge University Press, pp. 416-438.

(b) Proportions in art and nature

Graf, H. (1958) *Bibliographie zum Problem der Proportionen: Literatur uber Proportionen, Mass und Zahl in Architektur, Bildender Kunst und Natur*, [*Bibliography for the Problem of Proportions: Literature on Proportions, Measure, and Number in Architecture, Fine Art, and Nature*, in German], Speyer [Germany]: Pfälzische Landesbibliothek, 96 pp.

* Also see the additions to this bibliography in the following book:

Wittkower, R. (1971) *Architectural Principles in the Age of Humanism*, New York: Norton, 1971, "Appendix 3: Bibliographical notes on the theory of proportion", 162-166.

Naredi-Rainer, P. von (1982) *Architektur und Harmonie: Zahl, Mass und Proportion in der abendländischen Baukunst*, [*Architecture and Harmony: Number, Measure and Proportion in Occidental Architecture*, in German], Köln: DuMont, "Bibliographie", 232-283.

(c) Rhythm

Winick, S. D. (1974) *Rhythm: An Annotated Bibliography*, Metuchen, New Jersey: Scarecrow Press, v + 157 pp.

(d) Tilings and patterns

Grünbaum, B. and Shephard, G. C. (1987) *Tilings and Patterns*, New York: Freeman, "References", pp. 653-694.

* Abridged ed., *Tilings and Patterns; An Introduction*, New York: Freeman, 1989, "References", 401-442. [The first seven chapters of the original book and the full list of references].

(2) In the case of translated books:

- There are books where the original titles refer to symmetry (or its derivatives), but the translated versions do not → in this case we still list the bibliographic data of the translated versions.
- There are books where the original titles do not refer to symmetry (or its derivatives), but the translated versions introduce this term → in this case we do not list the book and its translated versions.

In short, our decision is based on the author's original intention, not on the later view of the translators.

(3) Items shorter than 50 pages are also excluded. We plan, however, to publish further bibliographies on symmetry and related topics, covering not only university-textbooks, scholarly monographs, and popular-scientific books, but also collections of essays, proceedings, and other works.

International aspects

It is interesting to note that many references in this bibliography are not yet available in major computer catalogs, data banks, and electronic bookstores: they frequently miss older items and books written in languages that are not widely spoken at their centers. We think, however, that these works are also important. Often they include tables and illustrations that are easy to understand without reading the actual language. A beautiful example is Kumagai and Sawada textbook *Moyou to shinmetorii* (*Ornamental Patterns and Symmetry*, in Japanese) in Section 1.1.3. In addition to this, the data of translated books

- may help the international cooperation among interested scholars and instructors,
- may provide useful information to lecturers and students who visit particular countries and would like to refer to locally available works,
- may orient publishers and translators.

We observed in various cases that translators of books did not revise the list of references, just adopted it. This method led to such comic cases where, for example, an English book on symmetry (translated from German) refers not to the original version of papers and books in English, but to their later German translations. Should the reader learn German to follow the references? I also believe that even publishers did not realize some basic data on translated books that are available in our bibliography. The lack of information led to duplicating or even triplicating the same work. I have no different explanation of the surprizing fact that Hermann Weyl's book *Symmetry* (Princeton, 1952) has

- three different Spanish translations: (1) Buenos Aires, 1958; (2) Barcelona, 1974; (3) Madrid, 1990.
- three different Chinese translations (with see slightly different titles!): (1) Beijing [Peking], 1986; (2) Taibei [Taipei, Taiwan], (3) Shanghai.

These are not reprint editions of the same translation, but different interpretations of the book.

If a book has more than one translation, we list these in a chronological order (according to the first editions in the corresponding languages).

In those cases where the translated titles significantly differ from the original ones (or new subtitles are added), those "modified" titles are also translated into English. For example, Pagels' book *Perfect Symmetry: The Search for the Beginning of Time*, New York: Simon and Schuster, 1985; 2nd ed., New York: Bantam, 1991 became in Japanese *Toki no hajimari e no tabi: Taishousei no butsuri* [Journey to the Beginning of Time: The Physics of Symmetry],while, as a further twist, the second edition was translated as *Hoshi kara ginga e: Heesheru no niwa* [*From the Stars to the Milky Way: Herschel's Garden*]. There is no similar "problem" with the Italian and Portuguese translations of the same book. They follow more or less the original title and therefore these titles are not translated into English.

Concerning translated books, we give the possible "new" (transliterated) names of authors in those cases where these are important to locate the book in the corresponding language territory, e.g.,

- Sheikov, a Bulgarian author (in English transliterated form) became
- Scheikov in the German translation of his book,
- Sejkov in the Hungarian version.

Luckily there is no similar problem in Japan: most library catalogs list the Japanese translations of foreign books under the original names of authors.

The translation of terms is often a very difficult task. In some cases we added alternative expressions <interrupting the translated titles> or brief notes [in brackets at the end]. The related problems led to two case studies and related hypertext essays:

- objectology or object-design as possible English equivalents of the Japanese *monogaku*,
- *futaishou* as a possible Japanese equivalant of *dissymmetry* (lack of some elements of symmetry).

Some conventions used in this bibliography:

To keep the bibliography shorter, we adopted the following conventions:
- If a book is published in a series whose title is important to find some extra information about it, we give the series title after the actual title of the book (note that the title of the book is italicized, while the series title is not).
- For place of publication, only the first one is given, followed by the name of the state or country if any difficulty may occur in locating the corresponding city [and maybe some additional information in brackets, e.g., the new names of some places in the former U.S.S.R.].
- The names of publishers are given in short form, e.g., we have Springer instead of Springer Verlag. We use, however, the full names of publishers where the sort forms may lead to ambiguities, e.g., we should make clear that a book is published either by the Academy of Science of the U.S.S.R. (*Akademiya Nauk SSSR*) or by the Publishing House of the same institution (*Izdatel'stvo Akademii Nauk SSSR*).
- In the case of parallel editions, we refer to both publishers.
- Reprint, paperback, and new editions are also listed; these are marked by asterisk (*).
- Translations are listed in new paragraphs; these are marked by dash (-).
- In some cases there are brief notes after the books [in brackets].
- We use the conventional transliteration of Cyrillic words [sometimes giving alternative versions of names in brackets].
- In the case of the transliteration of Japanese names and titles, we use the system preferred by most wordprocessors and some computerized data banks where, e.g., instead *ô* and *û*, we have *ou* and *uu* (without diacritical symbols!), respectively. We do not introduce, however, this style in case of "Tokyo", because this city is known in this form, while the linguistically correct "*Toukyou*" would be very strange for most readers. We use some standard abbreviations: *ed.* (edition or editor), *eds.* (editions), *ibid.* (ibidem, in the same place), *pp.* (pages), *trans.* (translation).

A request:
Of course this bibliography is not complete. We kindly ask our readers to report any missing item.

1 INTERDISCIPLINARY TEXTBOOKS AND TEACHING MATERIALS

The border line between textbooks and scholarly monographs is not always clear. We list here such books where there are some indications that the works are written (partly or fully) with educational purposes: these are texts, guides, problem-books, or other teaching materials. Since this intention is not always clear from the titles of books, we pay a special attention to subtitles, series titles, the detailed data of the publishers, and even remarks in the prefaces. In the case of some non-English books, not only the titles, but also other bibliographic data are translated into English. In the case of names of institutions I try to give the official translation <with remarks that give further information or alternative translations that are closer to the original>. Occasionally, there are notes that explain the intention of the author [these are in brackets at end of the item].

1.1 Interdisciplinary works in a broad sense

1.1 1 General introductions

- Science-technology and arts-humanities:

Bérczi, S. (1990) *Szimmetria és struktúraépítés*, [*Symmetry and Structure-Building*, in Hungarian], Egyetemi jegyzet [University Text], Budapest: Tankönyvkiadó, 260 pp. [Published for a course at the Eötvös Loránd University, Budapest].

* 2nd printing, ibid., 1991, 260 pp.

- Many fields of science:

Sivardière, J. (1995) *La Symétrie en mathématiques, physique et en chimie*, [*Symmetry in Mathematics, Physics, and Chemistry*, in French], Collection Grenoble Sciences, Grenoble: Presses Universitaires de Grenoble, 880 pp. [Each of the 48 chapters contains exercises].

- Philosophy of science:

There are some related booklets, but these are shorter than our limit of 50 pages. See, e.g.,

* Zemlyanskii, F. M. (1974) *Struktura i simmetriya: Materialy dlya spetskursa*, [*Structure and Symmetry: Materials for a Special Topic Course*, in Russian], Chelyabinsk [Russia]: Chelyabinskii gosudarstvennyi pedagogicheskii institut [Chelyabinsk State Teacher-Training Institute <College>], 40 pp.

Also see:

* Khakimov (1986) on systems and symmetry → Section 1 2.6

1.1.2 Specific scientific fields (with an outlook to arts)

Herfort, P. and Klotz, A. (1997) *Ornamente und Fraktale: Visualisierung von Symmetrie und Selbstähnlichkeit*, [*Ornaments and Fractals: Visualization of Symmetry and Self-Similarity*, in German], [Series] Vieweg Mathematik für Schüler und Studenten, Wiesbaden: Vieweg, xii + 273 pp., 1 computer disk (IBM PC).

Klemm, M (1982) *Symmetrien von Ornamenten und Kristallen*, [*Symmetries of Ornaments and Crystals*, in German], Hochschultext [University Text], Berlin: Springer, vi + 214 pp.

Roanes Macías, E and Roanes Lozano, E. (1993) *Simulación didáctica de los grupos de simetría en el arte hispano-musulmán*, [*Didactical Simulation of the Groups of Symmetry in the Spanish-Muslim Art*, in Spanish], Madrid: Pablo Montesino and Universidad Complutense, 63 pp., 1 computer disk (5 1/4 in.).

Also see:

* Povileiko (1970) on technology and design → Section 1 2.7,

* MacGillavry on Escher → Section 2 2.3

1.1.3 Arts and design (with an outlook to science)

Huff, W. S. (1967-77) *Symmetry: An Appreciation of its Presence in Man's Consciousness*, Parts 2-6, Designed by T. Gonda, Pittsburgh: [Privately Published], 93 pp. in various pagings. [This series of booklets was distributed in Northern America for those universities that have design programs; Part 1 is not published; the order of publishing: Part 4, 1967; Part 6, 1970; Part 5, 1971; Part 2, 1975; Part 3, 1977].

* Reprint ed., Parts 6, 4, 5, In: *Oppositions*, Nos. 3, 6, 10, New York: The Institute for Architecture and Urban Studies, 1974, 63-78; 1976, 69-83; 1977, 76-99.

Kumagai, S. and Sawada, Y. (1983) *Moyou to shinmetorii*, [*Ornamental Patterns and Symmetry*, in Japanese with tables in English and a bilingual index of terms], Nonoichi-machi, Ishikawa-ken: Kanazawa Kougyou Daigaku Shuppankyoku [Kanazawa Institute of Technology Press], v + 147 pp. [A visual approach to plane symmetry groups, including black-and-white and colored ones; coauthored by a professor of design and a professor of mathematics].

1.1.4 Philosophy (see the Philosophy of science)

1.2 More specialized works of a given field (with some interdisciplinary outlook)

1.2.1 Mathematics

Some works on mathematical education and teaching aids on elementary mathematics are considered, but kept in the subsection 1.2.1.1.

Alsina Catalá, C., Pérez Gómez, R., and Ruiz Garrido, C. (1989) *Simetría dinámica*, [*Dynamic Symmetry*, in Spanish], Matematicas: Cultura y aprendizaje, No. 13, Madrid: Síntesis, 143 pp. [The title refers to geometrical transformations, not to Hambidge's dynamic symmetry, cf., Section 3.4.2.1].

Armstrong, M. A. (1988) *Groups and Symmetry,* Undergraduate Texts in Mathematics, New York: Springer, xi + 186 pp.

Farmer, D. W. (1996) *Groups and Symmetry: A Guide to Discovering Mathematics*, Mathematical World, Vol. 5, Providence, Rhode Island: American Mathematical Society, viii + 102 pp.

Martin, G. E. (1982) *Transformation Geometry: An Introduction to Symmetry*, Undergraduate Texts in Mathematics, New York: Springer, xii + 237 pp.

* 2nd printing, corrected, ibid., 1987.

Morcillo Rubio, J. and García Pérez, V. (1989) *Teoría de grupos y simetría*, [*Theory of Groups and Symmetry*, in Spanish], Madrid: Universidad Nacional de Educación a Distancia, 74 pp.

* Reprint ed., ibid., 1991.

Takahashi, R. (1998) *Taishousei no suugaku: Mon'you no kikagaku to gunron*, [*The Mathematics of Symmetry: Geometry of Patterns and Group Theory*, in Japanese], Tokyo: Housou Daigaku [University of the Air <Broadcasting University>], 163 pp.

Tang, Y. Q. (1979) *Duìchènxìng yuánli: Youxiàn duìchènqúnde biaoxiàn ji qi qúnlùn yuánli*, [*Symmetry Principles: The Representation of Finite Symmetry Groups and Their Group-Theoretic Principles*, in Chinese], Beijing [Peking]: Kexué chuban shè [Science Publishing Company], iii + 284 pp. [Each chapter contains exercises; the English description of the book is available in Mathematical Reviews 1984, cf., 84e:20052].

Also see:

* Graduate textbooks → Section 1.3.

1.2.1.1 Mathematical education, elementary mathematics

Breiteig, T. (1978) *Symmetri og monster i planet*, [*Symmetry and Pattern in the Plane*, in Norwegian], Kristiansand [Norway]: Kristiansand laererhogskole [Kristiansand Teacher-College], 79 pp.

Crowe, D. (1986) *Symmetry, Rigid Motions, and Patterns*, Arlington, Massachusetts: COMAP [Consortium for Mathematics and its Applications], viii + 36 [+ 20] pp.

* Abbreviated version, The UMAP Journal, 3 (1987), 207-236.

Dienes, Z P. and Mezard, S. (1971) *Logica, insiemi e simmetria*, [*Logic, Sets and Symmetry*, in Italian], Paris: O.C.D.L., 63 pp.

Fey, J. T. and Lappan, G. (1997) *Kaleidoscopes, Hubcaps and Mirrors: Symmetry and Transformations*, Ed. by C. Anderson, White Plains, New York: Seymour Publications, 209 pp.

Kufner, A. (1982) *Symetrické funkce*, [*Symmetric Functions*, in Czech], Skola mladych matematiku [Series: School of Young Mathematicians], Praha [Prague]: Mlada fronta, 116 pp.

Rossevatn, K. M. (1998) *Dynamisk geometri i undervisning: Symmetri og rotasjon*, [*Dynamic Geometry in Teaching: Symmetry and Rotation*, in Norwegian], Kristiansand [Norway]: Institutt for matematiske fag, Hogskolen i Agder [Institute for the Mathematical Subject, College in Agder], 127 pp.

Rull Perez, F. (1987) *Estudio de las propiedades de simetría de los bordados y encajes en la región de Castilla y Leon*, [*Study of the Symmetry-Properties of the Embroideries and Laces in the Region of Castilla and Leon*, in Spanish], Valladolid: Instituto de Ciencias de la Educacion, Universidad de Valladolid, 80 pp.

Walser, H. (1998) *Symmetrie*, [*Symmetry*, in German], [Series] Einblicke in die Wissenschaft: Mathematik, Leipzig: Teubner, 106 pp.

There are many related booklets which are shorter than our limit of 50 pages. Illustrating the broad international interest in symmetry, we refer here to two items that was published in Fiji, a South Pacific island

country (population ca. 750,000), and Kiribati, a country of tropical islands and atolls (population ca. 70,000), respectively:

* *Symmetry*, Pupils' Pamphlet A18, [Suva, Fiji]: University of the South Pacific, 30 pp.

* *Symmetry*, Class 6, [Tarawa, Kiribati]: USP [University of the South Pacific] Kiribati Project, 28 pp.

1.2.2 Crystallography

Alvarez Pérez, A. and Briansó, J. L. (1983) *Los Sistemas crístalográficos y su simetría*, [*Crystallographic Systems and Their Symmetry*, in Spanish], Ballaterra: Universitat Autónoma de Barcelona.

Arenas Rosado, J. F. and Fernández Gómez, M. (1979) *Apuntes de teoría de grupos y simetría*, [*Lectures Notes on Theory of Groups and Symmetry*, in Spanish], Granada: Universidad, Facultad de Ciencias, Departamento de Química-Física, 518 leaves.

Bojarski, Z., Habla, H., and Surowiec, M. (1976) *Materialy do cwiczen z krystalografii*, [*Materials for Exercises in Crystallography*, in Polish],

* Zeszyt 3: *Symetria w morfologii kryształów, grupy punktowe*, [Booklet 3: *Symmetry in the Morphology of Crystals, Point Groups*, in Polish],

* Zeszyt 4: *Symetria w budowie wewnetrznej cial krystalicznych, grupy przestrzenne*, [*Symmetry in the Internal Structure of Crystalline Materials, Space Groups*, in Polish], Katowice [Poland]: Uniwersytet Slaski [University of Silesia], 48 + 51 pp. [The subtitles of Booklets 1, 2, and 5 do not refer to symmetry].

* Cf., Bojarski, Z., Habla, H., and Surowiec, M., *Materialy do nauki krystalografii*, [*Materials for the Science of Crystallography*, in Polish], Ed. by Z. Bojarski, Warszawa: Panstwowe Wydawnictwo Naukowe (PWN), 1986, 287 pp. [Some of the earlier materials are integrated here].

Dubov, P. L., Frank-Kamenetskii, V. A., and Shafranovskii, I. I. (1984-87)

* [1] *Klassicheskaya simmetriya*, [*Classical Symmetry*, in Russian],

* [2] *Obobshchennaya simmetriya*, [*Generalized Symmetry*, in Russian],

* [3] *Antisimmetriya*, [*Antisymmetry* <Black-and-White Symmetry>, in Russian],

* [4] *Tablitsy dlya samostoyatel'nykh zanyatii studentov pri izuchenii simmetrii kristallov: Fedorovskie gruppy kubicheskoi singonii*, [*Tables for Individual Work of Students for the Study of Symmetry of Crystals: Fedorov Groups* <Space Groups> of the Cubic System, in Russian],

Leningrad [now Sankt-Peterburg]: Leningradskii gosudarstvennyi universitet [Leningrad <St. Petersburg> State University], 85 + 73 + 78 + 34 pp. [In the case of [1] the order of authors is different: Frank-Kamenetskii, Dubov, Shafranovskii].

Hahn, T., ed. (1985) *International Tables for Crystallography*, Brief Teaching Edition of Vol. A: Space-Group Symmetry, Dordrecht [The Netherlands]: Reidel, viii + 119 pp.

* 2nd revised ed., ibid., 1988, viii + 119 pp.

* 3rd enlarged ed., Dordrecht [The Netherlands]: Kluwer, 1993, viii + 152 pp.

Harsch, G. and Schmidt, R. (1981) *Kristallgeometrie: Packungen und Symmetrie in Stereodarstellung*, [*Crystal-Geometry: Packings and Symmetry in Stereo-Representation*, in German], Arbeitsbücher Chemie, Frankfurt am Main: Diesterweg and Aarau [Switzerland]: Sauerländer, 120 pp.

Loub, J. (1987) *Krystalová struktura, symetrie a rentgenová difrakce: Urceno pro posluchace fakulty prirodovedecke*, [*Crystal Structure, Symmetry and X-Ray Diffraction: Intended for Students of the Faculty of Natural Science* <Faculty of Science>, in Czech], Praha [Prague]: Státní pedagogicke nakladatelství (SPN), 142 pp. [Published for Charles University].

Nedoma, J. (1984) *Elementy symetrii: Grupy punktowe*, [*Elements of Symmetry: Point-Groups*, in Polish], Kraków [Cracow]: Akademia Górniczo-Hutnicza [Academy <College> of Mining and Metallurgy], 198 pp.

Planelles Fuster, J. (1996) *Teoria de grups de simetria*, [*Theory of Groups of Symmetry*, in Catalan], Castelló [Castellón de la Plana]: Publicacions de la Universitat Jaume I, 162 pp.

Trzaska Durski, Z. (1983) *Symetria w krystalografii*, [*Symmetry in Crystallography*, in Polish], Warszawa: Wydawnictwo Politechniki Warszawskiej [Publishing House of the Warsaw Polytechnics <Warsaw University of Technology>], 165 pp.

1.2.3 Physics (other than crystallography)

Abiko, S. and Koide, S. (1987) *Butsurigaku: Enerugii, taishousei, entoropii*, [*Physics: Energy, Symmetry, Entropy*, in Japanese], Tokyo: Toukyou Kyougakusha, xii + 417 pp.

Schottenloher, M. (1993) *Geometrie und Symmetrie in der Physik: Leitmotiv der mathematischen Physik*, [*Geometry and Symmetry in Physics: Leitmotiv of Mathematical Physics*, in German], Vieweg-Lehrbuch mathematischen Physik, Wiesbaden: Vieweg, xxii + 408 pp.

Also see·

* Engineering, technology → Section 1.2.7,

* Graduate textbooks → Section 1.3

1.2.4 Chemistry (other than crystallography)

Borsdorf, R., Dietz, F., Leonhardt, G., and Reinhold, J. (1975) *Einführung in die Molekülsymmetrie: Ein Lehrprogramm für Hochschulen, Chemie Programm*, [*Introduction to Molecular Symmetry: A Course-Program for Universities, Chemistry Program*, in German], Taschentext, Weinheim [Germany]: VCH and Physik Verlag, 112 pp.

Doran, P. B. (1965) *Symmetry in Inorganic Chemistry*, Reading, Massachusetts: Addison-Wesley, vi + 122 pp.

- Polish trans., *Symetria w chemii nieorganicznej*, Warszawa: Panstwowe Wydawnictwo Naukowe (PWN), 1968.

- Japanese trans., *Muki kagaku nyuumon: Taishousei to kouzou*, [*Introduction to Inorganic Chemistry: Symmetry and Structure*, in Japanese], Tokyo: Baifuukan, 1970, 183 pp.

- German trans., *Symmetrie und anorganische Strukturchemie: Lehrbuch für Chemiker, Physiker, Physikochemiker und Kristallographen ab 3. Semester*, [*Symmetry in Inorganic Structure-Chemistry: Textbook for Chemists, Physicists, Physico-Chemists and Crystallographers from the Third Semester*, in German], [Series] Uni-Text / Lehrprogram, Wiesbaden: Vieweg, 1972, 146 pp.

Fiser, J. (1976) *Uvod do molekulové symetrie: Urceno pro posluchace fakulty prirodovedecke*, [*Introduction to Molecular Symmetry: Intended for Students of the Faculty of Natural Science* <Faculty of Science>, in Czech], Praha [Prague]: Státní pedagogicke nakladatelství (SPN), 197 pp.

Fiser, J. (1980) *Uvod do molekulové symetrie: Aplikace teorie grup v chemii*, [*Introduction to Molecular Symmetry: Application of Theory of Group in Chemistry*, in Czech], Praha [Prague]: Státní nakladatelství technické literatury (SNTL), 287 pp.

Grodzicki, A. (1977) *Symetria czasteczek a ich widma oscylacyjne: Materialy do cwiczen ze spektroskopii molekularnej*, [*Symmetry of Particles and Their Vibrational Spectra: Materials for Exercises in Molecular Spectroscopy*, in Polish], Torun [Poland]: Uniwersytet Mikolaja Kopernika [Nicolas Copernicus University], 72 pp.

Grodzicki, A. (1988) *Symetria czasteczek a ich widma oscylacyjne: Skrypt dla studentów chemii, fizyki i biologii uniwersytetów*, [*Symmetry of Molecules and Their Vibrational Spectra: Lecture-Notes for Students of Chemistry, Physics, and Biology of Universtities*, in Polish], Warszawa: Panstwowe Wydawnictwo Naukowe (PWN), 87 pp.

Hollas, J. M. (1972) *Symmetry in Molecules*, Chapman and Hall Chemistry Textbook Series, London: Chapman and Hall, x + 218 pp.

- German trans., revised, *Symmetrie von Molekülen: Eine Einführung in die Anwendung von Symmetriebetrachtungen in der Chemie*, [*Symmetry in Molecules: An Introduction to the Application of Symmetry-Considerations in Chemistry*, in German], de Gruyter Lehrbuch, Berlin: de Gruyter, 1975, 232 pp.

Jaffé, H. H. and Orchin, M. (1965) *Symmetry in Chemistry*, New York: Wiley, x + 191 pp.

* Reprint ed., Huntington, New York: Krieger, 1977, x + 193 pp.

- Japanese trans., *Gunron nyuumon: Kagaku ni okeru taishou*, [*Introduction to Group Theory: Symmetry in Chemistry*, in Japanese], Tokyo: Toukyou Kagaku Doujin, 1966, 191 pp.

* Japanese reprint eds , ibid., 191 pp.

- Spanish trans., *Simetría en química*, Madrid: Alhambra, 1967, xi + 208 pp.

- German trans., *Symmetrie in der Chemie: Anwendung der Gruppentheorie auf chemische Probleme*, [*Symmetry in Chemistry: The Application of Group Theory for Chemical Problems*, in German], Heidelberg: Hüthig and Stuttgart. UTB (Uni-Taschenbucher), 1973, 186 pp.

- Russian trans., Dzhaffe, G. and Orchin, M., *Simmetriya v khimii*, Moskva: Mir, 1976.

Kettle, S. F. A. (1985) *Symmetry and Structure*, Chichester [England]: Wiley, x + 330 pp

* Paperback ed., ibid., 1989.

* Reprint ed., corrected, ibid., 1992.

* 2nd ed., *Symmetry and Structure: Readable Group Theory for Chemists*, Chichester [England]: Wiley, 1995, xii + 416 pp.

- German trans. of the 1st corrected ed., *Symmetrie und Struktur: Eine Einführung in die Gruppentheorie*, [*Symmetry and Structure: An Introduction to Group Theory*, in German], [Series] Teubner Studienbücher: Chemie, Stuttgart: Teubner, 1994, 393 pp.

Klasinc, L., Maksic, Z., and Trinajstic, N. (1979) *Simetrija molekula*, [*Symmetry of Molecules*, in Serbo-Croatian], Zagreb: Skolska knjiga, viii + 131 pp.

Kober, F. (1983) *Symmetrie der Moleküle*, [*Symmetry of Molecules*, in German], Studienbücher Chemie, Frankfurt am Main: Diesterweg and Aarau [Switzerland]: Sauerländer, vi + 217 pp.

Kuzma, M. (1991) *Symetria polimerów: Wlasnosci fizyczne*, [*Symmetry of Polymers: Physical Properties*, in Polish], Rzeszów: Wyzsza Szkola Pedagogiczna w Rzeszówie [Teacher-Training College in Rzeszów], 224 pp.

Nakazaki, M. (1969) *Bunshi no katachi to taishou: Sono hyouji hou*, [*Form and Symmetry of Molecules: Their Representation Rules*, in Japanese], Tokyo: Nankoudou, vi + 278 pp.

* Reprint ed., ibid., 1973, vi + 278 pp.

Nakazaki, M. (1973) *Bunshi no taishou to gunron*, [*Symmetry of Molecules and Group Theory*, in Japanese], Tokyo: Toukyou Kagaku Doujin, vi + 260 pp.

* Reprint eds., ibid., vi + 260 pp.

Nakazaki, M. (1975) *Ritai kagaku 1: Taishou o chuushin ni*, [*Stereochemistry 1: Symmetry in the Focus*, in Japanese], Tokyo: Toukyou Kagaku Doujin, vi + 346 pp.

Nakazaki, M. (1976) *Kagaku to taishousei: Gunron nyuumon*, [*Chemistry and Symmetry: Introduction to Group Theory*, in Japanese], Tokyo: Nankoudou, vi + 220 pp.

Papulov, Yu. G. (1979) *Simmetriya molekul: Uchebnoe posobie*, [*Symmetry of Molecules: A Textbook*, in Russian], Kalinin [now Tver', Russia]: Kalininskii gosudarstvennyi universitet [Kalinin <Tver> State University], 84 pp.

Papulov, Yu. G. (1988) *Simmetriya v khimii*, [*Symmetry in Chemistry*, in Russian], Kalinin [now Tver', Russia]: Kalininskii gosudarstvennyi universitet [Kalinin <Tver> State Unmviersity], 83 pp.

Vincent, A. (1977) *Molecular Symmetry and Group Theory: A Programmed Introduction to Chemical Applications*, London: Wiley, 156 pp.

- Hungarian trans., *Molekuláris szimmetria és csoportelmélet: Programozott bevezetés a kémiai alkalmazásokba*, Budapest: Tankönyvkiadó, 1987, 183 pp.

Wolff, R. and Kober, F. (1977) *Symmetrie und Gruppentheorie in der Chemie*, [*Symmetry and Group Theory in Chemistry*, in German], Der Chemieunterricht [Chemistry Education], Jahrgang 8, Heft 1, Stuttgart: Klett, 83 pp.

Zorkii, P. M. (1986) *Simmetriya molekul i kristallicheskikh struktur*, [*Symmetry of Molecules and Crystalline Structures*, in Russian], Moskva: Izdatel'stvo Moskovskogo gosudarstvennogo universiteta [Publishing House of Moscow State University], 231 pp.

Zorkii, P. M. and Afonina, N. N. (1979) *Simmetriya molekul i kristallov*, [*Symmetry of Molecules and Crystals*, in Russian], Moskva: Izdatel'stvo Moskovskogo gosudarstvennogo universiteta [Publishing House of Moscow State University], 176 pp.

Note. Dorain (1965), Jaffé and Orchin (1965), and Kettle (1985), see above, were not published originally as textbooks. However, their German translations are in series of university textbooks.

1.2.4.1 Chemical reactions (orbital theory)

There are some guides, programmed texts, and problem books on orbital symmetry, which is useful to predict and explain certain types of reactions in inoragnic chemistry. However, this topic is more specialized and we keep all of the related books together in Section 3.2.1.2.

See there especially, Bellamy (1974), Entwistle (1972), Gilchrist and Storr (1972), Lehr and Marchand (1972), Orchin and Jaffé (1971b), and Sunjic (1979).

1.2.5 Biology

Hámori, J. (1996) *Agyi aszimmetriák*, [*Brain Asymmetries*, in Hungarian], Pécs [Hungary]: Janus Pannonius Tudományegyetem [Janus Pannonius University], 152 pp.

Also

* Grodzicki (1988) on spectroscopy → Section 1.2.4.

* Khakimov (1986) on symmetry in nature → Section 1.2.6.

1.2.6 Earth sciences

Khakimov, E. M. (1986) *Sistemno-simmetriinyi analiz ob'ektov prirody* (Posobie po spetskursu), [*Systemo-Symmetric Analysis of Objects of Nature* (Textbook for a Special Topic Course), in Russian], Kazan' [Russia]: Chelyabinskii gosudarstvennyi pedagogicheskii institut [Chelyabinsk State Teacher-Training Institute <College>], 95 pp. [Published for students of geologo-geographical disciplines, also recommended for students of biology and chemistry (cf., preface, p. 4), and those who are interested in the philosophical questions of science (cf., annotation, p. 2)].

1.2.7 Engineering, technology

Aksan, M. (1969) *Ucus dinamigi: Simetrik hareketler*, [*Aerodynamics: Symmetric Movements*, in Turkish], Istanbul Teknik Üniversitesi Kütüphanesi Sayi 777 [Istanbul Technical University's Library <Series of Books> No. 777], Istanbul: Istanbul Teknik Üniversitesi, 127 pp.

Grigorovskii, B. K. (1982) *Printsip simmetrii v zadachakh izmeritel'noi tekhniki* (Uchebnoe posobie), [*Symmetry Principle in Exercises of Measuring Technique* (Textbook), in Russian], Kuibyshev [Russia]: Aviatsionnyi institut [Aviation Institute <College>], 94 pp.

Povileiko, R. P. (1970) *Simmetriya v tekhnike* (Eksperimental'naya lektsiya dlya studentov konstruktorskikh spetsial'nostei mashinostroitel'nykh i priborostroitel'nykh fakul'tetov Novosibirskogo èlektrotekhnicheskogo instituta), [*Symmetry in Technology* (Experimental Lecture for Students Specialized in Design at the Faculties of Machine-Building and Instrument-Making of the Novosibirsk Institute <College> of Electrotechnology <Electrical Engineering>), in Russian], Novosibirsk [Russia]: Novosibirskii èlektrotekhnicheskii institut, 129 pp.

1.2.8 Arts and the Humanities

Goncharenko, S. S. (1993) *Zerkal'naya simmetriya v muzyke: Na materiale tvorchestva kompozitorov XIX i pervoi poloviny XX veka*, [*Mirror Symmetry in Music: On the Material of Works by Composers of the 19th and the First Half of the 20th century*, in Russian], Novosibirsk: Novosibirskaya gosudarstvennaya konservatoriya im. M. I. Glinki [Novosibirsk M. I. Glinka State Conservatoire <Conservatory named after M. I. Glinka>], 231 pp.

Markova, O. B. (1996) *Simmetricheskie kompozitsii liricheskogo stikhotvoreniya*, [*Symmetrical Compositions of Lyrical Poems*, in Russian], Almaty [Kazakhstan]: Zhibek Zholy, 94 pp. [Added note: A teaching aid for philological faculties of higher educational institutions].

1.3 Graduate textbooks: Mathematics and/or physics

Altarelli, G. (1969) *Symmetry Groups and Current Algebra*, Lectures delivered by G. Altarelli, Notes compiled by R. Garcia, H. Moreno, and E. Hinojosa, Mexico City: Centro de investigacion y estudios avanzados del Instituto politechnico nacional, iii + 157 pp.

Fuchs, J. (1997) *Symmetries, Lie Algebras and Representations: A Graduate Course for Physicists*, Cambridge Monographs on Mathematical Physics, Cambridge [England]: Cambridge University Press, xxi + 438 pp.

Joshua, S. J. (1991) *Symmetry Principles and Magnetic Symmetry in Solid State Physics*, Graduate Student Series in Physics, Bristol: Hilger, xii + 270 pp.

* Paparback ed., ibid.

Marsden, J E. and Ratiu, T. (1994) *Introduction to Mechanics and Symmetry: A Basic Exposition of Classical Mechanical Systems*, Texts in Applied Mathematics, Vol. 17, New York: Springer, xiv + 500 pp.

Sailer, K. (1994) *Szimmetriák sértése a kvantumelméletben: Speciális előadások*, [*Breaking of Symmetries in Quantum Theory: Special-Topic Lectures*, in Hungarian], Debrecen [Hungary]: Kossuth Lajos Tudományegyetem [Kossuth Lajos University], 170 pp.

Zamorzaev, A. M. and Palistrant, A. F. (1977) *Teoriya diskretnykh grupp simmetrii: Lektsii po spetskursu*, [*Theory of Discrete Symmetry Groups: Lectures for a Special Topic Course*, in Russian], Kishinev [Moldavskoi SSR, now Moldova]: Kishinevskii gosudarstvennyi universitet [Kishinev State University], 101 pp. [Mathematics, Mathematical Crystallography].

2 INTERDISCIPLINARY MONOGRAPHS AND POPULAR-SCIENTIFIC BOOKS

2.1 General works with systematic surveys

2.1.1 Pioneering works published until 1952 (when three books appeared independently by Jaskowski, Weyl, and Wolf and Kuhn)

These books have significant historic importance. In addition to these, all of them have materials that are still current. Students may survey them in seminar reports.

Jaeger, F. M. (1917) *Lectures on the Principle of Symmetry and its Applications in All Natural Sciences*, Amsterdam: Elsevier, xii + 333 pp.

* 2nd enlarged ed., ibid., 1920, xii + 348 pp.

- French trans., *Le Principe de symétrie et ses applications*, Paris: Gauthier-Villars, 1925, xv + 420 pp.

Jaskowski, S. (1952) *O symetrii w zdobnictwie i przyrodzie*, [*On Symmetry in Decorative Art and Nature*, in Polish], Warszawa: Panstwowe Zaklady Wydawnictw Szkolnych, 168 pp.

Niggli, P. (1941) *Von der Symmetrie und von den Baugesetzen der Kristalle*, [*On Symmetry and on the Building-Laws of Crystals*, in German], Die Gestalt, Heft 4, Leipzig: Akademische Verlagsgesellschaft, 64 pp.

Nicolle, J. (1950) *La Symétrie et ses applications*, [*Symmetry and its Applications*, in French], [With a preface by L. de Broglie], Paris: Michel, 182 pp.

- German trans., *Die Symmetrie und ihre Anwendungen*, Berlin: Deutscher Verlag der Wissenschaften, 1954, 172 pp.

Shubnikov, A. V. (1940) *Simmetriya (Zakony simmetrii i ih primenenie v nauke, tekhnike i prikladnom iskusstve)*, [*Symmetry (The Laws of Symmetry and Their Application in Science, Technology, and Applied Art)*, in Russian], Moskva: Izdatel'stvo Akademii Nauk SSSR, 176 pp. [Cf., Shubnikov and Koptsik (1972) in Section 2.1.2, which is published as the 2nd enlarged ed. of this; however, the volume of that book is about twice larger than this one, and thus we suggest to consider it as a separate item].

Vul'f [Wulff], G. V. (1908) *Simmetriya i ee proyavleniya v prirode*, [*Symmetry and its Manifestations in Nature*, in Russian], Moskva: Sytin, 134 pp.

* 2nd ed., Moskva: Izdatel'skii otdel narodnogo komissariata prosveshcheniya, 1919, 135 pp.

* Reprint ed., In: Vulf', Yu. [sic] V., *Izbrannye raboty po kristallofizike i kristallografii*, [*Selected Works on Crystalphysics and Crystallography*, in Russian], Moskva: Gosudarstvennoe izdatel'stvo tekhniko-teoreticheskoi literatury, 1952, 242-320. [Note that the author's first name was used in two different versions: Georgii and Yurii].

Weyl, H. (1952) *Symmetry*, Princeton, New Jersey: Princeton University Press, 168 pp [Based on a series of lectures given for a broad audience].

* Reprint and paperback eds., ibid., 168 pp.

- German trans. [authorized by Weyl], *Symmetrie*, [Series] Wissenschaft und Kultur, Band 11, [With a new preface by Weyl], Basel: Birkhäuser, 1955, 157 pp.

* German trans., 2nd ed., ibid., 1981, 157 pp.

- Japanese trans , *Shinmetorii: Bi to seimei no bunpou*, [*Symmetry: The Grammar of Beauty and Life*, in Japanese], Tokyo: Kinokuniya Shoten, 1957, ii + 165 pp. [With a commentary by H. Touyama, pp. 159-165].

* Japanese reprint ed , *Shinmetorii*, ibid., 1970, ii + 165 pp. [The earlier subtitle is not used; H. Touyama's commentary is revised, pp. 159-165]

* Japanese reprint eds. of the latter, ibid.

- Spanish trans., *La Simetría*, [Series] Colección Interciencia, 5, Buenos Aires: Nueva Vision, 1958, 132 pp.

* Spanish trans., other version, *La Simetría*, Barcelona: Promoción Cultural, 1974. [With an introduction by E. Bonet].

* Spanish trans., other version, *Simetría*, Madrid: McGraw-Hill, 1990, x + 130 pp.

- Polish trans., *Symetria*, Warszawa: Panstwowe Wydawnictwo Naukowe (PWN), 1960, 202 pp.

* Polish trans., 2nd corrected ed., *Symetria*, Klasycy Nauki [Series: Classics of Science], Warszawa: Prószynski i S-ka, 1997, 157 pp.

- Italian trans., *La simmetria*, Milano: Feltrinelli, 1962, 175 pp.

* Italian trans., 2nd ed., ibid., 1981, 173 pp.

- French trans., *Symétrie et mathématique moderne*, [*Symmetry and Modern Mathematics*, in French], Paris: Flammarion, 1964, 151 pp.

* French reprint eds., ibid.

- Rumanian trans., *Simetria*, Bucuresti: Editura Stiintifica, 1966, 184 pp.

- Russian trans., Veil', G., *Simmetriya*, Ed. by B. A. Rozenfel'd, Moskva: Nauka, 1968, 190 pp. [With a commentary by the editor, pp. 168-173, and two additonal articles in Russian: "Weyl and the concept of symmetry" by I. M. Yaglom [IAglom], pp. 5-32, and "Weyl and the metodological problems of science" by B. V. Biryukov, pp. 174-190; the cover design is based on M. C. Escher's Lizards].

- Bulgarian trans., Vail, Kh., *Simetriya*, Sofiya [Sofia]: Nauka i izkustvo, 1969, 215 pp. [Translated from English; additional materials translated from the Russian ed.: a part of the commentary, pp 167-169, and I. M. Yaglom's article, pp. 170-215].

- Hungarian trans., *Szimmetria*, Budapest: Gondolat, 1982, 226 pp. [With additonal articles by T. Nagy (physics), J. Kiss (biology), S. Bérczi (phyllotaxis, polyhedra), respectively].

- Chinese trans., *Duìchèn*, Beijing [Peking]: Shangwù, 1986, 116 pp.

* Chinese trans., other version, *Duìchèn: Meide kexué chanshù*, [*Symmetry: Explaining the Beauty of Science*, in Chinese], Táibei [Taipei, Taiwan]: Zhèngzhong, 1988, 151 pp.

* Chinese trans., other version, *Duìchènxìng*, Shanghai: Shanghai fanyì chuban gongsi, 1991, vi + 156 pp.

- Greek trans., *Summetría*, Athêna [Athens]: Trohalía, 1991, 188 pp.

Wolf, K. L. and Kuhn, D. (1952) *Gestalt und Symmetrie: Eine Systematik der symmetrischen Körper*, [*Gestalt and Symmetry: A Systematic Presentation of Symmetric Bodies*, in German], Tübingen: Niemeyer, 64 pp.

- Spanish trans., *Forma y simetría: Una sistemática de los cuerpos simétricos*, Buenos Aires: Editorial Universitaria de Buenos Aires, 1977, 55 pp.

Also see the following pre-1952 books:

* Shepard (1948) on pattern analysis → Section 2.2.2,

* Plehn (1911) on colored patterns → Section 2.2.3,

* Veen (1911) on the diamond → Section 3.2.2,

* Danver (1942) on astronomy → Section 3.2.4,

* Jocobsohn-Lask (1924) on biology → Section 3 3 1,

* Hay (1846) on basic design → Section 3.4.2,

* Schröder (1902) and Werker (1922) on music → Section 3 4.4,

* Anderson (1897) on physical education → Section 3.5,

* Gauze (1940) on asymmetry of the protoplasm → Section 4 2,

* Lautman (1946) on mathematical and physical symmetry and dissymetry → Section 4.3.

Also see the modern editions of classical works:

* Fedorov (1949), Fedorov (1971) on symmetry groups (collections of late 19th century works in Russian and in English, respectively) → Section 3.2 2,

* García, S. (1681/1991) on architecture → Section 3 4 2,

* Tímár (1979) on Durer's book on human proportions → Section 3 4 3.

2 1.2 Works published after 1952

Alsina i Català, C. [Alsina Catalá, C.] and Fortuny, J. M. (1988) *Fascinant simetria*, [*Fascinating Symmetry*, in Catalan], Barcelona: Fundació Caixa de Pensions, 71 pp. [Published for an exhibition at the Museu de la Ciència (Science Museum) in Barcelona].

- Spanish trans., *Fascinante simetría*, [*Fascinating Symmetry*, in Spanish], Barcelona: Fundación Caja de Pensiones, 1990, 71 pp

Genz, H. (1987) *Symmetrie - Bauplan der Natur*, [*Symmetry: Blueprint of Nature*, in German], München: Piper, 464 pp.

* 2nd revised ed., ibid., 1992, 464 pp.

Hahn, W. (1989) *Symmetrie als Entwicklungsprinzip in Natur und Kunst*, [in German with an English summary], [With a preface by R Riedl], Königstein [Germany]: Langewiesche, 320 pp. [Very many illustrations, including some color plates].

- English trans., enlarged, *Symmetry as a Developmental Principle in Nature and Art*, Singapore: World Scientific, 1998, xxi + 510 pp.

Hargittai, I. (1983) *Szimmetria egy kémikus szemével*, [in Hungarian], Budapest: Akadémiai Kiadó, 292 pp.

- English trans., enlarged, co-author Hargittai, M., *Symmetry through the Eyes of a Chemist*, Weinheim [Germany]: VCH, 1986, xii + 458 pp.

* English paperback ed., New York: VCH, 1987.

* English trans., 2nd ed , New York: Plenum Press, 1995, xii + 469 pp.

- Russian trans. of the first English ed., *Simmetriya glazami khimika*, Moscow: Mir, 1989, 494 pp.

Hargittai, I. and Hargittai, M. (1994) *Symmetry: A Unifying Concept*, Bolinas, California: Shelter Publications, xviii + 222 pp. [Many photographic illustrations].

* Reprint ed., ibid., 1996, xviii + 222 pp.

- German trans. *Symmetrie. Eine neue Art die Welt zu Sehen*, [*Symmetry: A New Way to See the World*, in German], Rowohlt Taschenbuch, 1998.

Hargittai, M. and Hargittai, I. (1989) *Fedezzuk föl a szimmetriát!*, [*Discover Symmetry!*, in Hungarian], Budapest: Tankönyvkiadó, 148 pp. [Popular-scientific, also for children].

- Swedish trans., *Upptack symmetri!*, Stockholm: Natur och Kultur, 1998, 144 pp.

Heilbronner, E. and Dunitz, J. (1992) *Reflections on Symmetry*: In Chemistry ... and Elsewhere, Weinheim [Germany]: VCH and Basel: Helvetica Chimica Acta, vi + 154 pp.

Lisicky, M. (1980) *Zivá symetria*, [*Living Symmetry*, in Slovakian], Bratislava [Czechoslovakia, now Slovakia]: Mladé letá [Popular-scientific, for children].

Mainzer, K. (1988) *Symmetrien der Natur Ein Handbuch zur Natur- und Wissenschaftsphilosophie*, Berlin: de Gruyter, xii + 739 pp.

- English trans., *Symmetries of Nature A Handbook for Philosophy of Nature and Science*, Berlin: de Gruyter, xiii + 681 pp.

Morita, M. (1980) *Taishousei genri: Busshitsu to uchuu o shihaisuru migi to hidari*, [*Symmetry Theory: Matter and Universe Ruled by Right and Left*, in Japanese], [Series] Blue Backs / Buruu bakkusu, B-420, Tokyo: Koudansha, 228 pp. [Popular-scientific].

Merle, P. (1955) *L'Homme, le rythme et la symétrie*, [*The Human, the Rhythm and the Symmetry*, in French], Paris: Expansion scientifique française, 254 pp.

Nicolle, J. (1955) *La Symétrie dans la nature et les travaux des hommes*, [*Symmetry in Nature and the Works of Humans*, in French], [With a preface by L. de Broglie], Paris: La Colombe, 136 pp.

Nicolle, J. (1957) *La Symétrie*, [*Symmetry*, in French], Que sais-je?, Le Point des connasissances actuelles, No. 743, Paris: Presses Universitaires de France, 116 pp.

* 2nd ed., ibid., 1965, 128 pp [Popular-scientific].

- Spanish trans., Simetría, Buenos Aires: Fabril.

Rohde, G M. (1982) *Simetria· generalidades sôbre simetria, geociências, biociências, ciências exatas, tecnologias e artes, filosofia*, [*Symmetry: Generalities Concerning Symmetry - Geosciences, Biosciences, Exact Sciences, Technics and Arts, Philosophy*, in Portuguese], Sao Paulo· Hemus, 191 pp.

Roman, T. (1963) *Simetria - prezentare matematica a unor fenomene din natura si arta*, [*Symmetry - Presenting the Mathematics of Certain Phenomena in Nature and Art*, in Rumanian], Bucuresti: Technica, 254 pp

Rosen, J. (1975) *Symmetry Discovered: Concepts and Applications in Nature and Science*, Cambridge [England]: Cambridge University Press, xi + 138 pp.

* Reprint ed., corrected, Mineola, New York: Dover, 1998, xiv + 152 pp.

- Japanese trans., *Shinmetorii o motomete*, Tokyo: Kinokuniya Shoten, 1977, 182 pp.

Rosen, J. (1983) *Symmetry Primer for Scientists*, New York: Wiley, xiv + 192 pp.

Rosen, J. (1995) *Symmetry in Science: An Introduction to the General Theory*, New York: Springer, xv + 213 pp.

Shafranovskii, I. I. (1968) *Simmetriya v prirode*, [*Symmetry in Nature*, in Russian], Leningrad [now Sankt-Peterburg]: Nedra, 184 pp.

* 2nd revised ed., ibid., 1985, 167 pp.

Sheikov, N. (1977) *Zhivot i simetriya*, [*Life and symmetry*, in Bulgarian], [Series] Biblioteka radar, Sofiya [Sofia]: Narodna mladezh, 169 pp.

* 2nd ed., ibid., 1986, 160 pp. [Popular-scientific].

- German trans., abridged and revised, Scheikov, N., *Leben und Symmetrie*, [Series] Akzent, Leipzig: Urania, 1982, 128 pp.

- Hungarian trans. of the German version, Sejkov, N., *Élet és szimmetria*, [Series] Gondolat zsebkönyvek, Budapest: Gondolat, 1987, 127 pp.

Shubnikov, A. V. and Koptsik, V. A. (1972) *Simmetriya v nauke i iskusstve*, [in Russian], Moskva: Nauka, 339 pp. [Cf., Shubnikov (1940) in 2.1.1 and the note there].

- English trans., *Symmetry in Science and Art*, New York: Plenum Press, 1974, xxv + 420 pp.

Stewart, I. and Golubitsky, M. (1992) *Fearful Symmetry: Is God a Geometer?*, Oxford: Blackwell, xix + 287 pp. [The main title of the book is a quote from W. Blake's poem *The Tyger* (1794); cf., Zee (1986) in Section 3.2.1, Reader and Croze (1977) in Section 3.3.1].

- German trans., *Denkt Gott Symmetrisch?: Das Ebenmass in Mathmematik und Natur*, [*Does God Think Symmetrically: Symmetry in Mathematics and Nature*, in German], Basel: Birkhäuser, 1993, 302 pp.

- Italian trans., *Terribili simmetrie: Dio e un geometra?*, [*Terrible Symmetries· Is God a Geometer?*, in Italian], Torino: Bollati Boringhieri, 1995, 341 pp.

- Japanese trans., *Taishousei no yabure ga sekai o tsukuru: Kami wa kikagaku o aishita ka*, [*The Breaking of Symmetry Creates the World: Does God Love Geometry?*, in Japanese], Tokyo: Hakuyousha, 1995, 346 pp.

- Spanish trans., *¿Es Dios un geómetra? Las simetrías de la naturaleza*, [*Is God a Geometer? The Symmetries of Nature*, in Spanish], Barceolona: Crítica, 1995, 311 pp

Tarasov, L. V. (1982) *Étot udivitel'no simmetrichnyi mir: Posobie dlya uchashchikhsya*, [*This Amazingly Symmetric World: Book for Pupils*, in Russian], Moskva: Prosveshchenie, 176 pp. [Popular-scientific].

- English trans., *This Amazingly Symmetric World*, Moscow: Mir, 1986, 164 pp

- German trans., Tarassow, L., *Symmetrie, Symmetrie!: Strukturprinzipien in Natur und Technik*, [*Symmetry, Symmetry!: Structure-Principles in Nature and Technology*, in German], Heidelberg: Spektrum, 1993, 235 pp.

Wade, D. (1993) *Crystal and Dragon: The Cosmic Dance of Symmetry and Chaos in Nature, Art and Consciousness*, Rochester, Vermont: Destiny Books, 287 pp.

* British version [with no reference to symmetry], *Crystal and Dragon: The Cosmic Two-Step*, Bideford [England]: Green Books, 1991, 287 pp.

Wolf, K. L. and Wolff, R. (1956) *Symmetrie: Versuch einer Anweisung zu gestalthaftem Sehen und sinnvollem Gestalten, systematisch dargestellt und an zahlreichen Beispielen erläutert*, 1. Textband, 2. Tafelband, [*Symmetry: An Attempt towards an Instruction in Seeing Gestalt and Meaningfully Creating Gestalt, Systematically Described and with Numerous Examples Explained*, 1. Text-Volume, 2. Plate-Volume, in German], Munster: Böhlau, viii + 139 and vi + 192 pp.

2.2 Works on pattern creation and pattern analysis

2.2.1 Pattern creation

Binkley, T. (1992) *Symmetry Studio: Computer-Aided Surface Design*, [Software created by T. Binkley and J. F. Simon, Jr], New York· Van Nostrand Reinhold, viii + 198 pp., 1 computer disk [Macintosh]

Field, M. and Golubitsky, M. (1992) *Symmetry in Chaos: A Search for Pattern in Mathematics, Art and Nature*, Oxford: Oxford University Press, xii + 218 pp.

- German trans., *Chaotische Symmetrien: Die Suche nach Mustern in Mathematik, Kunst und Natur*, Basel: Birkhäuser, 1993, 218 pp.

- French trans , *La Symétrie du chaos: A la recherche des liens entre mathématiques, art et nature*, Paris: Inter éditions, 1993, xii + 218 pp.

Gansweid, J. (1987) *Symmetrie und Gestaltung: Optische Bewegungseffekte entwickelt aus geometrischen Elementen*, [*Symmetry and Arrangement* <Creating Gestalt>*: Optical-Kinetical Effects Developed with Geometrical Elements*, in German], München: Callwey, 134 pp.

Kainuma, H. and Kainuma, Y. (1981) *Patchiwaaku to shinmetorii*, [*Patchwork and Symmetry*, in Japanese], Kasugai: Shinuma Yoshirou, 76 pp.

Lauwerier, H. (1995) *Symmetrie, kunst en computers*, [*Symmetry, Art and Computers*, in Dutch], Haarlem: Aramith, 120 pp., 1 compact disk.

McDowell, R. B. (1994) *Symmetry· A Design System for Quiltmakers*, Lafayette, California: C and T Publishers, 144 pp.

Waller, M. D. (1961) *Chladni Figures: A Study in Symmetry*, London: Bell, xxii + 163 pp. [Note: Visualization of sound waves - the sand pattern technique of Chladni (1756-1827) produces symmetric patterns on plates vibrated, for example, by a violin bow at their edges].

Also see:

* Herfort and Klotz (1997) → Section 1 1 2

2.2.2 Pattern analysis: comprehensive surveys

Jablan, S. V. (1984) *Teorija simetrije i ornament*, [in Serbo-Croatian], Beograd: APXAIA, 344 pp.

- English trans , revised, *Theory of Symmetry and Ornament*, Beograd· Matematicki institut, 1995, 331 pp.

Lauwerier, H. A. (1988) *Symmetrie: Regelmatige structuren in de kunst*, [*Symmetry: Regular Structures in Art*, in Dutch], Amsterdam: Aramith, 140 pp.

Lockwood, E. H. and Macmillan, R. H. (1978) *Geometric Symmetry*, Cambridge [England]: Cambridge University Press, x + 228 pp.

Müller, C. (1985) *Symmetrie und Ornament: Eine Analyse mathematischer Strukturen der darstellenden Kunst*, [*Symmetry and Ornament: An Analysis of Mathematical Structures in Representational Art*, in German], Opladen: Westdeutscher Verlag, 51 pp.

Shepard, A. O. (1948) *The Symmetry of Abstract Design with Special Reference to Ceramic Decoration*, Contributions to American Anthropology and History, Vol. 9, No.47, Washington, D.C.: Carnegie Institution of Washington, Publication No. 574, [Separate pamphlet in Vol. 9, paginated as 209-293].

Stevens, P. S. (1981) *Handbook of Regular Patterns: An Introduction to Symmetry in Two Dimensions*, Cambridge, Massachusetts· MIT Press, 400 pp.

* Paperback ed., ibid., 1981; Many new printings.

Washburn, D K. and Crowe, D. W. (1988) *Symmetries of Culture· Theory and Practice of Plane Pattern Analysis*, Seattle, Wash : University of Washington Press, x + 299 pp.

* Paperback ed., ibid., 1991

Also see:

* Bérczi (1990) → Section 1.1,

* Huff (1967-77, Parts 2-3), Kumagai and Sawada (1983) → Section 1.1.3,

* Crowe (1986), Roanes and Roanes (1993) → Section 1.2.1.1 and 1.1.2.

* Takahashi (1998) → Section 1 2 1,

* Jaskowski (1952), Shubnikov (1940) → Section 2.1.1,

* Shubnikov and Koptsik (1972), Wolf and Wolff (1956), and some other books → Section 2 1.2.

2.2.3 Pattern analysis: special fields

Abas, S. J. and Salman, A. S. (1995) *Symmetries of Islamic Geometrical Patterns*, [With forewords by M. Atiyah and A. Moustafa], Singapore: World Scientific, xxii + 396 pp, 16 color plates.

Bérczi, S. (1986-87) *Szimmetria és techné a magyar, avar és hanti díszítőművészetben*, [*Symmetry and technê in the Hungarian, Avar, and Hanti Ornamental Art*, in Hungarian], Budapest: Eötvös Loránd Tudományegyetem, Általános Technika Tanszék; Leuven, Belgium: Leuveni Katolikus Egyetem [Catholic University of Louvain], Collegium Hungaricum, 59 pp.

Gerdes, P. (1996) *Lunda Geometry: Designs, Polyominoes, Patterns, Symmetries*, Maputo, Mozambique: Universidade Pedagógica, 152 pp. [Lunda is a region of the North-Eastern part of Angola].

MacGillavry, C. H. (1965) *Symmetry Aspects of M. C. Escher's Periodic Drawings*, Utrecht: Oosthoek, [Published for the International Union of Crystallography], xi + 84 pp.

* 2nd ed., Utrecht: Bohn, Scheltema & Holkema, [Published for the International Union of Crystallography], 1976, xi + 84 pp.

* American reprint ed., *Fantasy and Symmetry: The Periodic Drawings of M. C. Escher*, New York: Abrams, 1976, xi + 84 pp.

- Japanese trans., *Esshaa: Shinmetorii no sekai*, [*Escher: The World of Symmetry*, in Japanese], [With an afterword by K. Fushimi (Husimi)], Tokyo: Saiensusha, 1981, 90 pp.

Otto, B. (1976) *Geometrische Ornamente auf anatolischer Keramik: Symmetrien frühester Schmuckformen im nahen Osten und in der Ägäis*, [*Geometrical Ornaments on Anatolian Ceramics: Symmetries of the Earliest Decoration-Forms in the Near East and in the Aegean*, in German], Mainz am Rhein: von Zabern, xiii + 203 pp.

Plehn, A. L. (1911) *Farbensymmetrie und Farbenwechsel: Prinzipien deutscher und italienischer Farbverteilung*, [*Color-Symmetry and Color-Change: Principles of German and Italian Color-Distribution*, in German], Strassburg: Heitz, 90 pp.

Schattschneider, D. (1990) *Visions of Symmetry: Notebooks, Periodic Drawings, and Related Work of M. C. Escher*, New York: Freeman, xiv + 354 pp.

* Paperback ed., ibid, 1992

- Japanese trans., *Esshaa - hen'you no geijutsu: Shinmetori no hakken*, [*Escher - The Art of Transformation: The Discovery of Symmetry*, in Japanese], Tokyo: Nikkei Saiensusha, 1991, xiii + 370 pp.

- French trans., *Visions de la symétrie: Les Cahiers, les dessins périodiques et les oeuvres corrélatives de M. C. Escher*, Paris: Seuil, 1992, 368 pp.

- Italian trans., *Visioni della simmetria: I disegni periodici di M. C. Escher*, [*Visions of Symmetry: The Periodic Drawings of M. C. Escher*, in Italian], Bologna: Zanichelli, 1992, xiii + 354 pp.

Tarayan, Z R. (1989) *Simvoly simmetrii ornamenta v armianskom prikladnom iskusstve*, [*Symbols of Ornamental Symmetry in Armenian Applied Arts*, in Russian], Erevan, Armenia: Izdatel'stvo Akademii Nauk Armyanskoi SSR, 198 pp., 26 plates.

Washburn, D. K. (1977) *A Symmetry Analysis of Upper Gila Area Ceramic Design*, Papers of the Peabody Museum of Archaeology and Ethnology, Vol 68, Cambridge, Massachusetts: Harvard University Press, xiii + 193 pp. [The Gila River rises in Sierra Madre, New Mexico, U.S.A., and crosses to the Colorado River in Arizona].

Also see:

* Rull Perez (1987) → Section 1 2.1.1,

* Lucich (1987), Witherspoon and Peterson (1995) → Section 3.4.1.

3 MORE SPECIALIZED MONOGRAPHS WITH SOME INTERDISCIPLINARY OUTLOOK

It is difficult to make strict rules for selecting books of interdisciplinary interest. Sometimes works referring to a concrete discipline still have an interdisciplinary importance. For example, a book on crystallographic symmetry groups is useful not only for crystallographers, but also for people interested in solid state physics, crystalphysics, crystalchemistry, materials science, and, in some cases, even for designers. As a general principle: we consider those books that have some importance outside its primary discipline. Following this

principle, we include books related to mathematical- physical topics (e.g., theoretical mechanics, quantum theory, particle physics) although many of these books have a limited target among a group of mathematicians and physicists. We also list books on symmetries in various artistic fields, because these could be useful for artists of other fields and scholars who would like to illustrate scientific books with artistic examples. We also include books on dynamic symmetry in design, a proportion-system proposed by Jay Hambidge on the basis of his studies on Greek art, because we witnessed that some aspects of this topic are also interesting for mathematics students (despite the fact that it has less value for the originally targeted artists and art historians). We also list some old books of historic importance (cf., Section 2.1.1 and the references there). Indeed, we think that dealing with the history of the subject is relevant and advanced students may prepare related reports. Although we also include books written by historians of science on various aspects of symmetry (see Section 3.1), we suggest combining these with the original sources.

What types of books are not included? It is not easy to give strict rules, but here are some general conventions.

We do not list books that use the term symmetry or its derivatives

- (1) as a metaphorical expression, e.g.,

Frye, N. (1947) *Fearful Symmetry: A Study of William Blake*, Princeton: Princeton University Press, 462 pp. [Here the main title is a quote from Blake's poem].

- (2) as an attribute in a specialized term of a discipline that are rarely used outside a particular field (e.g., symmetric space, symmetric logic).

Note that there are cases where a similar term has great importance in two or more field (e.g., asymmetric synthesis, a chemical process that also attracted the interest of biologists).

3.1 History and philosophy of science, cognitive science, psychology, general education

Altmann, S. L. (1992) *Icons and Symmetries*, Oxford: Clarendon Press and New York: Oxford University Press, xii + 104 pp. [History of mathematics and physics; three case-studies: (1) Oersted's paradox of the interaction between the magnetic needle and the electric current; (2) Hamilton's description of rotation by quaternions and the later development of related mathematical tools, (3) symmetry in the classification of energy levels in atoms and solids].

- Spanish trans., *Iconos y simetrías*, Zaragoza: Prensas Universitarias, 1994, 147 pp.

Burckhardt, J. J. (1988) *Die Symmetrie der Kristalle: Von René-Just Hauy zur kristallographischen Schule in Zurich*, [*The Symmetry of Crystals: From René-Just Hauy to the Crystallographic School in Zurich*, in German], Basel: Birkhäuser, 195 pp.

Chakravorty, K. R. (1977) *Science Based on Symmetry*, Calcutta: Firma KLM, xxi + ca. 500 pp. [Philosophy of science; Indian philosophy, religion, and mysticism].

Hommel, H. (1987) *Symmetrie im Spiegel der Antike*, [*Symmetry as Reflected in the Antiquity*, in German], Sitzungsberichte der Heidelberger Akademie der Wissenschaften, Philosophisch-Historische Klasse, Jahrgang 1986, Bericht 5, Hieldelberg: Winter, 59 pp.

Khvan, M. P. (1986) *Filosofskoe znachenie printsipa simmetrii v fizike elementarnykh chastits*, [*Philosophical Meaning of the Symmetry Principle in Particle Physics*, in Russian], Moskva: Izdatel'stvo Universiteta druzhba narodov, 199 pp.

Leyton, M. (1992) *Symmetry, Causality, Mind*, Cambridge, Massachusetts: MIT Press, vii + 630 pp. [Cognitive science; Case studies: perception, liguistics, art, and political prisoners].

Melandri, E. (1974) *L'analogia, la proporzione, la simmetria*, [*Analogy, Proportion, Symmetry*, in Italian], Scienze dell'uomo, Vol. 27, Milano: ISEDI, 185 pp. [Logic].

Piersa, H. (1990) *Symetria i jej funkcje poznawcze w fizyce*, [*Symmetry and its Congnitive Functions in Physics*, in Polish], Rozprawa habilitacyjna, Lublin, Poland: Wydawnictwo Katolickiego Uniwersytetu Lubelskiego (KUL), 257 pp.

Scholz, E. (1989) *Symmetrie, Gruppe, Dualität: Zur Beziehung zwischen theoretischer Mathematik und Anwendungen in Kristallographie und Baustatik des 19. Jahrhunderts*, [*Symmetry, Group, Duality· On the Connection between Theoretical Mathematics and Applications in Crystallography and Structural Design of the 19th Century*, in German], Basel: Birkhäuser and Berlin: Deutscher Verlag der Wissenschaften, 406 pp.

Slok, J. et al. (1975) *Symmetri i videnskaberne*, [*Symmetry and the Sciences*, in Danish], Det lærde Selskabs publikationsserie, Ny serie, Hæfte 7-8, Aarhus [Denmark]: Universitetsforlaget i Aarhus, 77 pp. [Philosophy

of science; note: we include this item because the title-page presents it as a book with multiple authors, although it can be also interpreted as a collection of papers].

Sodnomgombo, D. and Khvan, M. P. (1981) *Filosofiya i simmetriya*, [*Philosophy and Symmetry,* in Russian], Ulan Bator, Mongolia: Gosizdat, 206 pp. [Physics].

Tsalikídês, E. G. (1995) *Kosmikê armonía kai summetría dia mésou tês klassikês kai eukleídeiou geômetrías*, [*Cosmic Hamony and Symmetry by Means of Classical and Euclidean Geometry*, in Greek], Thessalonfkê [Thessaloniki]: Zêtê, 181 pp. [History of geometry].

Urmantsev, Yu. A. (1974) *Simmetriya prirody i priroda simmetrii* (Filosofskie i estestvennonauchnye aspekty), [*Symmetry of Nature and the Nature of Symmetry* (Philosophical and Scientific Aspects), in Russian], Moskva: Mysl', 229 pp. [Philosophy, Biology, System approach].

Van Fraassen, B. C. (1989) *Laws and Symmetry*, Oxford. Oxford University Press, xv + 395 pp. [Philosophy, Physics]

- French trans., *Lois et symétrie*, [Series] Mathesis, Paris: Vrin, 1994, 520 pp.

Yaglom [IAglom], I. M. (1988) *Felix Klein and Sophus Lie: Evolution of the Idea of Symmetry in the Nineteenth Century*, Boston: Birkhäuser, vii + 237 pp. [History of mathematics and physics].

Also see:

* Khakimov (1986) on philosophy of science ⟶ Section 1.2.6,

* Dienes and Mezard (1971) on logic ⟶ Section 1.2.1.1,

* Horwich (1987) on the philosophical problems of asymmetry in time ⟶ Section 4.3, and

* the pre-1952 works in the context of history of science ⟶ Section 2.1.1,

* the books on the philosophical aspects of symmetry vs. asymmetry ⟶ Section 4.1.

3.2 Exact sciences (mathematics, physics, and chemistry, including mathematical crystallography)

3.2.1 General works and popular-scientific books

Aneva, B. (1990) *Supersimetria: Matematichni metodi na teoretichnata fizika*, [*Supersymmetry: Mathematical Methods in Theoretical Physics*, in Bulgarian], [Series] Lektsii za mladi ucheni, Sofiya [Sofia]: Izdatelstvo na Bulgarskata akademiya na naukite, 82 pp

Arai, A. (1993) *Taishousei no suuri*, [*The Mathematical Principles of Symmetry*, in Japanese], Tokyo: Nihon Hyouronsha, v + 221 pp.

Bandou, M. (1996) B*utsuri to taishousei: kuouku kara shinka made*, [*Physics and Symmetry: From Quarks to Evolution*, in Japanese], Tokyo: Maruzen, viii + 182 pp.

Bunch, B. (1989) *Reality's Mirror: Exploring the Mathematics of Symmetry*, New York: Wiley, xi + 286 pp.

- Japanese trans., *Jitsuzai no kagami: Shinmetorii no sekai*, [Reality's Mirror: The World of Symmetry, in Japanese], Tokyo: Seidosha, 1994, 350 pp.

Elliott, J. P. and Dawber P. G. (1979) *Symmetry in Physics*, Vol. 1, Principles and Simple Applications, Vol. 2, Further Applications, London: Macmillan, xix + xviii + 557 pp. [Vol 1, pp. 1-280; Vol. 2, pp. 281-557].

* Reprint ed., corrected, ibid., 1984. [616 pp. in various pagings].

- Russian trans., Élliot, D. and Dober, P., *Simmetriya v fizike,* Tom 1, Osnovnye printsipy i prostye prilozheniya, Tom. 2, Dal'neishie prilozheniya, Moskva: Mir, 1983, 364 + 410 pp.

Feynman, R. P. (1997) *Six Not-So-Easy Pieces: Einstein's Relativity, Symmetry, and Space-Time*, [Originally prepared for publication by R. B. Leighton and M. Sands; New introduction by R Penrose], Reading, Massachusetts: Addison-Wesley, xxvii + 152 pp.

Gribbin, J. R. (1998) *In Search of SUSY: Supersymmetry, String and the Theory of Everything*, London: Penguin. [Physics, popular scientific].

* American reprint ed., *The Search for Superstrings, Symmetry, and the Theory of Everything*, Boston: Little Brown, 1999, x + 212 pp.

Holden, A. (1971) *Shapes, Space, and Symmetry,* New York: Columbia University Press, viii + 200 pp.

* Reprint ed., New York· Dover, 1991, 200 pp [Polyhedra].

- French trans., *Formes, espace et symétries: Construisez facielement vos solides*, [*Shapes, Space, and Symmetry: Build Your Solids*, in French], [Series] Les Distracts, Paris: Conception, édition, diffusion, information (CEDIC), 1977, 206 pp.

Holod, P. I. and Klimyk, A. U. (1992) *Matematychni osnovy teorii symetrii*, [*Mathematical Foundations of Theory of Symmetry*, in Ukrainian], Kiyiv [Kiev]: Naukova dumka, 366 pp.

Icke, V. (1995) *The Force of Symmetry*, Cambridge [England]: Cambridge University Press, xxi + 338 pp. [Physics, popular scientific].

* Paparback ed., ibid., 1995.

Kompaneets, A. S. (1978) *Simmetriya v mikro- i makromire*, [*Symmetry in the Micro- and the Macro-Worlds*, in Russian], Moskva: Nauka, 207 pp. [Popular-scientific].

Mozrzymas, J. (1992) *Ewolucja symetrii*, [*Evolution of Symmetry*, in Polish], Wroclaw: Uniwersytet Wroclawski, 96 pp. [Physics].

Pagels, H. R. (1985) *Perfect Symmetry: The Search for the Beginning of Time*, New York: Simon and Schuster, 390 pp.

* 2nd ed., New York: Bantam, 1991, 390 pp.

- Dutch trans. of the 1st ed., co-author Shilling, G., *Volmaakte symmetrie: Speurtocht naar de oorsprong van ruimte en tijd*, Amsterdam: Contact, 1988, 432 pp.

- Japanese trans. of the 1st ed., *Toki no hajimari e no tabi: Taishousei no butsuri*, [*Journey to the Beginning of Time: The Physics of Symmetry*, in Japanese], Tokyo: Chijin Shokan, 1989, 402 pp.

- Japanese trans. of the 2nd ed., *Hoshi kara ginga e: Heesheru no niwa*, [*From the Stars to the Milky Way: Herschel's Garden*, in Japanese], ibid., 1993, 262 pp.

- Portuguese trans. of the 1st ed., *Simetria perfeita*, Lisboa: Gradiva, 1990, 455 pp.

Raichev, P. P. (1974) *Simetriyata na atomniya svyat*, [*Symmetry of the Atomic World*, in Bulgarian], Sofiya [Sofia]: Nauka i izkustvo, 66 pp. [Popular-scientific].

Rychlewski, J. (1991) *Symetria przyczyn i skutków*, [*Symmetry of Causes and Effects*, in Polish], Warszawa: Panstwowe Wydawnictwo Naukowe (PWN), 156 pp. [Physics].

Salam, A. (1966) *Symmetry Concepts in Modern Physics: Iqbal Memorial Lectures*, Lahore, Pakistan: Atomic Energy Centre, 55 pp. [Later the author was awarded the Nobel Prize in Physics for symmetry-related works.]

Schmutzer, E. (1972) *Symmetrien und Erhaltungssätze der Physik*, [*Symmetries and Conservation Laws of Physics*, in German], Braunschweig: Vieweg and Berlin: Akademie-Verlag, 165 pp.

- Russian trans., Shmuttser, É., *Simmetrii i zakony sokhraneniya v fizike*, Moskva: Mir, 1974, 159 pp.

Todorov, I. (1985) *Fizika, geometriya, simetriya*, [*Physics, Geometry, Symmetry*, in Bulgarian], Sofiya [Sofia]: Narodna prosveta, 144 pp. [Five lectures given for a broad audience of physicists, mathematicians, and philosophers, 1971-1983].

Verheyen, H. (1996) *Symmetry Orbits*, Design Science Collection, Boston: Birkhäuser, vi + 236 pp. [Geometry, Crystallography].

Wigner, E. P. (1967) *Symmetries and Reflections: Scientific Essays*, Bloomington, Indiana: Indiana University Press, viii + 280 pp. [Physics, Philosophy; the author was awarded the Nobel Prize in Physics for symmetry-related works.].

* Reprint ed., Westport, Connecticut: Greenwood Press, 1978, viii + 280 pp.

- Russian trans., enlarged, Vigner, E. P., *Étyudi o simmetrii*, [*Etudes on Symmetry*, in Russian], Ed. by Ya. A. Smorodinskii, Moskva: Mir, 1971, 318 pp. [Added part: some related papers by Wigner].

- Hungarian trans, Wigner, J., *Szimmetriák és reflexiók*, Budapest: Gondolat, 1972, 355 pp. [The initial "J" refers to Jenó (Eugene, in English), which was Wigner's original given name in Hungary].

Yale, P. B. (1968) *Geometry and Symmetry*, Holden-Day Series in Mathematics, San Francisco: Holden-Day, xi + 288 pp.

* Reprint ed., New York. Dover, 1988.

Zee, A. (1986) *Fearful Symmetry: The Search for Beauty in Modern Physics*, New York: Macmillan, xiv + 322 pp. [Popular scientific; the main title of the book is a quote from Blake's poem The Tyger (1794); cf., Stewart and Golubitsky (1992) in Section 2.1.2, Reader and Croze (1977) in Section 3.3.1].

* Reprint ed., New York: Collier Books, 1989, xiv + 322 pp.

- Japanese trans., *Uchuu no dezain genri: Paritι, geeji, kuouku*, [*Design Principle of the Universe: Parity, Gauge, Quarks*, in Japanese], Tokyo: Hakuyousha, 1989, 438 pp.
- German trans., *Magische Symmetrie: Die Asthetik in der modernen Physik*, [*Magical Symmetry: The Aesthetics of Modern Physic*, in German], Frankfurt am Maιn: Insel, 1993, 360 pp.

Also see:

* the books on history and philosophy of mathematics and physics → Section 3.1.

3.2.2 Structure of matter - atomic or molecular level; applications of group theory

Mathematical-crystallographical works on colored symmetry and chemical books on orbital symmetry and the theory of chemical reactions are considered, but kept separately in subsections 3.2.1.1 and 3.2.1.2, respectively.

Altmann, S. L. (1991) *Band Theory of Solids: An Introduction from the Point of View of Symmetry*, Oxford: Clarendon Press and New York: Oxford University Press, xiv + 286 pp.

Alworth, W. L (1972) *Stereochemιstry and its Applicatιon in Biochemistry: The Relation Between Substrate Symmetry and Biological Stereospecificity*, New York: Wιley, xi + 311 pp.

- Spanish trans., Estereoquímica y su aplιcación en bιoquímica: La relacιón entre la simetría del sustrato y la estereoespecιficidad biológιca, Madrid: Alhambra, 1980, xii + 376 pp.

Baggott, J. E. (1994) *Perfect Symmetry: The Accidental Discovery of Buckminsterfullerene*, Oxford: Oxford Universιty Press., ix + 315 pp. [Buckminsterfullerene = a new form of (carbon) molecules that resemble Buckminster Fuller's dome-structures].

* Paparback ed., ibid., 1996. ix + 315 pp.

- Japanese trans., *Kyuukyoku no shinmetorii: Furaaren hakken monogatari*, [*Ultimate Symmetry: The Story of the Discovery of the Fullerene*, in Japanese], Tokyo: Hakuyousha, 1996, 364 pp.

Belger, M. and Ehrenberg, L. (1981) *Theorie und Anwendung der Symmetriegruppen*, [*Theory and Application of Symmetry Groups*, in German], Mathematik für Ingenieure, Naturwissenschaftler, Ökonomen und sonstige anwendungsorientierte Berufe, Band 23, Leipzig: Teubner 116 pp.
* 2nd revised ed., ibid., 1988, 116 pp.

Belov, N. V. (1986) *Ocherki po strukturnoi kristallografii i fedorovskim gruppam simmetrii*, [*Studies on Structural Crystallography and Fedorov Groups* <Space Groups> *of Symmetry*, in Russιan], Compiled by I. M. Rumanova, G. A. Geguzina, and E. M. Dolivo-Dobrovolskaya, Ed. by E. G. Fesenko, Moskva: Nauka, 278 pp.

Bernal, I., Hamilton, W. C., and Ricci, J. S. (1972) *Symmetry: A Stereoscopic Guide for Chemists*, San Francisco: Freeman, viii + 180 pp.

Bhagavantam, S. (1966) *Crystal Symmetry and Physical Properties*, London: Academic Press, x + 230 pp.

Bir, G. L. and Pikus, G. E. (1972) *Simmetriya i deformatsionnye effekty v poluprovodnikakh*, [in Russian], Moskva: Nauka, 584 pp.

- English trans., *Symmetry and Strain-Induced Effects in Semiconductors*, [With a foreword by J. C. Hensel], New York: Wiley, 1974, x + 484 pp.
- Polish trans., *Symetria i odksztalcenia w polprzewodnikach*, [in Polish], Warszawa: Panstwowe Wydawnictwo Naukowe (PWN), 1977, 561 pp.

Birss, R. R. (1964) *Symmetry and Magnetism*, Series of Monographs on Selected Topics in Solid State Physics, Vol. 3, Amsterdam: North-Holland and New York: Interscience, xx + 252 pp.

Blaizot, J. P. and Toledano, J.-C. (1997) *Symétries et physique microscopique*, [*Symmetries and Microscopical Physics*, in French], Paris: Ellipses, xiii + 188 pp.

Boardman, A. D., O'Connor, D. E., and Young, P. A. (1973) *Symmetry and its Applications in Science*, New York: Wiley, xiii + 305 pp.

Bradley, C. J. and Cracknell, A. P. (1972) *The Mathematical Theory of Symmetry in Solids: Representation Theory for Point Groups and Space Groups*, Oxford: Clarendon Press, xii + 745 pp.

- Japanese trans. of a part, *Tengun to kuukangun no hyougen*, [*Representation of Point Groups and Space Groups*, in Japanese], Tokyo: Uchida Roukakuho Shinsha, 1975, 361 pp.

Bunker, P. R. (1979) *Molecular Symmetry and Spectroscopy*, New York: Academic Press, xv + 424 pp.
* 2nd ed., co-author Jensen, P., NRC Research Press, 1998.

- Russian trans. of the 1st ed., Banker, F. R., *Simmetriya molekul i molekulyarnaya spektroskopiya*, Moskva: Mir, 1981, 451 pp.

Burzlaff, H. and Zimmermann, H. (1977) *Kristallographie*, Band 1, Symmetrielehre, [Crystallography, Vol. 1, Symmetry-Theory, in German], Stuttgart: Thieme, xii + 275 pp.

Butler, P. H. (1981) *Point Group Symmetry Applications: Methods and Tables*, New York: Plenum Press, ix + 567 pp.

Carter, R. L. (1998) *Molecular Symmetry and Group Theory*, New York: Wiley, x + 299 pp.

Cracknell, A. P. (1975) *Magnetism in Crystalline Materials: Applications of the Theory of Groups of Cambiant Symmetry*, International Series of Monographs in Natural Philosophy, Vol. 72, Oxford: Pergamon Press, vii + 276 pp.

Dmitriev, I. S. (1976) *Simmetriya v mire molekul*, [in Russian], Leningrad [now Sankt-Peterburg]: Khimiya, 124 pp.

- Czech trans., Dmitrijev, I. S., *Symetrie ve svete molekul*, Praha [Prague]: Státní nakladatelství technické literatury (SNTL), 119 pp.

- English trans., Revised, *Symmetry in the World of Molecules*, Moscow: Mir, 1979, 147 pp.

- German trans., *Symmetrie in der Welt der Moleküle*, Leipzig: Deutscher Verlag für Grundstoffindustrie, 1987, 146 pp.

Donaldson, J. D. and Ross, S. D. (1972) *Symmetry and Stereochemistry*, New York: Halsted Press Division, Wiley, 234 pp.

* British reprint ed., London: Intertext Books, 1972, 234 pp.

Douglas, B. E. and Hollingsworth, C. A. (1985) *Symmetry in Bounding and Spectra: An Introduction*, San Diego: Academic Press, xii + 456 pp.

Evarestov, R. A. and Smirnov, V. P. (1993) *Site Symmetry in Crystals: Theory and Applications*, Springer Series in Solid-State Sciences, Vol. 108, Berlin: Springer, xi + 274 pp.

* 2nd ed., ibid., 1997, xiii + 280 pp.

Ezra, G. S. (1982) *Symmetry Properties of Molecules*, Lecture Notes in Chemistry, Vol. 28, Berlin: Springer, viii + 202 pp.

Fedorov, E. S. (1949) *Simmetriya i struktura kristallov: Osnovnye raboty*, [*Symmetry and Structure of Crystals: Basic Works*, in Russian], Ed. by A. V. Shubnikov and I. I. Shafranovskii, Klassiki nauki [Series], Moskva: Izdatel'stvo Akademii Nauk SSSR, 630 pp. [Basic works of late 19th century, including the discovery of the 230 crystallographic space groups].

- English trans. of the major part of this book in: Fedorov (1971).

Fedorov, E. S. (1971) *Symmetry of Crystals*, ACA Monograph, No. 7, New York: American Crystallographic Association, x + 315 pp. [Trans. of Fedorov (1949) except the biography and the bibliography of Fedorov; translated by D. Harker and K. Harker].

Fieck, G. (1982) *Symmetry of Polycentric Systems: The Polycentric Tensor Algebra for Molecules*, Lecture Notes in Physics, Vol. 167, Berlin: Springer, vi + 137 pp.

Flurry, R. L., Jr. (1980) *Symmetry Groups: Theory and Chemical Applications*, Englewood Cliffs, New Jersey: Prentice-Hall, xii + 356 pp.

- Russian trans., Flarri, R L., *Gruppy simmetrii: Teoriya i khimicheskie prilozheniya*, Moskva: Mir, 1983, 395 pp.

Franzen, H. F. (1994) *Physical Chemistry of Solids: Basic Principles of Symmetry and Stability of Crystalline Solids*, Advanced Series in Physical Chemistry, Vol. 1, Singapore: World Scientific, xiv + 280 pp.

Fricke, H. (1965) *Symmetrie als Schlüssel zum Verständnis der organishen Chemie*, [*Symmetry as a Key for Understanding Organic Chemistry*, in German], Praxis-Schriftenreihe, Abteilung Chemie, Band 14, Köln: Aulis, 65 pp.

Fujita, S. (1991) *Symmetry and Combinatorial Enumeration in Chemistry*, Berlin: Springer, ix + 368 pp.

Griffith, J. S. (1962) *The Irreducible Tensor Method for Molecular Symmetry Groups*, Prentice-Hall International Series in Chemistry, Englewood Cliffs, New Jersey: Prentice-Hall, 134 pp.

Hall, L H. (1969) *Group Theory and Symmetry in Chemistry*, New York: McGraw-Hill, xiii + 370 pp.

Harter, W. G. (1993) *Principles of Symmetry, Dynamics, and Spectroscopy*, New York: Wiley, xxii + 846 pp.

Hatfield, W E. and Parker, W. E. (1974) *Symmetry in Chemical Bonding and Structure*, Colombus, Ohio: Merrill, ix + 277 pp.

Ho, T.-L. (1995) *Symmetry: A Basis for Synthesis Design*, New York: Wiley, xv + 561 pp. [Chemistry].

Hochstrasser, R. M. (1966) *Molecular Aspects of Symmetry*, New York: Benjamin, xiii + 355 pp.

- Russian trans., Khokhshtrasser, R., *Molekulyarnye aspekty simmetrii*, Moskva: Mir, 1968, 384 pp.

Ivchenko, E. L. and Pikus, G. E. (1995) *Superlattices and Other Heterostructures: Symmetry and Optical Phenomena*, Springer Series in Solid-State Sciences, Vol 110, Berlin: Springer, xi+370 pp. [Semiconductors].

* 2nd ed., ibid , 1997, xiii + 382 pp.

Izyumov, Yu. A. and Syromyatnikov, V. N. (1984) *Fazovye perekhody i simmetriya kristallov*, [in Russian], Moskva: Nauka, 245 pp.

- English trans., enlarged, *Phase Transition and Crystal Symmetry*, Dordrecht [The Netherlands]: Kluwer, 1990, xx + 443 pp.

Knox, R. S. and Gold, A. (1964) *Symmetry in the Solid State*, New York: Benjamin, xii + 344 pp

- Russian trans., Noks, R. and Gold, A., *Simmetriya v tverdom tele*, Moskva: Mir, 1970, 424 pp.

Kocinski, J. (1983) *Theory of Symmetry Changes and Continuous Phase Transitions*, Amsterdam: Elsevier, viii + 283 pp

Ladd, M. F. C. (1989) *Symmetry in Molecules and Crystals*, Chichester [England]: Ellis Horwood and New York: Halsted Press, 274 pp.

Lax, M. J. (1974) *Symmetry Principles in Solid State and Molecular Physics*, New York: Wiley, 1974, xi + 499 pp.

Ludwig, W. and Falter, C. (1988) *Symmetries in Physics: Group Theory Applied to Physical Problems*, Springer Series in Solid-State Sciences, Vol. 64, Berlin: Springer, xi + 461 pp.
* 2nd enlarged ed., ibid., 1996, xiii + 473 pp.

McWeeny, R. (1963) Symmetry: *An Introduction to Group Theory and its Applications*, *The International Encyclopedia of Physical Chemistry and Chemical Physics*, Topic 1, Mathematical Techniques, Vol. 3, New York: Macmillan and Oxford: Pergamon Press, xiv + 248 pp.

Mead, C. A. (1974) *Symmetry and Chirality*, Topics in Current Chemistry, Vol. 49, Berlin: Springer, iv + 88 pp.

Meyer, A. (1981) *Symmetriebeziehungen zwischen Kristallstrukturen*, Bände 1-2, [*Symmetry-Relations between Crystal-Structures*, Vols. 1-2, in German], Bochum, Drei-Eck-Verlag, 264 + 164 pp.

Miller, W., Jr. (1972) *Symmetry Groups and Their Applications*, Pure and Applied Mathematics, Vol. 50, New York: Academic Press, x + 432 pp.

Muck, A. (1987) *Symetrie krystalu a vibracní spektra*, [*Symmmetry of Crystals and Vibrational Spectra*, in Czech], Praha [Prague]: Státní nakladatelství technické literatury (SNTL), 266 pp.

- Polish trans., *Symetria kryształów a widma oscylacyjne*, Warszawa: Wydawnictwa Naukowo-Techniczne, 1992, 282 pp.

Schonland, D. S. (1965) *Molecular Symmetry: An Introduction to Group Theory and its Uses in Chemistry*, London: Van Nostrand, xii + 298 pp.

- French trans., *La Symétrie moléculaire: Introduction à la théorie des groupes et à ses applications à la chimie*, Paris: Gauthiers-Villars, 1971, xii + 336 pp.

Senechal, M (1990) *Crystalline Symmetries: An Informal Mathematical Introduction*, Bristol: Hilger, xii + 137 pp.

Slater, J. C. (1965) *Symmetry and Energy Bands in Crystals*, New York: McGraw-Hill, xii + 563 pp.

* Reprint ed., corrected, New York: Dover, 1972, xii + 563 pp.

Steinborn, D. (1993) *Symmetrie und Struktur in der Chemie*, [*Symmetry and Structure in Chemistry*, in German], Weinheim [Germany]: VCH, xv + 435 pp.

Vainshtein, B. K. (1979) *Sovremennaya kristallografiya*, Tom 1: Simmetriya kristallov, Metody strukturnoi kristallografii, [in Russian], Moskva: Nauka, 383 pp.

English trans , *Modern Crystallography 1:* Symmetry of Crystals, Methods of Structural Crystallography, Springer Series in Solid-State Sciences, Vol. 15, Berlin: Springer, 1981, xvii + 399 pp.

* English trans., 2nd enlarged ed., *Modern Crystallography* 1: Fundamentals of Crystals: Symmetry and Methods of Structural Crystallography, ibid., 1996, xxi + 482 pp.

Veen, A. L W. E. van der (1911) *Physish en kristallografish onderzoek naar de symmetry van diamant*, [*Physical and Crystallographic Investigation into the Symmetry of Diamond*, in Dutch], Leiden: Stijthoff, 58 pp. + 3 stereoscopic tables. [The Dutch spelling is archaic: the modern version of "symmetry" is "symmetrie", etc.].

Zheludev, I. S. (1976) *Simmetriya i ee prilozheniya*, [*Symmetry and its Applications*, in Russian], Moskva: Atomizdat, 286 pp.

* 2nd enlarged ed., Moskva: Énergoizdat, 1983, 303 pp.

- Japanese trans. of the 1st ed., *Taishousei to sono ouyou*, Tokyo: Koudansha, 1979, 303 pp.

Zheludev, I. S. (1987) *Fizika kristallov i simmetriya*, [*Physics of Crystals and Symmetry*, in Russian], Moskva: Nauka, 187 pp.

- German trans., *Kristallphysik und Symmetrie*, Berlin: Akademie-Verlag, 224 pp.

Zhuvikin, G. V. and Hefferlin, R (1994) *Symmetry Principles for Periodic Systems of Molecules*, Collegedale, Tennessee: Southern College, 84 pp. + 2 charts.

Also see:

* Burckhardt (1988) on the history of crystallography → Section 3.1,

* Scholz, E. (1989) on the history of crystallographic groups → Section 3.1,

* many textbooks → Section 1 3

3.2.1.1 Colored symmetry (a mathematical method for describing physical properties of crystals)

Jaswon, M. A. and Rose, M. A (1983) *Crystal Symmetry: Theory of Colour Crystallography*, Chichester [England]: Ellis Horwood and New York: Halsted Press, 190 pp.

Koptsik, V. A. (1966) *Shubnikovskie gruppy: Spravochnik po simmetrii i fizicheskim svoistvam kristallicheskikh struktur*, [*Shubnikov Groups* <Black-and-White Groups>: *A Handbook on Symmetries and Physical Properties of Crystal-Structures*, in Russian], Moskva: Izdatel'stvo Moskovskogo universiteta, 723 pp

Loeb, A. L (1971) *Color and Symmetry*, Wiley Monographs in Crystallography, New York: Wiley, xiii + 179 pp.

* Reprint ed , Huntington, New York: Krieger, 1978, xiii + 179 pp.

Shubnikov, A. V. (1951) *Simmetriya i antisimmetriya konechnykh figur*, [*Symmetry and Antisymmetry of Finite Figures*, in Russian], Moskva: Izdatel'stvo Akademii Nauk SSSR, 172 pp. [Antisymmetry = black-and-white or two-colored symmetry].

- English trans. in: Shubnikov, Belov, et al. (1964).

Shubnikov, A. V., Belov, N. V., et al. (1964) *Colored Symmetry*, Ed. by W. T. Holser, New York: Macmillan and Oxford: Pergamon Press, xxv + 263 pp. [The first part is the translation of Shubnikov (1951), the second part is based on the works by Belov et al].

Zamorzaev, A. M. (1976) *Teoriya prostoi i kratnoi antisimmetrii*, [*Theory of Simple and Multiple Antisymmetry*, in Russian], Kishinev [Moldavskoi SSR, now Moldova]: Shtiintsa, 283 pp. [Antisymmetry = black-and-white symmetry].

Zamorzaev, A. M., Galyarskii, E. I. and Palistrant, A. F. (1978) *Tsvetnaya simmetriya, ee obobshcheniya i prilozheniya*, [*Colored Symmetry, its Generalizations and Applications*, in Russian], Kishinev [Moldavskoi SSR, now Moldova]: Shtiintsa, 275 pp.

Zamorzaev, A. M., Karpova, Yu. S., Lungu, A. P., and Palistrant, A. F. (1986) *P-simmetriya i ee dal'neishee razvitie*, [*P-Symmetry and its Further Development*, in Russian], Kishinev [Moldavskoi SSR, now Moldova]: Shtiintsa, 154 pp. [P-symmetry is the generalization of colored symmetry].

Also see:

* Kumagai and Sawada (1983) → Section 1.1.3,

* Dubov et al. (1984-87, Vol. 3) → Section 1.2 2,

* Zamorzaev and Palistrant (1977) → Section 1 3,

* Jaskowski (1952) → Section 2 1 1,

* Shubnikov and Koptsik (1972) → Section 2 1 2,

* Jablan (1984), Lockwood and Macmillan (1978), Washburn and Crowe (1988) → Section 2 2.2,

* MacGillavry (1965), Schattschneider (1990) → Section 2 2 3,

* Vainshtein (1979) → Section 3.2 2.

Most of these books also present artistic examples (ornamental art, Escher's drawings, etc.). In connection with a fully artistic approach to color and symmetry, without any reference to crystallographic groups, see

* Plehn (1911) → Section 2 2 3

3.2.1.2 Orbital symmetry and other symmetry principles in the theory of chemical reactions

Bellamy, A. J. (1974) *An Introduction to Conservation of Orbital Symmetry: A Programmed Text*, [Series] Longman Text, London: Longman, x + 77 pp.

- German trans., *Lehrprogram Orbitalsymmetrie*, [*Study-Program Orbital Symmetry*, in German], Weinhem [Germany]: Verlag Chemie, 1974, vi + 107 pp.

Entwistle, N. (1972) *Orbital Symmetry Correlations in Organic Chemistry: A Guide to the Woodward-Hoffman Rules*, New York: Van Nostrand Reinhold, vii + 62 pp.

Gilchrist, T. L and Storr, R. C. (1972) *Organic Reactions and Orbital Symmetry*, Cambridge Chemistry Texts, Cambridge [England]. Cambridge University Press, viii + 271 pp.

* 2nd ed., ibid., 1979, vii + 311 pp.

Halevi, E. A. (1992) *Orbital Symmetry and Reaction Mechanism: The OCAMS View*, Berlin: Springer, xxii + 310 pp. [OCAMS = Optical Correspondence Analysis in Maximum Symmetry].

Lehr, R. E. and Marchand, A P. (1972) *Orbital Symmetry: A Problem-Solving Approach*, New York: Academic Press, x + 190 pp.

* British version, London: Academic Press, x + 190 pp.

Orchin, M. and Jaffé, H. H. (1971) *Symmetry, Orbitals, and Spectra (S.O.S)*, New York: Wiley, xiii + 396 pp.

- Japanese trans., *Kagaku ketsugouron: Bunshi kidou to taishousei*, [*Chemical Bound-Rule: Molecule Orbitals and Symmetry*, in Japanese], Tokyo: Baifuukan, 1974, 373 pp.

Orchin, M. and Jaffé, H. H. (1971) *Supplement for Symmetry, Orbitals, and Spectra: Problems and Answers*, [With the help of G. Kuehnlenz and R. Ellis], New York: Wiley, vii + 220 pp.

Pearson, R. G. (1976) Symmetry Rules for Chemical Reactions: Orbital Topology and Elementary Processes, New York: Wiley, ix + 548 pp.

- Russian trans., Pirson, R., *Pravila simmetrii v khimicheskikh reaktsiyakh*, Moskva: Mir, 1979.

Schipper, P. E. (1994) *Symmetry and Topology in Chemical Reactivity*, Singapore: World Scientific, xii + 272 pp.

Sunjic, V. (1979) *Simetrija granicnih orbitala i reaktivnost u organskoj kemiji*, [Symmetry of Limited Orbitals and Reactivity in Organic Chemistry, in Serbo-Croatian], Zagreb: Skolska knjiga, 150 pp.

Woodward, R B. and Hoffman, R. (1970) *The Conservation of Orbital Symmetry*, Weinhem [Germany]: Verlag Chemie, 177 pp. [Later both authors were awarded the Nobel Prize in Chemistry for related works.]

- German trans., *Die Enthaltung der Orbitalsymmetrie*, Weinhem [Germany]: Verlag Chemie, 1972, 177 pp.

3.2.3 Structure of matter - subatomic level; applications of mathematical methods in quantum theory and particle physics

Coleman, S. (1985) *Aspects of Symmetry: Selected Erice Lectures of Sidney Coleman*, Cambridge [England]: Cambridge University Press, xiv + 402 pp. [Physics].

Dyson, F. J. (1966) *Symmetry Groups in Nuclear and Particle Physics: A Lecture-Note and Reprint Volume*, Mathematical Physics Monographs Series, New York: Benjamin, xii + 320 pp. ["Sequel to The Eightfold Way edited by Gell-Mann and Ne'eman"].

Froggatt, C. D. and Nielsen, H. B. (1991) *Origins of Symmetries*, Singapore: World Scientific, x + 581 pp. [pp. 191-581 reprinted papers]. [Physics].

Lopes, J. L. (1969) *Lectures on Symmetry*, [Series] Documents on Modern Physics, New York: Gordon and Breach, xi + 170 pp.

Ne'eman, Y. (1979) *Symétries jauges et variétés de groupe*, [*Gauge Symmetries and Group Manifolds*, in French], Montréal. Presses de l'Université de Montréal, 141 pp. [Mathematical physics].

3.2.4 Astronomy, astrophysics

Banhatti, D. G. (1998) *Bilateral Symmetry in Active Galaxies*, Amsterdam: North-Holland, 182 pp.

Danver, C. G. (1942) *A Morphological Investigation of Some Near Galaxies, with Regards to the Lengths and the Form of Their Arms, Their Inclinations and Their Symmetry Properties*, Lund [Sweden]: Observatory, 192 pp.

Mozrzymas, J. and Wolanski, A (1993) *Harmonia sfer niebieskich i muzyka abstrakcyjnych symetrii*, [*The Harmony of Heavenly Spheres and the Music of Abstract Symmetry*, in Polish], Wroclaw: Leopoldinum, 1993, 148 pp.

3.2.5 Other mathematical-physical questions, applied mathematics

3.2.5.1 Geometry and algebra

Böhm, J. and Quaisser, E. (1990) *Schönheit und Harmonie geometrischer Formen: Spharoformen und symmetrische Körper*, [*Beauty and Harmony of Geometrical Figures: Spherical Figures and Symmetric Bodies*, in German], Berlin: Akademie-Verlag, 123 + xx pp.

Boltyanskii, V. G. and Vilenkin, N. Ya. (1967) *Simmetriya v algebre*, [*Symmetry in Algebra*, in Russian], Moskva: Nauka, 282 pp.

Johnston, B. L. and Richman, F. (1997) *Numbers and Symmetry: An Introduction to Algebra*, Boca Raton, Florida: CRC Press, 260 pp.

Lander, E. S. (1983) *Symmetric Designs: An Algebraic Approach*, London Mathematical Society Lecture Note Series, Vol. 74, Cambridge [England]: Cambridge University Press, xii + 306 pp. [Combinatorial configurations].

Miles, R. E. (1995) *Symmetric Bends: How to Join Two Lengths of Cord*, K & E Series on Knots and Everything, Vol. 8., Singapore: World Scientific, xii + 163 pp. [Mathematical Knot Theory].

Robertson, S. A. (1984) *Polytopes and Symmetry*, London Mathematical Society Lecture Note Series, Vol. 90, Cambridge [England]: Cambridge University Press, xv + 112 pp. [Polytope = higher dimensional polyhedron].

3.2.5.2 Mathematical analysis, theoretical mechanics, nonlinear mathematics, and related questions

Field, M (1996) *Lectures on bifurcation, dynamics and symmetry*, Pitman Research Notes in Mathematics, Vol. 356, Harlow: Longman, 159 pp.

Gaeta, G. (1994) *Nonlinear Symmetries and Nonlinear Equations*, Mathematics and its Applications, Vol. 299, Dordrecht [The Netherlands]: Kluwer, xix + 258 pp.

Garcia, N. M. L. (1985) *Simetria e periodicidade*, [*Symmetry and Periodicity*, in Portuguese], Lisboa: ED, v + 214 [Mathematics].

Garrett, R. (1987) *Symmetry of Sailing: The Physics of Sailing for Yachtsmen*, London: Adlard Coles Nautical, x + 268 pp.

* Paperback ed., ibid., 1995, x + 268 pp.

* American ed., Dobbs Ferry, New York: Sheridan House, 1996, x + 268 pp.

- Italian trans., Fisica della vela: La simmetria tra aerodinamica e idrodinamica nel movimento di un'imbarcazione, [Physics of Sailing: The Symmetry in Aerodynamics and Hydrodynamics in the Movement of a Boat, in Italian], Bologna: Zanichelli, 1990, 416 pp.

Holmes, P., Lumley, J. L., Berkooz, G. (1996) *Turbulence, Coherent Structures, Dynamical Systems, and Symmetry*, Cambridge Monographs on Mechanics, Cambridge [England]: Cambridge University Press, xviii + 420 pp.

Kavanau, J. L. (1980) *Symmetry: An Analytical Tratment*, Los Angeles: Science Software Systems, ca. 800 pages in various pagings. [Analytic geometry].

Kavanau, J. L. (1982) *Curves and Symmetry*, Los Angeles: Science Software Systems. [Analytic geometry].

Marsden, J. E., Montgomery R., and Ratiu, T. (1990) *Reduction, Symmetry, and Phases in Mechanics*, Memoirs of the American Mathematical Society, No. 436, Providence, Rhode Island: American Mathematical Society, iv + 110 pp.

Mitropolskii, Yu A. and Lopatin, A. K. (1995) *Nonlinear Mechanics, Groups and Symmetry*, Mathematics and its Applications, Vol. 319, Dordrecht [The Netherlands]: Kluwer, ix + 377 pp.

Olver, P. J. (1995) *Equivalence, Invariants, and Symmetry*, Cambridge [England]: Cambridge University Press, xvi + 525 pp. [Mathematical physics].

Sattinger, D. H. (1983) *Branching in the Presence of Symmetry*, CBMS-NSF Regional Conference Series in Applied Mathematics, Vol. 40, Philadelphia: Society for Industrial and Applied Mathematics, vii + 73 pp.

Vanderbauwhede, A. (1982) *Local Bifurcation and Symmetry*, Research Notes in Mathematics, Vol. 75, Boston: Pitman, 350 pp.

Yamashita, J. (1996) *Hoteishiki to taishousei*, [*Equations and Symmetry*, in Japanese], [Series] Suugaku a no tabi, Vol. 1, Kyoto: Gendai Suugakusha, 448 pp. [Mathematics].

Also see:

* the books on broken symmetry and asymmetry in physics → Sections 4.1 and 4.3,

* Petukhov (1981) on biomechanics → Section 3.3.3

3.3 Descriptive sciences (life sciences, earth sciences) and mathematical models in economics, medicine, and technology

3.3.1 Life sciences (biology, medicine, and psychology)

Charnov, E. L. (1993) *Life History of Invariants: Some Explorations of Symmetry in Evolutionary Ecology*, Oxford Series in Ecology and Evolution, Oxford: Oxford University Press, xv + 167 pp.

Chubarov, V. A. (1994) *Simmetrii litsa i traditsionnaya kitaiskaya meditsina*, [*Symmetries of the Face and Traditional Chinese Medicine*, in Russian], Sankt-Peterburg: Mezhdunarodyi tsentr ekonomiki, nauki i tekhniki, 206 pp.

Dubrov, A. P. (1980) *Simmetriya funktsional'nykh protsessov*, [*Symmetry of Functional Processes*, in Russian], Moskva: Znanie, 64 pp. [Biology, Biophysics - with some challenging ideas].

Dubrov, A. P. (1987) *Simmetriya bioritmov i reaktivnosti*, [in Russian], Moskva: Meditsina.

- English trans., *Symmetry of Biorhythms and Reactivity*, New York: Gordon and Breach, 1989, ix + 268 pp. [Biology, Biophysics - with some challenging ideas].

Jocobsohn-Lask, L. (1924) *Die Kreuzung der Nervenbahnen und die bilaterale Symmetrie des tierischen Körpers*, [The Crossing of Neural Pathways and the Bilateral Symmetry of the Animal Body, in German], Abhandlungen aus der Neurologie, Psychiatrie, Psychologie und ihren Grenzgebieten, Heft 26, Berlin: Karger, 125 pp

Jungnitsch, G. (1984) *Vergleichende Untersuchung bei vollsinnigen und geburtsblinden Personen an einer Form der Symmetrietauschung*, [*Comparative Study with Fully Sensible and Blind from Birth Persons on a Form of Symmetry-Illusion*, in German], Psychologia Universalis, No. 45, Bodenheim [at Frankfurt am Main]: Hain, 1984, 244 pp.

Malakhov, A. A. (1965) *L5-simmetriya zhizni*, [*L5-Symmetry of Life*, in Russian], Sverdlovsk [Russia]: Sredne-Ural'skoe knizhnoe izdatel'stvo, 60 pp. [L5-symmetry = 5-fold rotational symmetry].

McCall, J. J. (1997) *Search, Symmetry, and Arbitrage: A Unified Approach to the Social and Biological Sciences*, Boulder, Colorado: Westview Press.

Reader, J. and Croze, H. (1977) *Pyramids of Life: Illuminations of Nature's Fearful Symmetry*, Philadelphia: Lippincott, 222 pp. [Zoology, Animal ecology; "fearful symmetry" is a quote from W. Blake's poem *The Tyger* (1794); cf., Stewart and Golubitsky (1992) in Section 2.1.2, Zee (1986) in Section 3.2.2].

* British ed., *Pyramids of Life: An Investigation of Nature's Fearful Symmetry*, London: Collins, 1977, 222 pp.

Sukhanov, V. B. (1968) *Obshchaya sistema simmetrichnoi lokomotsii nazemnykh pozvonochnykh i osobennosti peredvizheniya nizshikh tetrapod*, [in Russian], Leningrad [now Sankt-Peterburg]: Nauka, 227 pp.

- English trans., *General System of Symmetrical Locomotion of Terrestrial Vertebrates and Some Features of Movement of Lower Tetrapods*, New Delhi: Amerind, [Published for the Smithsonian Institution and the National Science Foundation, Washington, D.C.], 1974, vii + 274 pp.

Sulima, Yu. G. (1970) *Biosimmetricheskie i bioritmicheskie yavleniya i priznaki u sel'skohozyaistvennykh rastenii*, [*Biosymmetrical and Biorhythmical Phenomena and Characteristics of Agricultural Plants*, in Russian], Kishinev [Moldavskoi SSR, now Moldova]: Izdatel'stvo Akademii Nauk Moldavskoi SSR, 148 pp.

Also see:

* Stewart and Golubitsky (1992) on mathematics and biology → Section 2.1 2,
* Urmantsev (1974) on philosophy and biology → Section 3.1,
* Tímár (1979) on Dürer's book on human proportions → Section 3 4.3, and
* the books on asymmetry in biology → Section 4 2.

There is a survey-booklet on symmetry in biology which is shorter than our limit of 50 pages:

* Kasinov, V. B. (1971) *O simmetrii v biologii*, [*On Symmetry in Biology*, in Russian], Leningrad [now Sankt-Peterburg]: Nauka, 48 pp.

3 3.2 Earth sciences (mineralogy and geology)

De Michele, V (1972) *Crystals. Symmetry in the Mineral Kingdom*, London: Orbis Books, 80 pp.

Makagonov, E. P. (1991) *Simmetriya srostkov mineralnykh individov*, [*Symmetry of Systems of Single Minerals*, in Russian], Moskva: Nauka, 193 pp.

Shafranovskii, I I. and Plotnikov, L. M. (1975) *Simmetriya v geologii*, [*Symmetry in Geology*, in Russian], Leningrad [now Sankt-Peterburg]: Nedra, 144 pp.

Ufimtsev, G. F. (1991) *Gornye poiasa kontinentov i simmetriya rel'efa zemli*, [*Mountain Belts of Continents and Symmetry of the Relief of the Earth*, in Russian], Novosibirsk: Nauka, 168 pp.

Yushkin [IUshkin], N. P., Shafranovskii, I. I., and Yanulov [IAnulov], K. P. (1987) *Zakony simmetrii v mineralogii*, [*Laws of Symmetry in Mineralogy*, in Russian], Leningrad [now Sankt-Peterburg]: Nauka, 333 pp.

3.3.3 Mathematical models in economics, medicine, and technology

Bobrowski, L. (1987) *Dyskryminacja symetriczna w rozpoznawaniu obrazów: Teoria, algorytmy, zastosowania w komputerowym wspomaganiu diagnostyki medycznej*, [*Symmetric Discrimination in Recognition of Images: Theory, Algorithms, Application in Computer-Assisted Medical Diagnostics*, in Polish], Wroclaw: Ossolineum, 170 pp.

Kholodnyi, V. A. and Price, J. V. (1998) *Foreign Exchange Option Symmetry*, Singapore: World Scientific, xvii + 134 pp. [Mathematical economics].

Petukhov, S. V. (1981) *Biomekhanika, bionika i simmetriya*, [*Biomechanics, Bionics, and Symmetry*, in Russian], Moskva: Nauka, 238 pp.

Sato, R. and Ramachandran, R V. (1998) *Symmetry and Economic Invariance: An Introduction*, Research Monographs in Japan-U.S. Business and Economics, Boston: Kluwer, viii + 134 pp. [Mathematical economics].

Tamari, B. (1997) *Conservation and Symmetry Laws and Stabilization Programs in Economics*, Jerusalem: Ecometry, 58 pp. [Mathematical economics].

Also see the following books that deal with some aspects of symmetry in technology,

* Povileiko (1970) → Section 1 2 7,
* Grigorovskii (1982) → Section 1.2 7,
* Shubnikov (1940) → Section 2.1 1,
* Rohde (1982) → Section 2.1.2,
* Bérczi (1986-87) → Section 2.2.3.

3.4 Art and the humanities

3.4.1 Anthropology

Lucich, P. (1987) *Genealogical Symmetry: Rational Foundations of Australian Kinship*, Armidale, New South Wales: Light Stone Publications, xxxi + 684 pp.

Witherspoon, G. and Peterson, G. (1995) *Dynamic Symmetry and Holistic Asymmetry in Navajo and Western Art and Cosmology*, American Indian Studies, Vol. 5, New York: Lang, x + 191 pp.

Also see:

* the books on pattern analysis → Sections 2 2 2 and 2.2 3.

In connection with physical anthropology, see:

* Tímár (1979) on Dürer's book on human proportions → Section 3 4.3,
* Schneider (1973) on asymmetry of Greek heads in art → Section 3.4 3,
* Chubarov (1994) on symmetry of the face and traditional Chinese medicine → Section 3.3 1,
* Anderson (1897), Mentzer and Friedberg (1983), Starosta (1990) on symmetry and physical education → Sec 3.5.

3 4.2 Architecture and design

Note that books on Hambidge's dynamic symmetry are listed separately in the → subsection 3.4.2.1.

Bibliography:

Stocklas, K., ed., (1986) *Symmetrie und Asymmetrie in der Architektur*, [*Symmetry and Asymmetry in Architecture*, in German], [Series] IRB-Literaturauslese, Fachbibliographie, No. 1192, Stuttgart: IRB [Informationszentrum Raum und Bau, Fraunhofer Gesellschaft], 64 pp.

* Stocklas, K., ed., 2nd revised ed., ibid., 1989, 40 pp.

* Stocklas, K., ed., 3rd revised ed., ibid., 1992, 54 pp.

* Hezel, D., ed., 4th revised ed., ibid., 1995, 71 pp.

Baglivo, J. A. and Graver, J. E. (1983) *Incidence and Symmetry in Design and Architecture*, Cambridge [England]: Cambridge University Press, xi + 306 pp.

García, S. (1681/1991) *Compendio de architectura y simetría de los templos: Conforme a la medida del cuerpo humano, con algunas demostraziones de geometría, año de 1681*, [*Summary of Architecture and Symmetry of the Temples: In Accordance with the Measurement of the Human Body, with Some Geometrical Demonstrations, Year of 1681*, in Spanish], Valladolid: Colegio Oficial de Arquitectos, Vols. 1-2. [Including the facsimile reproduction of Manuscript 8884 of the Biblioteca Nacional, Madrid; here "simetría" means proportion].

* Spanish text ed., *Compendio de architectura y simetría de los templos*, Salamanca: Hijos de Francisco Nuñez, 1941, 145 pp.

* Mexican text ed., *Compendio de arquitectura y simetría de los templos*, Churubusco, Mexico: Escuela Nacional de Conservación, Restauración y Museografía, 1979, 650 pp.

Hay, D. R. (1846) *First Principles of Symmetrical Beauty*, Edinburgh: Blackwood, viii + 88 pp., 100 plates. [Symmetry is "the result of harmonic ratio of numbers"; plane figures the bases of all forms, curvilinear figures; applications: ornamental design, Greek architecture, vases, pottery, etc.].

Kalayan, H. (1988) *The Architectural Information through Symmetry*, Amman: Department of Antiquities, The Hashimite Kingdom of Jordan, 89 pp.

Kambartel, W. (1972) *Symmetrie und Schönheit: Über mogliche Voraussetzungen des neueren Kunstbewusstseins in der Architekturtheorie Claude Perraults*, [*Symmetry and Beauty: On Possible Prerequisites of the New Artistic Consciousness in the Theory of Architecture of Claude Perrault*, in German], München: Fink, 179 pp.

Kask, T. (1971) *Symmetrie und Regelmässigkeit: Französische Architektur im "Grand Siècle"*, [*Symmetry and Regularity: French Architecture in the "Grand Siècle"*, in German], Basel: Birkhäuser, 157 pp.

Kurokawa, M. (1998) *Hantaishou no monogaku*, [*Objects* <Objectology, Object-Design> *of Antisymmetry* <Dissymmetry>, in Japanese], Tokyo: TOTO Shuppan, 162 pp. [The author (p. 54) would like to refer to dissymmetry (the lack of some elements of symmetry), but, unfortunataly, adopts the term hantaishou (antisymmetry), which is an alternative expression for black-and-white symmetry. This usage of hantaishou came from the Japanese translation of the book La Dissymétrie by Caillois (1973), see it in Section 4.1 with an additional note on this problem.] [Objectology or Object-Design is our suggested equivalent of Kurakowa's term monogaku or, in other reading, butsugaku. This term is not a well-established in Japanese; it is coming from *mono* or *butsu* = thing, object, *-gaku* = learning, study, science, (as suffix) -ology. Obviously, the term *monogaku* is broader than product-design and industrial design since objects of fine art and architecture are also considered. This is the reason that we initiate the new expressions objectology or object-design]

Also see:

Antisymmetry, Shubnikov (1951) → Section 3.2.1 1

Note, Caillois (1973) Japan version, → Section 4 1

Meunié, L. (1968) *L'Architecture et la géométrie. Symétries et rythmes harmoniques*, [*Architecture and Geometry· Symmetries and Harmonic Rhythms*, in French], Paris: Vincent, Fréal, 93 pp.

Ressa A (1990) *Chiese barocche in Piemonte: Nella evoluzione delle figure planimetriche a simmetria centrale*, [*Baroque Churches in Piemonte· On the Development of the Layout-Figures in Central Symmetry*, in Italian], Roma: Quasar, 210 pp.

Ruiz de la Roza, J. A. (1987) *Traza y simetría de la arquitectura: En la antiguedad y medievo*, [*Design and Symmetry of Architecture: In the Antiquity and the Middle Ages*, in Spanish], Sevilla: Servicio de Publicaciones de la Universidad, 393 pp.

Smolina, N. I. (1990) *Traditsii simmetrii v arkhitekture*, [*Traditions of Symmetry in Architecture*, in Russian], Moskva: Stroiizdat, 343 pp.

Stocklas, K (1986) - see at the beginning of this section: Bibliography.

Szambien, W. (1986) *Symétrie, goût, caractère: Théorie et terminologie de l'architecture à l'âge classique, 1550-1800*, [*Symmetry, Taste, Character: Theory and Terminology of Architecture in the Age of Classicism, 1550-1800*, in French], Paris: Picard, 232 pp.

- Spanish trans., *Simetría, gusto, carácter. Teoría y terminología de la arquitectura en la época clásica (1550-1800)*, Madrid: Akal, 299 pp.

Also see:

* Huff, W. S. (1967-77) on basic design → Section 1 1 3,

* Povileiko, R. P. (1970) on industrial design → Section 1.2.7,

* Horst (1994) on garden art → Section 3 4.3

3.4.2.1 Design with dynamic symmetry (a system of proportions based on square roots of integers)

Note that these books represent a method of proportional analysis of art works that are outdated in some sense, but still provide interesting sources not only for some historians of art, but also for educators of mathematics.

Bairati, C. (1952) *La simmetria dinamica: Scienza ed arte nell'architettura classica*, [*Dynamic Symmetry: Science and Art in Classical Architecture*, in Italian], Milano: Editrice Poltecnica Tamburini, 100 pp.

Edwards, E B. (1967) *Pattern and Design with Dynamic Symmetry*, New York: Dover, xx + 122 pp. [Reprint of the book Dynamarhythmic Design, 1932].

Hambidge, J. (1920) *Dynamic Symmetry: The Greek Vase*, New Haven, Connecticut: Yale University Press, 161 pp.

* 2nd printing, ibid., 1931, 161 pp.

* Reprint of the original work in a luxury ed., Found Class Reprints.

Hambidge, J. (1923) *Dynamic Symmetry in Composition as Used by the Artists*, New York: Brentano, 83 pp.

* Reprint ed., ibid., 1927, 83 pp.

* Reprint ed., New Haven, Conn.: Yale University Press, 1948, 83 pp.

Hambidge, J. (1924) *The Parthenon and Other Greek Temples: Their Dynamic Symmetry*, [With a preface by L D. Caskey], New Haven, Connecticut: Yale University Press, xxii + 103 pp.

- French trans., *Le Parthénon et autres tenples grecs: Leur symétrie dynamique*, Marseille: Aurea Carmina, 1995, 130 pp.

Hambidge, J. (1926) *The Elements of Dynamic Symmetry*, New Haven, Connecticut: Yale University Press and New York: Brentano, xx + 140 pp.

* Reprint ed., New Haven, Conn.: Yale University Press, 1948, xvii + 133 pp.

* Reprint ed., New York: Dover, 1967, xvii + 133 pp.

Hambidge, J. (1932) *Practical Applications of Dynamic Symmetry*, Ed. by M. C. Hambidge, New Haven, Connecticut: Yale University Press and London: Milford and Oxford University Press, xviii + 109 pp.

* Reprint ed., New Haven, Connecticut: Yale University Press, 1942, xviii + 109 pp.

* Reprint ed., New York: Devin-Adair, 1960, xviii + 109 pp.

Hèmbidzh, D. [Hambidge, J.] (1936) *Dinamicheskaya simmetriya v arkhitekture*, [*Dynamic Symmetry in Architecture*, in Russian], Moskva: Izdatel'stvo Vsesoyuznoi akademii arkhitektury, 1936, 202 pp. [Russian translation of some works by J. Hambidge]

Herter, C. (1966) *Dynamic Symmetry: A Primer*, New York: Norton, xiii + 236 pp.

Knee, K. M. (1988) *The Dynamic Symmetry Proportional System is Found in Some Byzantine and Russian Icons of the Fourteenth and Sixteenth Centuries*, Redondo Beach, California: Oakwood Publications, 86 leaves.

3 4.3 Visual art (painting, sculpture, garden art)

Biet, S. (1998) *Alexander Calder: Verborgene Symmetrie*, [*Alexander Calder Hidden Symmetry*, in German], Frankfurt am Main: Fischer, ii + 145 [+ 8] pp. [Calder's mobiles]

Funck-Hellet, C. (1950) *Composition et nombre d'or dans les oeuvres peintes de la Renaissance: Proportion, symétrie, symbolisme*, [*Composition and Golden Number in the Painted Works of the Renaissance: Proportion, Symmetry, Symbolism*, in French], Paris: Vincent, Fréal, 111 pp. [Some of the analyses are wayward]

Horst, A. J. van der (1994) *Speelse symmetrie in de tuin*, [*Playful Symmetry in the Garden*, in Dutch], Warnsveld, The Netherlands: Terra, 144 pp.

- French trans., *Jardins et symétrie*, [*Gardens and Symmetry*, in French], Paris: Abbeville, 1996, 144 pp.

- German trans., *Symmetrie im Garten: Spielerischer Umgang mit Gestaltungselementen*, [*Symmetry in the Garden: Playful Relations with Form-Elements*, in German], Hildesheim [Germany]: Gerstenberg, 1996, 144 pp.

Leonard, K. (1988) *How to Read a Painting: Lessons in Proportion, Balance and Symmetry*, Illustrated by W. Edwards, New Berlin, Wisconsin: Sax Arts and Crafts, 102 pp

Mohr, M. (1987) *Fractured Symmetry: Algorithmische Arbeiten / Algorithmic Works, 1967-1987*, [in German and English], Ludwigshafen [Germany]: Wilhelm-Hack-Museum, 119 pp. [Published for an art exhibition].

Scheibler, I. (1960) *Die symmetrische Bildform in der frühgriechischen Flächenkunst*, [*Symmetric Picture-Form in the Early Greek Art of Surface-Decoration*, in German], Kallmünz [Germany]: Lassleben, 131 pp.

Schneider, L. A. (1973) *Asymmetrie griechischer Kopfe vom 5. Jahrhundert bis zum Hellenismus*, [*Asymmetry of Greek Heads from the 5th Century [B.C.] to the Hellenism*, in German], Stuttgart: Franz Steiner, viii + 168 pp.

Tímár, L (1979) *Albrecht Dürer: Della simmetria dei corpi humani*, [in English], Budapest: Chemical Works of Gedeon Richter, 64 pp. [On Dürer's book on human proportions with many illustrations from the 1591 Italian ed. and 1613 French ed.].

- Hungarian version, ibid., 1979.

Also see:

* MacGillavry (1965) and Schattschneider (1990) on the graphic art of M C. Escher → Section 2 2.3,

* Witherspoon and Peterson (1995) on Navaho painting and its modern adaptation → Section 3.4 1,

* Kurokawa (1998) on dissymmetry in art → Section 3 4 2, and

* the books on dynamic symmetry → Section 3 4 2 1.

3.4.4 Music

Hofman-Jablan, J. (1995) *Simetrija muzickog dela*, [*Symmetry of Musical Work*, in Serbo-Croatian with an English abstract], Beograd. Zaduzbina Andrejevic, 159 pp.

- English trans., Abbreviated paper version, *Visual Mathematics*, [Electronic journal], Vol. 1, No. 1, http://www.mi.sanu.ac.yu/vismath/, http://members.tripod.com/vismath/.

Karakulov, B. I. (1989) *Symmetriya muzykalnoi sistemy: O melodii*, [*Symmetry of the Musical System: On the Melody*, in Russian], Alma-Ata [Kazakhskoi SSR, now Kazakhstan]: Nauka, 129 pp.

Lendvai, E. (1993) *Symmetries of Music: An Introduction to Semantics of Music*, Compiled and ed. by M. Szabó and M Mohay, Kecskemét [Hungary]: Kodály Institute, 155 pp.

- Hungarian trans., *Szimmetria a zenében*, Kecskemét [Hungary]: Kodály Intézet, 1994, 165 pp.

- German trans , *Symmetrien in der Musik: Einführung in die musikalische Semantik*, Kecskemét [Hungary]: Kodály Institut and Wien· Universal Edition, 1995, 173 pp.

Massenkeil, G. (1962) *Untersuchungen zum Problem der Symmetrie in der Instrumentalmusik W. A. Mozarts*, [*Studies on the Problem of Symmetry in the Instrumental Music of W. A. Mozart*, in German], Stuttgart: Franz Steiner, vii + 145 pp., 106 examples of notes.

Melchert, H. (1994) *Symmetrie· Form im Rezitativ der Bachschen Matthauspassion*, [*Symmetry: Form in the Recitative of Bach's* "St. *Matthew Passion*", in German], Ed. by R. Schaal, Veröffentlichungen zur Musikforschung, No. 17, Wilhelmshaven [Germany]. Noetzel, 96 pp., 28 examples of notes.

Schröder, H. (1902) *Symmetrische Umkehrung in der Musik: Ein Beitrag zur Harmonie- und Kompositionslehre, mit Hinweis auf die hier technisch notwendige Wiedereinführung antiker Tonarten im Style moderner Harmonik*, [*Symmetrical Inversion in Music. A Contribution to the Study of Harmony- and Composition-Theory with a Reference to the Here Technically Necessary Reintroduction of Ancient Keys in the Style of Modern Harmony*, in German], Publikationen der Internationalen Musikgesellschaft, Beihefte, Heft 8, Leipzig: Breitkopf und Härtel, 128 pp

* Reprint ed , Vaduz [Liechtenstein]: Sändig, 1973, 128 pp.

* Reprint ed., Walluf [at Wiesbaden, Germany]: Sandig, 1973, 128 pp.

Werker, W. (1922) *Studien über die Symmetrie im Bau der Fugen und die motivische Zusammengehorigkeit der Praludien und Fugen des "Wohltemperierten Klaviers" von Johann Sebastian Bach*, [*Studies on the*

Structural Symmetry in the Fugues and the Motivic Relationship between the Preludes and Fugues in Johann Sebastian Bach's "The Well-Tempered Clavier", in German], Leipzig: Breitkopf und Härtel, vii + 356 pp.

* Reprint ed., ibid., 1969, 356 pp.

* Reprint ed., Vaduz [Liechtenstein]: Sändig, 1984, 354 pp.

Also see:

* Goncharenko (1993) → Section 1.2.8.

3.4.5 Literature and linguistics

Eggers, H. (1956) *Symmetrie und Proportion epischen Erzahlens: Studien zur Kunstform Hartmanns von Aue*, [*Symmetry and Proportion of Epic Short Stories: Studies of Hartmann von Aue's Artistic Form*, in German], Stuttgart: Klett, 101 pp.

Étkind, E. G. (1988) *Simmetricheskie kompozitsii u Pushkina*, [*Symmetrical Compositions at Pushkin*, in Russian], Parizh [Paris]: Institut d'études slaves, 84 pp.

Gibson, J. M. (1890s-?) *The Unity and Symmetry of the Bible*, New York: Hodder and Stoughton, viii + 125 pp.

* Microfiche ed., Chicago: American Theological Library Association, 1985.

Fedynyshynets, V. (1989) *Symetriya poezii: Khudozhnie oformlennya avtora*, [*Symmetry of Poetry: Artistic Presentation of the Author*, in Ukrainian], Uzhhorod [Ukraine]: Karpaty, 93 pp.

Greenberg, M. (1986) *Corneille, Classicism, and the Ruses of Symmetry*, Cambridge [England]: Cambridge University Press, xv + 189 pp.

Knight, W. F. J. (1939) *Accentual Symmetry in Vergil*, Oxford: Blackwell, x + 107 pp.

* Reprint ed., [Series] Garland Library of Latin Poetry, New York: Garland, 1979, x + 107 pp.

Konstan, D. (1994) *Sexual Symmetry: Love in the Ancient Novel and Related Genres*, Princeton: Princeton University Press, xiii + 270 pp.

Longobardi, G. (1988) *Symmetry Principles in the Theory of Syntax*, [Series] Quaderni patavini di linguistica, Monografie, 4, Padova, Italy: Unipress, ii + 123 pp.

Montgomery, R. L., Jr. (1961) *Symmetry and Sense: The Poetry of Sir Philip Sidney*, New York: Greenwood Press, vii + 134 pp.

* Reprint ed., ibid., 1969, vii + 134 pp.

Norrman, R. (1998) *Wholeness Restored: Love of Symmetry as a Shaping Froce in the Writings of Henry James, Kurt Vonnegut, Samuel Butler and Raymond Chandler*, Frankfurt am Main: Lang, 283 pp.

Schlocker G. (1957) *Équilibre et symétrie dans la phrase française moderne*, [*Equilibrium and Symmetry in Modern French Phrase*, in French], Paris: Klincksieck, 124 pp.

Also see:

* Markova (1996) → Section 1 2 8,

* the books on broken symmetry and asymmetry in linguistics, literature, and semiotics → Section 4.4.

3.5 Recreation, games, and sport

Anderson, W. G. (1897) *Anderson's Physical Education: Health and Strength, Grace and Symmetry*, New York: Dana, 102 pp.

Mentzer, M. and Friedberg, A (1983) *Mike Mentzer's Spot Bodybuilding: A Revolutionary New Approach to Body Fitness and Symmetry*, New York: Simon and Schuster, 111 pp.

Starosta, W. (1990) *Symetria i asymetria ruchów w treningu sportowym*, [*Symmetry and Asymmetry of Motions in Physical Training*, in Polish], Warszawa: Institut Sportu, 320 pp

Sveton, E. (1989) *Symetria: Súbor hier pre deti, mládez a dospelych*, [*Symmetry: A Set of Games for Children, Youth and Adults*, in Slovakian], Bratislava [Czechoslovakia, now Slovakia]: Slovenske pedagogické nakladatelstvo, 281 pp. + 2 attachments [Board games].

Also see:

* Garrett (1987) on the physics of sailing → Section 3 2 5 2.

There is a booklet on symmetry in chess which is shorter than our limit of 50 pages:

* Zavodny, Z (1991) *Symetrické pescove formace v centru*, [*Symmetric Pawn Formation in the Center*, in Czech], [Series] Sachove strategie, Frydek-Místek [Czechoslovakia, now Czech Republic]: Pliska, 47 pp.

4 INTERDISCIPLINARY BOOKS ON DISSYMMETRY, BROKEN SYMMETRY, ASYMMETRY (INCLUDING SYMMETRY VS. ASYMMETRY, ASYMMETRY OF BRAIN, AND ASYMMETRY OF TIME)

Note the differences between these concepts:

(1) dissymmetry is the lack of some elements of symmetry (cf., Pasteur's molecular dissymmetry: the lack of some elements of symmetry is necessary to have left- and right-handed molecules) or the small deviation from the perfect symmetry (cf., P. Curie's principle of dissymmetry),

(2) broken symmetry is the occasional violation of an existing or suspected symmetry (cf., Lee and Yang's broken symmetry in particle physics),

(3) asymmetry is the total lack of symmetry.

(In connection with antisymmetry, or black-and-white symmetry, in crystallography, cf., Shubnikov (1951) in Section 3.2.1.1.).

4.1 General

Akopyan, I. D. (1980) *Simmetriya i asimmetriya v poznanii*, [*Symmetry and Asymmetry in Cognition*, in Russian], Erevan, Armenia: Izdatel'stvo Akademii Nauk Armyanskoi SSR, 132 pp.

Caglioti, G. (1983) *Simmetrie infrante nella scienza e nell'arte*, [*Broken Symmetries in Science and Art*, in Italian], [With a preface by P. Fenoglio], Milano: CLUP, 182 pp.

- German trans., *Symmetriebrechung und Wahrnehmung: Beispiele aus der Erfahrungswelt*, [*Symmetry-Breaking and Perception· Examples from the Empirical World*, in German], [With a new preface by H. Haken], Braunschweig. Vieweg, 1990, x + 200 pp.

- English trans., *The Dynamics of Ambiguity*, [With a new preface by H. Haken], Berlin: Springer, 1992, xx + 170 pp.

- Japanese trans. of the English version, *"Aimaisa" no butsurigaku: Chitsujo to muchitsujo no adida o toraeru atarashi kokoromi*, [*The Physics of "Ambiguity": A New Trial to Grasp the Gap of Order and Disorder*, in Japanese], [With a new preface by K. Hushimi (Husimi)], [Series] Blue Backs / Buruu bakkusu, B-1159, Tokyo: Koudansha, 1997, 243 + 5 pp.

- Russian trans. of the English version, Kal'oti, D , *Ot vospriyatiya k mysli: O dinamike neodnoznachnogo i narusheniyakh simmetrii v nauke i iskusstve*, [*From Perception to Thought On Dynamics of Ambiguity and Violations of Symmetry in Science and Art*, in Russian], [With a new preface by I. Prigozhin (I. Prigogine) and an introduction and an afterword by V. A Koptsik], Moskva: Mir, 1998, 222 pp.

Caillois, R. (1973) *La Dissymétrie*, [*Dissymmetry*, in French], Paris: Gallimard, 90 pp.

* Cf., *Cohérences aventureuses; Au coeur du fantastique; La Dissymétrie: esthétique généralisée*, [*Adventurous Coherences; A Fantastic Heart; Dissymmetry: Generalized Aesthetics*, in French - three works in one volume], Idées, Vol. 359, New edition, Paris: Gallimard, 1976, 281 pp.

Gardner, M. (1964) *The Ambidextrous Universe. Left, Right, and the Fall of Parity*, New York· Basic Books, x + 294 pp. [Popular-scientific, see the reference to "asymmetry" in the subtitles of the 2nd and 3rd eds.].

* British reprint ed., London: Allen Lane, Penguin Press, 1967, 272 pp

* British reprint ed., Harmondsworth [England]: Penguin Books, [Series] Pelican Books, 1970, 276 pp.

* 2nd revised ed., *The Ambidextrous Universe: Mirror Asymmetry and Time-Reversed Worlds*, New York: Scribner, 1979, 293 pp.

* British reprint ed., Harmondsworth [England]: Penguin Books, 1982, 293 pp.

* 3rd revised ed., *The New Ambidextrous Universe: Symmetry and Asymmetry from Mirror Reflections to Superstrings*, New York: Freeman, 1990, xiv + 392 pp.

* Paperback ed., ibid., 1991, xiv + 392 pp

- Japanese trans., *Hantaishou: Hidari to migi no benshouhou*, [*Antisymmetry* <Dissymmetry>: *The Dialectics of Left and Right*, in Japanese], Tokyo: Shisakusha, 1991, 152 pp. [The Japanese title Hantaishou (han- = anti-, against, opposite; taishou = symmetry), which is also adopted by Kurokawa (1998), see in Section 3.4.2, is unfortunate: its meaning is closer to the crystallographic term "antisymmetry" (black-and-white symmetry), cf., Shubnikov (1951) in Section 3.2.1.1. Since there is no well-estbalished Japanese term for dissymmetry in the given sense, I suggest a new Japanese expression: futaishou.].

Spanish trans. of the 1st ed., *Izquierda y derecha en el cosmos*, [*Left and Right in the Cosmos*, in Spanish]. Madrid: Alianza, 1966, 310 pp

* Spanish reprint ed., Estella: Salvat, 1973, 316 pp.

* Spanish trans. of the 2nd ed., *Izquierda y derecha en el cosmos: Simetría y asimetría frente a la teoría de la inversión del tiempo*, [*Left and Right in the Cosmos: Symmetry and Asymmetry Facing the Theory of the Inversion of Time*, in Spanish], Barcelona: Salvat, 1985, xiii + 309 pp

* Spanish trans. of the 3rd ed., *El universo ambidiestro: Simetrías y asimetrías en el cosmos*, [*Ambidextrous Cosmos: Symmetry and Asymmetry in the Cosmos*, in Spanish], Barcelona: Labor, 1993, 343 pp.
* Spanish reprint ed., Barcelona: RBA, 1994.

- Swedish trans. of the 1st ed., *Skapelsens symmetri*, [*Symmetry of Creation*, in Swedish], Stockholm: Rabén och Sjögren, 1966, 272 pp.

- German trans. of the 1st ed , *Das gespiegelte Universum: Links, rechts und der Sturz der Parität*, [*The Mirrored Universe: Left, Right and the Fall of Parity*, in German], Braunschweig: Vieweg, 1967, 285 pp.

* German revised and enlarged ed., *Unsere gespiegelte Welt: Denksportaufgaben und Zaubertricks*, [*Our Mirrored World: Puzzle-Problems and Magic Tricks*, in German], Berlin: Ullstein, 1982, 344 pp.
* German reprint ed., Berlin: Deutsche Buch-Gemeinschaft [with Austrian, German, and Swiss partners], 1984, 344 pp.

- Russian trans. of the 1st ed., *Étot pravyi, levyi mir*, [*This Right, Left World*, in Russian], Ed. by Ya. A. Smorodinskii, Moskva: Mir, 1967, 264 pp.

- Lithuanian trans. of the 1st ed., Vilnius: Mintis, 1969, 288 pp.

- Polish trans. of the 1st ed., *Zwierciadlany wszechswiat*, [*Mirrored Universe*, in Polish], [Series] Biblioteka problemów, No. 138, Warszawa: Panstwowe Wydawnictwo Naukowe (PWN), 1969, 354 pp.

Japanese trans. of the 1st ed., *Shizen ni okeru hidari to migi*, [*Left and Right in Nature*, in Japanese], Tokyo: Kinokuniya Shoten, 1971, 340 pp.

* Japanese reprint eds., ibid., 340 pp.

* Japanese trans. of the 3rd ed., *Shizen ni okeru hidari to migi: Shinpan*, [*Left and Right in Nature*: New Edition, in Japanese], ibid., 1992, vii + 500 pp.

- Italian trans. of the 2nd ed., *L' universo ambidestro: Nel mondo degli specchi, delle asimmetrie, delle inversioni temporali*, [*The Ambidextrous Universe· In the World of Mirrors, Asymmetries, Temporal Inversions*, in Italian], Bologna: Zanichelli, 1984, x + 245 pp.
* Italian reprint ed., Novara: Mondadori-De Agostini, 1996, viii + 244 pp.

- French trans. of the 2nd ed., *L'Univers ambidextre: Les Miroirs de l'espace-temps*, [*The Ambidextrous Universe: The Mirrors of the Space-Time*, in French], Paris: Seuil, 1985, 357 pp.
* French reprint ed , ibid., 1994, 357 pp.

- Dutch trans. of the 2nd ed., Revised, co-author Beekman, G., *Spiegelsymmetrie: Links en rechts in de natuur*, [*Mirror-Symmetry Left and Right in Nature*, in Dutch], Amsterdam: Aramith, 1986, 222 pp.

Genz, H and Decker, R. (1991) *Symmetrie und Symmetriebrechung in der Physik*, [*Symmetry and Symmetry-Breaking in Physics*, in German], Braunschweig: Vieweg, 376 pp.

Mayer-Kuckuk, T. (1989) *Der gebrochene Spiegel: Symmetrie, Symmetriebrechung und Ordnung in der Natur*, [*The Broken Mirror Symmetry, Symmetry-Breaking, and Order in Nature*, in German], Basel: Birkhäuser, 264 pp

Shubnikov, A. V. (1961) *Problema dissimmetrii material'nykh ob'ektov*, [*The Problem of Dissymmetry of Material Objects*, in Russian], Moskva: Izdatel'stvo Akademii Nauk SSSR, 55 pp

Sonin, A. S. (1987) *Postizhenie sovershenstva: Simmetriya, asimmetriya, dissimmetriya, antisimmetriya*, [*Comprehension of Perfectness· Symmetry, Asymmetry, Dissymmmetry, Antisymmetry*, in Russian], Moskva: Znanie, 203 pp.

Tayler, K. (1989) *Symmetry and Antisymmetry*, Cambridge [England]: Haslingfield Press, 111 pp. [Symmetry vs. antisymmetry = continuity vs. discontinuity, convergence vs. divergence, variance vs. invariance, etc. - this is not the usual crystallographic or mathematical meaning of antisymmetry].

Also see:

* Witherspoon and Peterson (1995) on symmetry and asymmetry in Navaho art and cosmology → Section 3.4 1,
* Stocklas (1986) on symmetry and asymmetry in architecture → Section 3.4 2,
* Kurokawa (1998) on dissymmetry in design → Section 3 4 2,
* Mohr (1987) on fractured symmetry in his art works → Section 3.4 3

4.2 Chemistry and biology, including asymmetry of brain

Brain asymmetry - there are many related books that use other expressions (cerebral dominance, dual brain, hemispheric lateralization, split brain, etc.); in accordance with the principles of this bibliography, such items are not listed (their data are available in the bibliographies of the listed books).

Bibliography:

Cohen, S. (1992) *Handedness, Cerebral Dominance and Brain Asymmetry in Nonhuman Primates: A Bibliography*, 1985-1991, Seattle, Washington: Primate Information Center, Regional Primate Research Center, University of Washington, 16 pp.

Bentley, R. (1969-70) *Molecular Asymmetry in Biology*, Vols 1-2, New York: Academic Press, xii + 322 + xiii + 566 pp.

Bianki, V. L. (1985) *Asimmetriya mozga zhivotnykh*, [*Asymmetry of the Brain of Animals*, in Russian], Leningrad [now Sankt-Peterburg]: Nauka, 295 pp.

Bradshaw, J. L. and Nettleton, N. C. (1983) *Human Cerebral Asymmetry*, Englewood Cliffs, New Jersey: Prentice-Hall, xvi + 335 pp.

Bragina, N. N. and Dobrokhotova, T. A. (1981) *Funktsional'nye asimmetrii cheloveka*, [*Functional Asymmetries of the Human*, in Russian], Moskva: Meditsina, 288 pp.
* 2nd revised ed., ibid., 1988, 237 pp.

Bryden, M. P. (1982) *Laterality: Functional Asymmetry in the Intact Brain*, New York: Academic Press, xiii + 319 pp.

Cohen, S. (1992) - see at the beginning of this section: → Bibliography.

Depenchuk, N. P. (1963) *Simmetriya i asimmetriya v zhivoi prirode*, [*Symmetry and Asymmetry in Living Nature*, in Russian], Kiev: Izdatel'stvo Akademii Nauk Ukrainskoi SSR, 174 pp.

Gâlaktionov, S G. (1978) *Asimmetriya biologicheskikh molekul*, [*Asymmetry of Biological Molecules*, in Russian], Minsk [Belorusskoi SSR, now Belarus]: Vyshèishaya shkola, 175 pp. [Popular-scientific].

Gauze, G. F. (1940) *Asimmetriya protoplazmy*, [*Asymmetry of the Protoplasm*, in Russian], Moskva: Izdatel'stvo Akademii Nauk SSSR, 126 pp.

Hellige, J. B. (1993) *Hemispheric Asymmetry: What's Right and What's Left*, Cambridge, Massachusetts: Harvard University Press, xiii + 396 pp.

Kizel', V. A. (1985) *Fizicheskie prichiny dissimmetrii zhivykh sistem*, [*Physical Causes of Dissymmetry of Living Systems*, in Russian], Moskva: Nauka, 118 pp.

Kuroda, R (1992) *Seimei sekai no hitaishousei: Shizen wa naze anbaransu ga suki ka*, [*Asymmetry of the Living World: Why Does Nature Like Imbalance?*, in Japanese], [Series] Chuukou shinsho, No. 1097, Tokyo: Chuuou Kouronsha, 216 pp. [Popular-scientific].

* Reprint ed., ibid., 1995.

Moller, A. P and Swaddle, J. P (1997) *Asymmetry, Developmental Stability, and Evolution*, Oxford: Oxford University Press, xi + 291 pp.

Neville, A. C. (1976) *Animal Asymmetry*, The Institute of Biology's Studies in Biology, No. 67, London: Arnold, 60 pp.

Saito, Y. (1979) *Inorganic Molecular Dissymmetry*, Inorganic Chemistry Concepts, Vol. 4, Berlin: Springer, ix + 167 pp

Vartanian, G. A and Klementev, B. I. (1991) *Khimicheskaya simmetriya i asimmetriya mozga*, [*Chemical Symmetry and Asymmetry of the Brain*, in Russian], Leningrad [now Sankt-Peterburg]: Nauka, 150 pp.

Yanagisawa, K. (1997) *Sayuu o kimeru idenshi: Karada no hitaishousei wa neze shoujiru no ka*, [*The Gene Determines Left-Right: Why Does the Asymmetry of the Body Arise?*, in Japanese], Blue Backs / Buruu bakkusu, B-1155, Tokyo· Koudansha, 200 + vi pp. [Popular-scientific].

Also see:

* Hámori (1996) on brain asymmetries → Section 1 2.5,

* Schneider (1973) on asymmetry of Greek heads in art → Section 3 4 3,

* Starosta (1990) on symmetry and asymmetry in physical training → Section 3.5,

* Ivanov (1978) on the asymmetry of brain → Section 4.4.

4.2.1 Asymmetric synthesis

Ager, D. and East, M B. (1996) *Asymmetric Synthesis Methodology*, [Series] New Directions in Organic and Biological Chemistry, Boca Raton, Florida. CRC Press, 483 pp.

Coppola, G. M. and Schuster, H. F. (1987) *Asymmetric Synthesis: Construction of Chiral Molecules Using Amino Acids*, New York: Wiley, xiii + 393 pp.

Gawley, R. E. and Aube, J. (1996) *Principles of Asymmetric Synthesis*, Tetrahedron Organic Chemistry Series, Vol. 14, Oxford: Pergamon Press, x + 372 pp.

Klabunovskii, E. I. (1960) *Asimmetricheskii sintez*, [*Asymmetric Synthesis*, in Russian], Moskva: Gosudarstvennoe nauchno-tekhnicheskoe izdatel'stvo khimicheskoi literatury, 229 pp.

Klabunovskii, E. I. and Vedenyapin, A. A. (1980) *Asimmetricheskii kataliz: Gidrogenizatsiya na metallakh*, [*Asymmetric Catalysis: Hydregenization on Metals*, in Russian], Moskva: Nauka, 200 pp.

Koskinen, A. (1993) *Asymmetric Synthesis of Natural Products*, Chichester [England]: Wiley, xiii + 234 pp.

Mikolajczyk, M., Drabowicz, J., and Kielbasinki, P. (1997) *Chiral Sulfur Reagents: Applications in Asymmetric Synthesis and Stereoselective Synthesis*, [Series] New Directions in Organic and Biological Chemistry, Boca Raton, Florida: CRC Press,

Morrison, J. D. and Mosher, H. S. (1971) *Asymmetric Organic Reactions*, Prentice-Hall International Series in Chemistry, Englewood Cliffs, New Jersey: Prentice-Hall, xii + 465 pp.

* 2nd revised printing, Washington, D.C.: American Chemical Society, 1976, xii + 465 pp.

- Japanese trans., *Fusei gousei*, [*Asymmetric Synthesis*, in Japanese], Tokyo: Toukyou Kagaku Doujin, 1973, xi + 487 pp.

- Russian trans., Morrison, D. and Mosher, G., *Asimmetrichnye organicheskie reaktsii*, Ed. by E I Klabunovskii, Moskva: Mir, 1978.

Noyori, R. (1994) *Asymmetric Catalysis in Organic Synthesis*, [Series] George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University, New York: Wiley, xvii + 378 pp.

Procter, G. (1996) *Asymmetric Synthesis*, New York: Oxford University Press, vi + 237 pp.

Ritchie, P. D. (1933) *Asymmetric Synthesis and Asymmetric Induction*, London: Oxford University Press Seyden-Penne, J Synthesis et catalyse asymmetriques,

- English trans., *Chiral Auxiliaries and Ligands in Asymmetric Synthesis*, [With trans. and scientific assistance from D. P. Curran], New York: Wiley, 1995, xx + 716 pp.

4.3 Mathematics and physics, including asymmetry of time

Boccara, N. (1976) *Symétries brisées· Théorie des transitions avec paramètre d'ordre*, [*Broken Symmetries· Theory of Transitions with Parameter of Order*, in French], Actualités scientifiques et industrielles, Vol. 1378, Paris: Hermann, 274 pp.

Chossat, P. (1996) *Symétries brisées*, [*Broken Symmetries*, in French], Paris· Pour la Science, 112 pp

Davies, P. C. W. (1974) *The Physics of Time Asymmetry*, Berkeley· University of California Press, xviii + 214 pp.

* Paperback ed., ibid., 1977, xviii + 214 pp.

Japanese trans., *Jikan no butsurigaku: Sono hitaishousei*, [*The Physics of Time: Its Asymmetry*, in Japanese], Tokyo: Baifuukan, 1979, xiv + 219 pp

* Reprint ed , ibid , 1982, xiv + 219 pp.

Forster, D. (1975) *Hydrodynamic Fluctuations, Broken Symmetry, and Correlation Functions,* Frontiers in Physics, Vol 47, Reading, Massachusetts: Benjamin, xix + 326 pp.

* Reprint ed., Redwood City, California: Addison-Wesley, 1989, xxiv + 326 pp.

Knops, H. J. F. (1969) *Ergodic Sates and Symmetry Breaking in Phase Transitions: C* Algebra Approach,* [With a Dutch summary], Tilburg, The Netherlands: Gianotten, 121 pp. [Mathematical physics].

Horwich, P. (1987) *Asymmetries in Time: Problems in the Philosophy of Science*, Cambridge, Massachusetts: MIT Press, xiii + 218 pp.

- Japanese trans., *Jikan ni muki wa aruka, [Is There Direction in Time?*, in Japanese], Tokyo: Maruzen, 1992, viii + 355 pp.

Lautman, A. (1946) *Symétrie et dissymétrie en mathématiques et physique: La Problème du temps, [Symmetry and Dissymmetry in Mathematics and Physics: The Problem of Time*, in French], Actualités scientifiques et industrielles, No. 1012· Essais philosophiques, No. 3, Paris: Hermann, 50 pp.

Lee, T. D. (1988) *Symmetries, Asymmetries, and the World of Particles*, Seattle, Washington: University of Washington Press, xii + 66 pp.

- Chinese trans., Li Zheng Dao, [Lee, Tseng Dao], *Dui chen, bu dui chen he li zi shi jie,* 1993, 101 pp.

Also see:

* Pagels (1986) on the beginning of time in an astrophysical sense → Section 3 2 1.

4.4 Linguistics, literature, semiotics

Andrews, E. (1990) *Markedness Theory: The Union of Asymmetry and Semiosis in Language, Sound and Meaning*. The Roman Jakobson Series in Linguistics and Poetics, Durham, N.C.: Duke University Press, viii + 220 pp.

Fido, F. (1988) *Il regime delle simmetrie imperfette· Studi sul "Decameron", [The Rule of Imperfect Symmetries: Study of the "Decameron"*, in Italian], Milano: Angeli, 151 pp.

Freund, J. (1991) *Broken Symmetries: A Study of Agency in Shakespeare's Plays*, Worcester Polytechnic Institute Studies in Science, Technology, and Culture, Vol. 8, New York: Lang, xvii + 214 pp.

Heintz, J. (1973) *Subjects and Predicables: A Study in Subject-Predicate Asymmetry*, Janua Linguarum, Series Minor, Vol. 79, The Hague: Mouton, 103 pp.

Ivanov, V V (1978) *Chetnoe i nechetnoe: Asimmetriya mozga i znakovykh sistem, [Even and Odd: The Asymmetry of the Brain and Sign-Systems*, in Russian], Moskva: Sovietskoe radio, 184 pp.

- German trans., *Gerade und Ungerade: Die Asymmetrie des Gehirns und der Zeichensysteme,* Stuttgart: Hirzel, 1983, 221 pp.

- Hungarian trans., *Páros és páratlan: Aszimmetria az agyban és a jelrendszerben*, Budapest: Kozmosz, 1986, 263 pp.

- Japanese trans., *Guusuu to kisuu no kigouron: Nou to shokigou shisutemu no hitaishou, [The Semiotics of Even and Odd The Asymmetry of the Brain and Various Semiotical Systems*, in Japanese], Tokyo: Aoki Shoten, 1988, xv + 261 + 7 pp.

Kadmon, N. (1992) *On unique and non-unique reference and asymmetric quantification,* Outstanding Dissertations in Linguistics, New York: Garland, vii + 377.

Lotman, J M. [Lotman, Yu. M.] (1985) *La semiosfera L'asimmetria e il dialogo nelle strutture pensanti, [The Semiosphere. The Asymmetry and the Dialogue in the Structures of Thinking*, in Italian], Venezia· Marsilio, 311 pp.

Marácz, L. K. (1991) *Asymmetries in Hungarian, Donostia* (San Sebastian) [Basque County, Spain]: Gipuzkoako Foru Aldundia (Deputación Foral de Gipuzkoa), 334 pp.

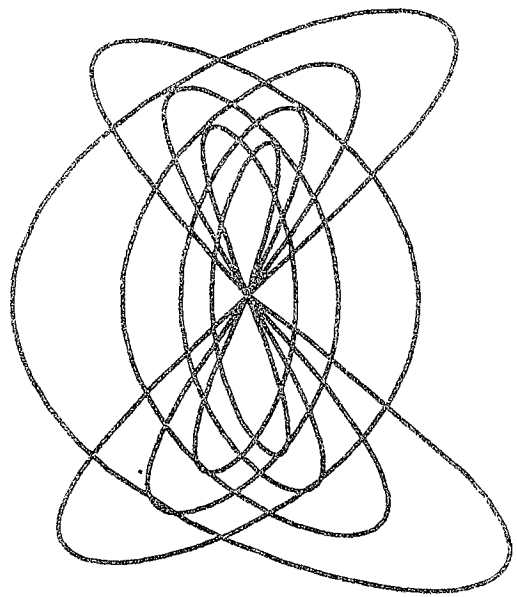
Rokoszowa, J. (1989) *Czas a jezyk: O asymetrii regól jezykowych, [Time and Language· On Asymmetry of Lingual Rules*, in Polish with an English summary], [Series] Rozprawy habilitacyjne, Uniwersytet Jagellonski, Nr. 169, Kraków: Nakl. Uniwersytetu Jagellonskiego, 126 pp.

Shapiro, M. (1976) *Asymmetry· An Inquiry into the Linguistic Structure of Poetry*, North-Holland Linguistic Series, Vol. 26, Amsterdam: North-Holland, xiv + 231 pp.

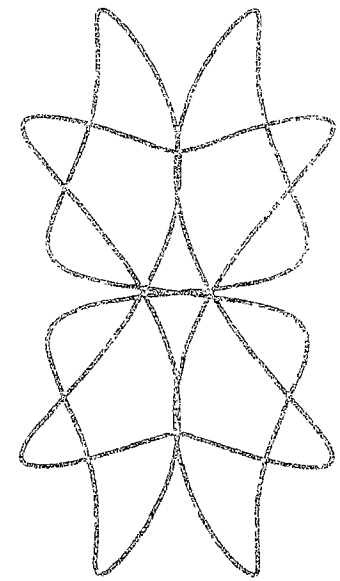
Spillner, B. (1971) *Symmetrisches und asymmetrisches Prinzip in der Syntax Marcel Prousts, [Symmetric and Asymmetric Principle in the Syntax of Marcel Proust*, in German], Frankfurt am Main: Hain, xii + 223 pp.

ADVISORY BOARD

ISIS-Symmetry
Budapest, P.O Box 994
H-1245 Hungary



Symmetry



ISIS-Symmetry
Budapest, P.O Box 994
H-1245 Hungary