SRYAHWA PUBLICATIONS

Open Access Journal of Physics
ISSN: 2637-5826 | Volume 8, Issue 1, 2026
https://doi.org/10.22259/2637-5826.0801004

RESEARCH ARTICLE

The Pasteur Racemic Mixture: Entanglement Interpreted as the Optical Isomerism

Jiří STÁVEK

Independent researcher, Prague, Czech Republic.

Received: 26 December 2025 Accepted: 13 January 2026 Published: 16 January 2026

Corresponding Authors: Jiří STÁVEK, Independent researcher, Prague, Czech Republic.

Abstract

We describe entanglement as a racemic mixture that has an equal amount (50 : 50) of left- and right-handed enantiomers. Louis Pasteur separated two enantiomeric isomers in 1848. Therefore, we want to introduce the Pasteur racemic sphere where all antipodes on this sphere represent the strong anticorrelation of enantiomers (anticorrelated singlet state). This strong anticorrelation is expressed via the trigonometric functions: the versine2θ = 2 sin2θ and the vercosine2θ = 2 cos2θ for the central angle 2θ in the unit circle with R = 1. These trigonometric functions describe the active surface of the spherical caps of both enantiomers during their reactions in the polarizing beamsplitters. The experimentalist will get correlation probabilities P++, P--, P+-, and P-+ for individual settings and the correlation coefficient E = - cos(2θ). The "colors" of enantiomers are depicted in the primary and secondary (complementary) colors inspired by the quantum chromodynamics school. The individual enantiomers are "white" and the formed pair of anticorrelated enantiomers is "white" as well. The individual polarizers change the original "color" of enantiomers. The resulting "color" of enantiomers can be expressed via the both trigonometric functions. This mathematical description is identical with quantum mechanics predictions. These "color" enantiomers represent the "local hidden variables" and explain the independent and immediate reactions with both polarizers. This proposal could reopen the door to the Einstein´s intuition expressed in the EPR paradox. Based on the old French school and their polarization studies, we can modify the correlation coefficients by optical active molecules in one path and optical inactive molecules in the other path. With the knowledge of the specific rotation of used optical active molecules we can prepare "tailor-made" correlation coefficients.

Keywords: Enantiomers, EPR Paradox, Local Hidden Variables, Optical Isomerism.

1. Introduction

Since 1935, the Einstein-Podolsky-Rosen (EPR) argument has provoked sustained debate about the completeness of quantum mechanics and the possibility of the existence of hidden variables [1]-[10]. In 1964, Bell provided inequalities enabling decisive experiments to contrast local hidden-variable models with quantum predictions [11] – [20]. Successive, increasingly loophole-tight tests have agreed with quantum theory and ruled out broad classes of local hidden-variable explanations [21] – [44]. Despite this, new proposals periodically revisit hidden-variable ideas or seek fresh physical pictures for the observed correlations [45] – [58]. The prevailing consensus holds that local hidden-variable theories are excluded. Yet it is still reasonable to ask whether a neglected, historically inspired avenue remains – one that reframes the correlation without invoking superluminal causation. In this paper we revisit the experiment of Louis Pasteur with the experimentally separated enantiomers. Pasteur founded the research school termed as the optical isomerism in 1848 [59], [60]. In 1964, Gell-Mann, Zweig and Greenberg started the quantum chromodynamics (QCD) school

Citation: Jiří STÁVEK . The Pasteur Racemic Mixture: Entanglement Interpreted as the Optical Isomerism. Open Access Journal of Physics. 2026; 8(1): 56-62.

for the interpretation of subnuclear events [61] – [63]. The rules of this QCD school can be applied for description of both enantiomers. The aim of this contribution is not to dispute the empirical success of Bell-type experiments, but to explore whether a historically rooted, physically transparent mechanism can coexist with the established formalism while offering new, testable predictions.

2. Properties of Entangled Photons - Enantiomers

Descartes proposed that "light globules" rotate with the same speed as is their longitudinal speed [64]. Descartes´ intuition is shown in Figure 1. This earlier Descartes´ proposal can be expressed in Figure 2 as the rotation of two photon enantiomers.

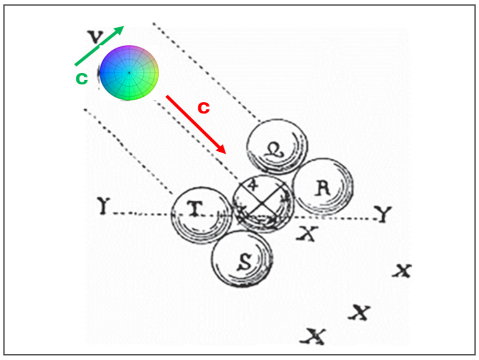

Figure 1. *Descartes model of "light globules": the rotation speed of those globules is identical with their longitudinal speed.*

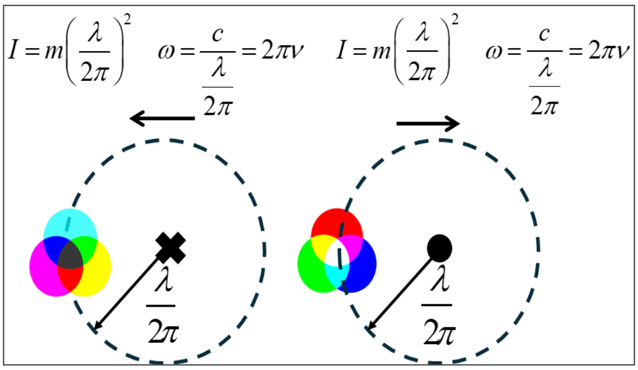

Figure 2. *Rotation of two photon enantiomers in the opposite directions. Photons with mass m rotate around the empty center with their inertia I and the angular velocity ω. The quantum of the moment of inertia introduced Bjerrum in 1912 [65].*

The rotation of photon mass around the empty center can be described by its moment of inertia I and its angular velocity ω (the quantum of the moment of inertia was proposed by Bjerrum in 1912 [65]).

$$\frac{h}{2\pi} = I\omega = m\left(\frac{\lambda}{2\pi}\right)^2 \frac{c}{\frac{\lambda}{2\pi}} = \frac{m\lambda c}{2\pi} \quad (1)$$

where h/2π is the reduced Planck constant.

In order to describe the entangled photons as two correlated enantiomers we will define the color orientations of those photons in Table I. This model was inspired by the quantum chromodynamics (QCD) school – the free particles should be "white".

Table 1. *The Color Description of Enantiomers*

Color direction	Color	Position
	Red (R)	+x
	Green (G)	+z
	Blue (B)	+y
	Cyan (G+B)	-x
	Magenta (R+B)	-z
	Yellow (R+G)	-y
	White (R+G+B)	Enantiomer
	White (C+M+Y)	Enantiomer

Figure 3 depicts the color orientation of enantiomers in the direction towards Alice and Bob.

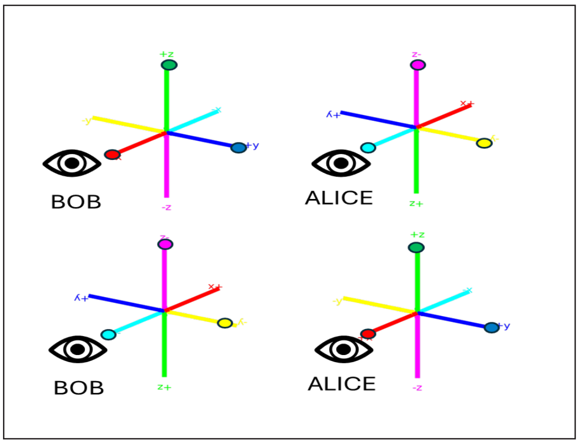

Figure 3. *Color position of entangled enantiomers in the direction towards Alice and Bob. The statistical occurrence of both enantiomers is 50:50.*

3. The Pasteur Racemic Mixture

Figure 4. Shows the color spheres of enantiomers that were not rotationally modified during their flights. Alice and Bob see the complementary colors.

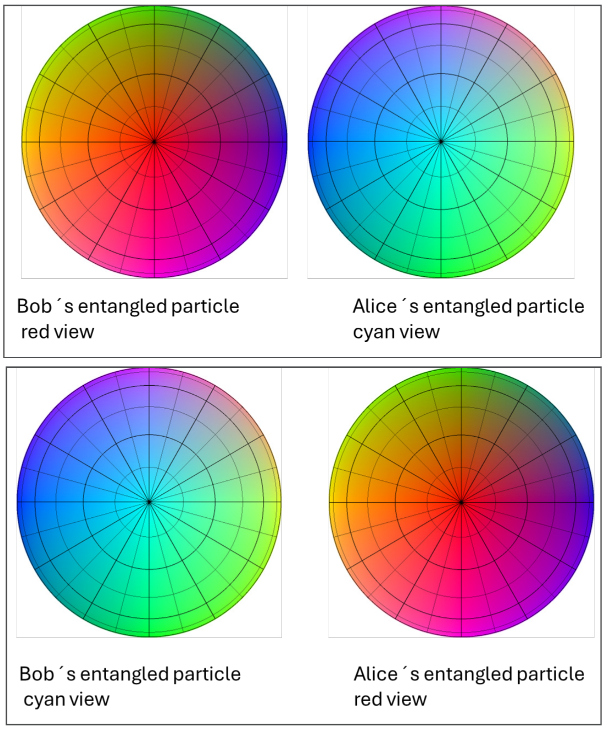

Figure 4. *Color view of enantiomers approaching towards Bob and Alice. In this case both enantiomers were not modified during their flights. The statistical occurrence of both enantiomers is 50:50.*

4. Correlation Coefficient of Enantiomers

There is the interesting Central Angle Theorem: The central angle subtended by two points on a circle is twice the inscribed angle subtended by those points. The Central Angle Theorem states that the measure of inscribed angle APB is always half the measure of the central angle AOB – Fig. 5. This theorem holds when P is in the major arc. If P is in the minor arc (that is, between A and B), then the inscribed angle is the supplement of half the central angle. This is an important property of this circle. The detector P "sees" those two points A and B in any position of detector under the angle 2θ.

There is one more important property of the enantiomer sphere – the surface of the both spherical caps. For the central angle 2θ we can use the trigonometric functions versine and vercosine.

$$\text{versin } 2\theta = 1 - \cos 2\theta = 2\sin^2\theta \tag{2}$$

$$\text{vercosin } 2\theta = 1 + \cos 2\theta = 2\cos^2\theta \tag{3}$$

The surface of both spherical caps is given as.

$$S_1 = 2\pi R\, R\left(1 - \cos 2\theta\right) = 4\pi R^2 \sin^2\theta \tag{4}$$

$$S_2 = 2\pi R\, R\left(1 + \cos 2\theta\right) = 4\pi R^2 \cos^2\theta \tag{5}$$

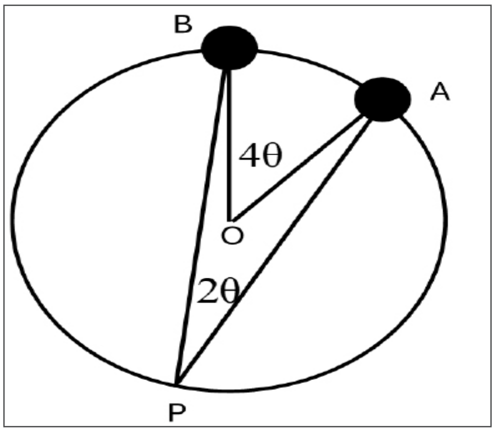

Figure 5. *The central Angle Theorem: the central angle subtended by two points on a circle is twice the inscribed angle subtended by two points. The detector "sees" those two points in any position under the angle 2θ.*

Figure 6 depicts the surface of both spherical caps. We assume that the "active" the surface of spherical caps plays a very important role during flight of enantiomers through the polarizing beamsplitter. The joint action of the polarizing beamsplitter and the "active" surface of approaching enantiomer will decide the path to the + channel direction or the – channel direction. Based on these ± directions at Alice and Bob sites the complete statistical evaluation can be determined – Figure 7. From the sizes of individual surfaces of those spherical caps, we can determine the probabilities P_{++}, P_{--}, P_{+-}, and P_{-+}. The correlation coefficient E is identical with the prediction of quantum mechanics for the anticorrelated singlet.

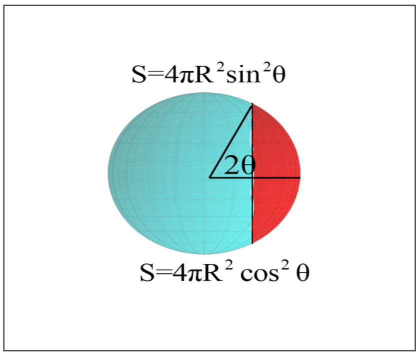

Figure 6. *The surface of both spherical caps with the central angle 2θ.*

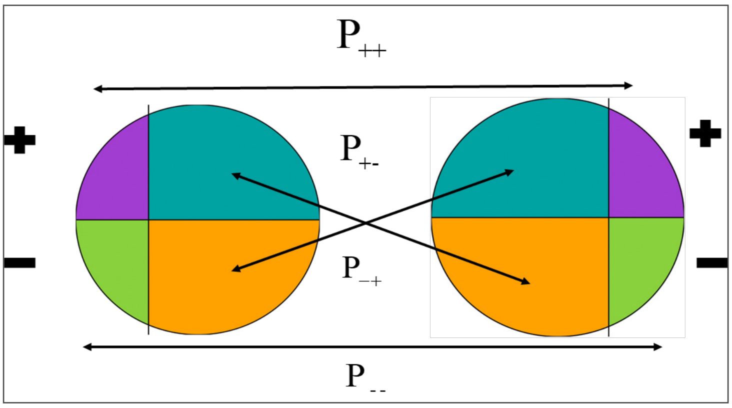

Figure 7. *The active surfaces of both spherical caps with the central angle 2θ determine the probabilities and the final correlation coefficient E can be calculated. The geometrical analyses of individual contributions are based on the size of surfaces.*

$$E = \frac{2 * 4\pi R^2 \left(P_{++} + P_{--} - P_{+-} - P_{-+}\right)}{2 * 4\pi R^2} \tag{6}$$

$$E = \frac{2 * 4\pi R^2 \left(\frac{1}{2}\sin^2\theta + \frac{1}{2}\sin^2\theta - \frac{1}{2}\cos^2\theta - \frac{1}{2}\cos^2\theta\right)}{2 * 4\pi R^2} \tag{7}$$

$$E = \frac{1}{2}\sin^2\theta + \frac{1}{2}\sin^2\theta - \frac{1}{2}\cos^2\theta - \frac{1}{2}\cos^2\theta = -\cos 2\theta \tag{8}$$

5. Old French School with Enantiomers

There is very well known that the Old French Masters founded the scientific field with the polarized light. E.g., Étienne-Louis Malus, Louis Pasteur, Jean Baptiste Biot, Augustin-Jean Fresnel, François Arago, Frédéric Wallerant, Aimé Cotton, Francis Perrin, and Alain Aspect with his coworkers – all contributed significantly to the study of polarized light [66].

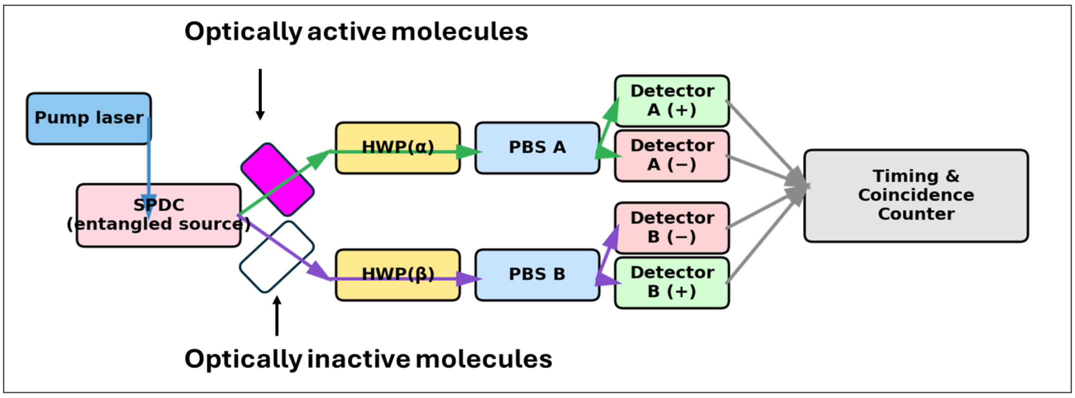

Figure 8. *A modification of the Alain Aspect Experiment with optically active molecules in one path while in the other path will be optically inactive molecules.*

Therefore, we propose to modify the "Alain Aspect Experiment" with introduction of optically active molecules, with their known specific rotation, into one path of the observed enantiomers. This modification can create "tailor-made" correlations between Alice and Bob – see Figure 8.

6. Conclusions

This entanglement model is not just a reinterpretation of standard correlation formulas. Based on the element of physical reality – the existence of enantiomers – a new derivation of the correlation coefficient was proposed. This "visible" parameter can be manipulated by the presence of optically active molecules and thus the resulting correlation coefficient can be modified beyond the predictions of quantum mechanics.

1. The entangled particles were described as two anticorrelated enantiomers.
2. These enantiomers were modeled by the rules of quantum chromodynamics.
3. The "element of the physical reality is the "active" surface of spherical caps of enantiomers.
4. The correlation coefficient can be "tailor-made" by the insertion of optically active molecules into one path of used settings for these experiments.

Acknowledgment

We were supported by the contract number 0110/2020.

Conflict of Interest

The author declares that there is no conflict of interest.

7. References

1. Einstein A, Podolsky B, Rosen N. Can quantum-mechanical description of physical reality be considered complete? *Physical Review*. 1935; 47(10): 777-780.
2. Bohr N. Can quantum-mechanical description of physical reality be considered complete? *Physical Review*. 1935; 48(8): 696-702.
3. Schrődinger E. Probability relations between separated systems. *Mathematical Proceedings of the Cambridge Philosophical Society*. 1936; 31(4): 555-563.
4. Schrődinger E. Discussion of probability relations between separated systems. *Mathematical Proceedings of the Cambridge Philosophical Society*. 1936; 32(3): 446-452.
5. Bohm D. *Quantum Theory*. Prentice Hall, Englewood Cliffs, 1951. Chapter 5 and 22.
6. Bohm D. A suggested interpretation of the quantum theory in terms of "hidden variables I". *Physical Review*. 1952; 85(2): 166.
7. Bohm D. A suggested interpretation of the quantum theory in terms of "hidden variables II". *Physical Review*. 1952; 85(2): 180.
8. Peres A. Einstein, Podolsky, Rosen, and Shannon. *Foundations of Physics*. 2005; 35(3): 511-514.
9. Wiseman HM, Jones SJ, Doherty AC. Steering, entanglement, nonlocality, and the Einstein-Podolsky-Rosen paradox. *Physical Review Letters*. 2007; 98(14): 140402.
10. Blaylock G. The EPR paradox, Bell´s inequality, and the question of locality. *American Journal of Physics*. 2010; 78(1): 111-120.
11. Bell JS. On the Einstein-Podolsky-Rosen paradox. *Physics Physique Физика*. 1964; 1(3): 195-200.
12. Bell JS. On the problem of hidden variables in quantum mechanics. *Reviews of Modern Physics*. 1966; 38(3): 447-452.
13. Clauser JF, Horne MA, Shimony A, Holt RA. Proposed experiment to test local hidden-variable theories. *Physical Review Letters*. 1969; 23(15): 880-884.
14. Aspect A. Proposed experiment to test the nonseparability of quantum mechanics. *Physical Review* D. 1976; 14(8): 1944-1951.

15. Fine A. Hidden variables, joint probability, and the Bell inequalities. *Physical Review Letters*. 1982; 48(5): 291-295.

16. Shimony A. Contextual hidden variable theories and Bell´s inequalities. British Journal for the Philosophy of Science. 1984; 35(1): 25-45.

17. Bell JS. *Speakable and unspeakable in quantum mechanics.* Cambridge University Press, 1987. ISBN: 9780521368698.

18. Mermin ND. Hidden variables and two theorems of John Bell. *Reviews of Modern Physics*. 1993; 65(3): 803-815.

19. Dehlinger D. Mitchell MW. Entangled photons, nonlocality, and Bell inequalities in the undergraduate laboratory. *American Journal of Physics*. 2002; 70(9): 903-910.

20. Freedman SJ, Clauser JF. Experimental test of local hidden-variable theories. *Physical Review Letters.* 1972; 28(14): 938-941.

21. Fry ES, Thompson RC. Experimental test of local hidden-variable theories. *Physical Review Letters.* 1976; 37(8): 465-468.

22. Clauser JF, Shimony A. Bell´s theorem – experimental tests and implications. *Rep. Prog. Phys.* 1978; 41(12): 1881-1927.

23. Aspect A, Grangier P, Roger G. Experimental tests of realistic local theories via Bell´ s theorem. *Physical Review Letters.* 1981; 47(7): 460-463.

24. Aspect A, Dalibard J, Roger G. Experimental test of Bell inequalities using time-varying analyzers. *Physical Review Letters.* 1982; 49(25): 1804-1807.

25. Aspect A, Grangier P, Roger G. Experimental realization of Einstein-Podolsky-Rosen Gedankenexperiment – a new violation of Bell inequalities. *Physical Review Letters.* 1982; 49(2): 91-94.

26. Shih YH, Alley CO. New type of Einstein-Podolsky-Rosen-Bohm experiment using pairs of light quanta produced by optical parametric down conversion. *Physical Review Letters.* 1988; 61(26): 2921-2924.

27. Tapster PR, Rarity JG, Owens PCM. Violation of Bell´s inequality over 4 km of optical fiber. *Physical Review Letters*. 1994; 73: 1923.

28. Kwiat PG, Mattle K, Weinfurter H, and A. Zeilinger. New high-intensity source of polarization-entangled photon-pairs. *Physical Review Letters.* 1995; 75: 4337.

29. Weihs G. et al. Violation of Bell´s inequality under strict Einstein locality conditions. *Physical Review Letters.* 1998; 81(23): 5039-5043.

30. Aspect A. Bell´s theorem: the naive view of an experimentalist. *Arxiv*: quant-ph/0402001. 2004.

31. Giustina M. et al. Bell violation using entangled photons without the fair-sampling assumption. *Nature.* 2013; 497, 227.

32. Christensen BG et al. Detection-loophole-free test of quantum nonlocality, and applications. *Physical Review Letters.* 2013; 111: 130406.

33. Gallichio J, Friedman AS, Kaiser DI. Testing Bell´s inequality with cosmic photons: closing the setting-independence loophole. *Physical Review Letters.* 2014; 112(11): 110405.

34. Giustina M et al. Significant-loophole-free test of Bell´s theorem with entangled photons. *Physical Review Letters.* 2015; 115: 250401.

35. Hensen B et al. Loophole-free Bell inequality violation using electron spins separated by 1.3 kilometers. *Nature*. 2015; 526: 682-686.

36. Aspect A. Closing the door on Einstein and Bohr´s quantum debate. *Physics*. 2015; 8: 123.

37. Shalm LK. Et al. Strong loophole-free test of local realism. Physical Review Letters. 2015; 115, 250402.

38. Abellán C. et al. Generation of fresh and pure random numbers for loophole free Bell tests. *Physical Review Letters.* 2015; 115: 250403.

39. Rosenfeld W. et al. Event-ready bell test using entangled atoms simultaneously closing detection and locality loopholes. Physical Review Letters. 2017; 119: 010402.

40. Yin J. et al. Satellite-based entanglement distribution over 1200 kilometers. *Science*. 2017; 356: 1140-1144.

41. Li MH. Et al. Test of local realism into the past without detection and locality loopholes. *Physical Review Letters.* 2018; 121(8): 080404.

42. Rauch et al. Cosmic Bell test using random measurement setting from high-redshift quasars. Physical Review Letters. 2018; 121(8): 080403.

43. Freire O. Jr. Alain Aspect´s experiments on Bell´s theorem: a turning point in the history of the research on the foundations of quantum mechanics. *The European Physical Journal D*. 2022; 76: 248.

44. Luc J. What are the bearers of hidden states? On an important ambiguity in the formulation of Bell´s theorem. 2025. Arxiv: 2501.17521v1. Accessed on November 21 2025.

45. Genovese M. Research on hidden variable theories: a review of recent progresses. 2007. Arxiv: quant-ph/070107v1.

46. Bacciagaluppi G, Crull E. Heisenberg (and Schrődinger, and Pauli) on hidden-variables. Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics. 2009; 40: 374-382.

47. Boozer AD. Hidden-variable theories and quantum nonlocality. *European Journal of Physics*. 2009; 30(2): 355-365.

48. Freire O. *The Quantum Dissidents: Rebuilding the Foundations of Quantum Mechanics* (1950-1990). With a forward by S.S. Schweber. Springer, 2015, ISBN-10:9783662446614.

49. Budron C. *Temporal quantum correlations and hidden variable models*. Springer, 2016. ISBN 978-3-319-24167-8.

50. Khrennikov A. Get rid of nonlocality from quantum physics. *Entropy*. 2019; 21, 806-815.

51. Kupczynski M. Closing the door on quantum nonlocality? *Entropy*. 2018; 20: 877-890.

52. Jung K. Polarization correlation of entangled photons derived without using non-local interactions. *Frontiers in Physics*. 2020; 8: 170.

53. Khrennikov A. Quantum versus classical entanglement: eliminating the issue of quantum nonlocality. *Foundations of Physics*. 2020; 50(12): 1762-1780.

54. Khrennikov A. Two faced Janus of quantum nonlocality. *Entropy*. 2020; 22(3): 303.

55. Vatarescu A. Polarimetric quantum-strong correlations with independent photons on the Poincaré sphere. *Quantum Beam Science*. 2022; 6, 32.

56. Hess K. Einstein-local counter-arguments and counter-examples to Bell-type proofs. *Journal of Modern Physics*. 2023; 14: 89-100.

57. Hess K. Malus-law models for Aspect-type experiments. Journal of Modern Physics. 2023; 14: 1167-1176.

58. Stávek J. The element of physical reality hidden in the letter of Malus to Lancret in 1800 can solve the EPR paradox (Malus thermochromatic loophole). *Eur. J. Appl. Phys.* 2023; 5(6): 10-16.

59. Pasteur L. Sur les relations qui peuvent exister entre la forme cristalline, la composition chimique et les sens de la polarisation rotaire. (On the relations that exist between crystalline form, chemical composition, and the sense of rotary polarization). *Annales de Chimie et de Physique.* 3rd series. 1848; 24(3): 442-459. (In French).

60. Pasteur L. Recherses sur les propriétés spécifiques des deux acides qui composent l´acide racémique. (Investigations into the specific properties of the two acids that compose racemic acid). *Annales de Chimie et de Physique.* 3rd series. 1850; 28(3): 56-59. (In French).

61. Gell-Mann M. A schematic model of baryons and mesons. *Phys. Lett.* 1964; 8(3): 214-215.

62. Zweig G. *An SU(3) model for strong interaction symmetry and its breaking* II. In: ´Developments in the quark theory of hadrons´. Ed. D. Lichteberg and S. Rosen. Nonantum, Mass., Hadronic Press, 1980, pp. 2-.

63. Greenberg OW. Spin and unitary-spin independence in a paraquark model of baryons and mesons. *Phys. Rev. Lett*. 1964; 13(20): 598-602.

64. Mantovani M. *Colours´little souls: Descartes on sensible qualities*. In Theories of Colour from Democritus to Descartes. Routledge. 2024; pp. 274-293.

65. Bjerrum N. Ű̈ber die Infrarotabsorptionspektren von Gasen. (On the infrared absorption spectra of gases). Nernst *Festschrifte*, W. Nernst zu seinem fűnfundzwanzigjährigen Doktorjubiläum gewidmet von seinen Schűlern. 1912; p. 90. Knapp,Halle,Germany.http://publ.royalacademy.dk/backend/web/uploads/2019-10-03/AFL%204/SP_53_00_00_1949_1686/SP_53_05_00_1949_5432.pdf

66. Kahr B. Polarization in France. Chirality. 2018; 30(4): 351-368.