THE LIFE AND SCIENTIFIC LEGACY OF ROMAN STANISŁAW INGARDEN

Miłosz Michalski

Institute of Physics, Nicolaus Copernicus University

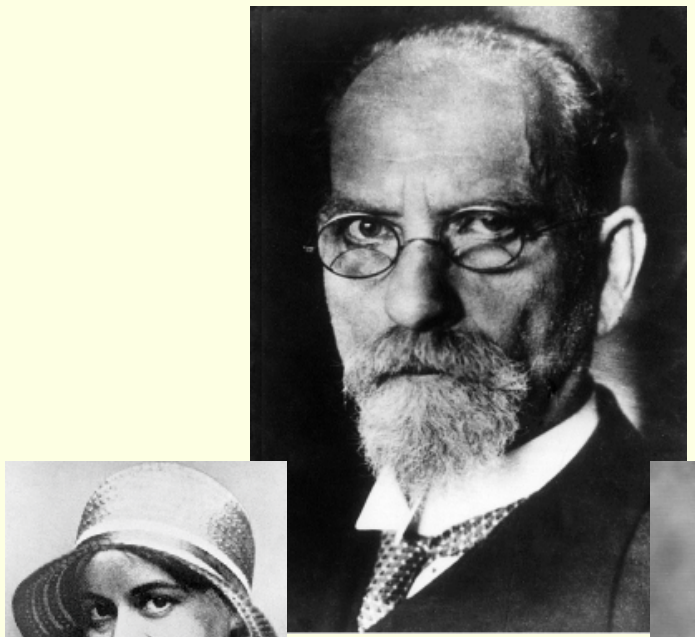
R.S. Ingarden Memorial Session, KCIK, 25 November 2020

Roman S. Ingarden, 1.10.1920 – 12.07.2011

2020 — The Roman Ingarden Year

Roman Witold Ingarden, 1893–1970

Roman W. Ingarden – student of Edmund Husserl



Edmudn Husserl

Edith Stein

Roman W. Ingarden

Studies in mathematics, physics and philosophy
Lwów–Götingen–Vien–Freiburg im Breisgau.
Doctorate in 1918 under E. Husserl.

The interview...

OM 46 – ZESZYT 4 – 1995

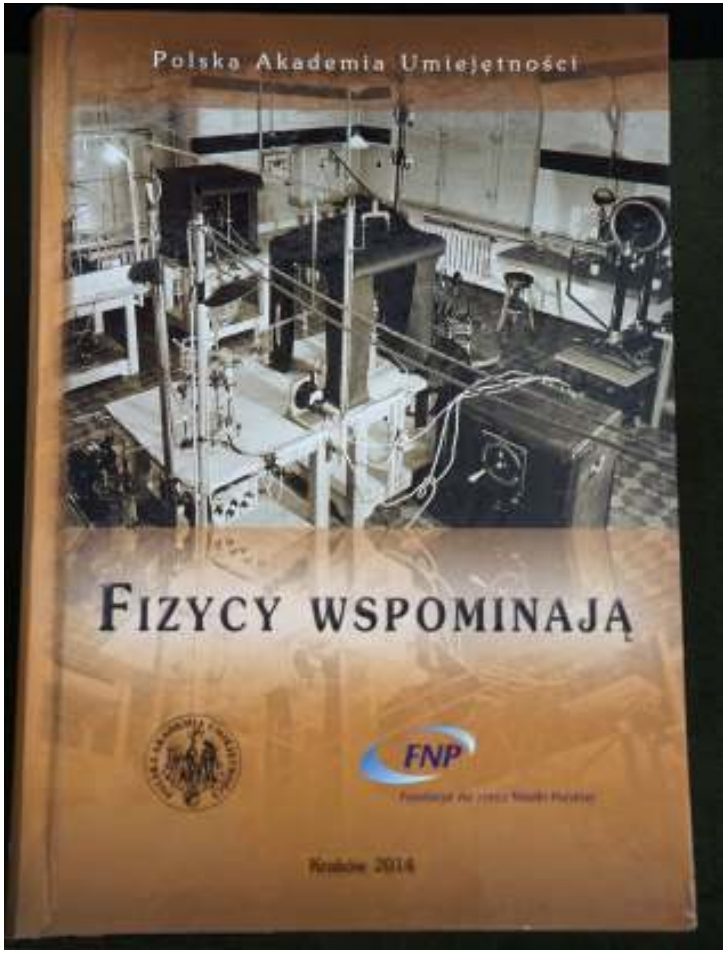
ROZMOWY

O optyce geometrycznej i termodynamice informacyjnej, a także o Lwowie, Wrocławiu i Toruniu – Rozmowa z R.S. Ingardenem

On geometrical optics and information thermodynamics, and also on Lwów, Wrocław and Toruń – An interview with R.S. Ingarden

Poniższa rozmowa stanowi skrót dwóch wywiadów,[1] jakie w styczniu i lutym 1993 r. na prośbę Redakcji *Postępów Fizyki* przeprowadzili z prof. Romanem Stanisławem Ingardenem prof. Sławomir Kalembka, historyk z Instytutu Historii UMK, oraz profesorowie Andrzej Kossakowski, Andrzej Jamiołkowski i Józef Szudy z Instytutu Fizyki UMK w Toruniu.

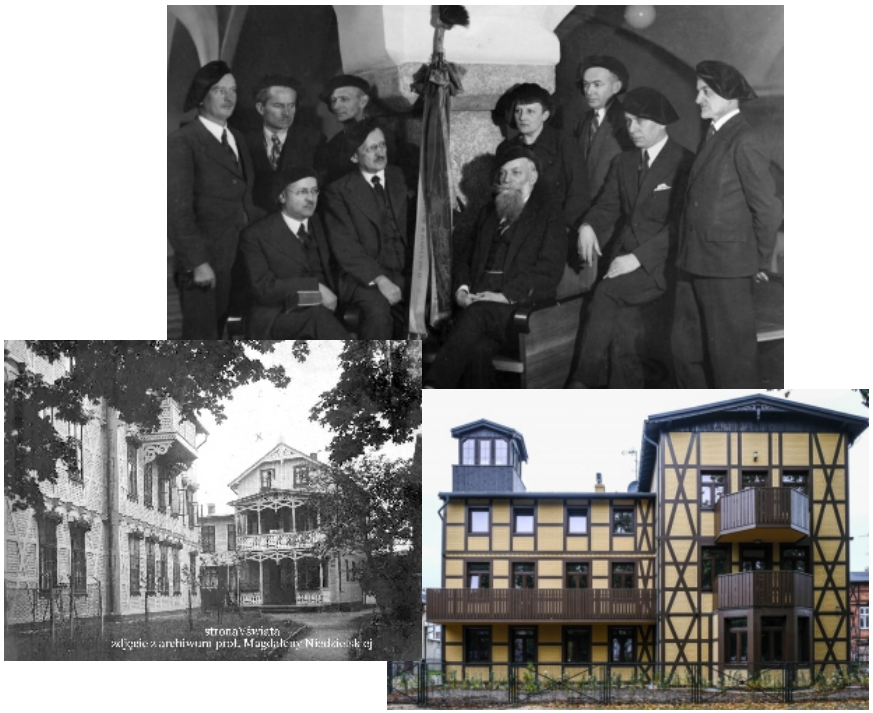
Redakcja



The Toruń years, 1921-26

Rodzina Romana Witolda Ingardena (1893—1970), od lewej: Maria Pol-Ingardenowa (1889—1979), żona, Janusz Stefan (ur. 1923), najmłodszy syn, Roman Kajetan (1852—1926), ojciec, Roman Stanisław (ur. 1920), najstarszy syn, Roman Witold, Jerzy Kazimierz (1921—1949), średni syn, zdjęcie z III 1924 r., ul. Mickiewicza 115 (dziś 93), Toruń

The Toruń years, 1921-26



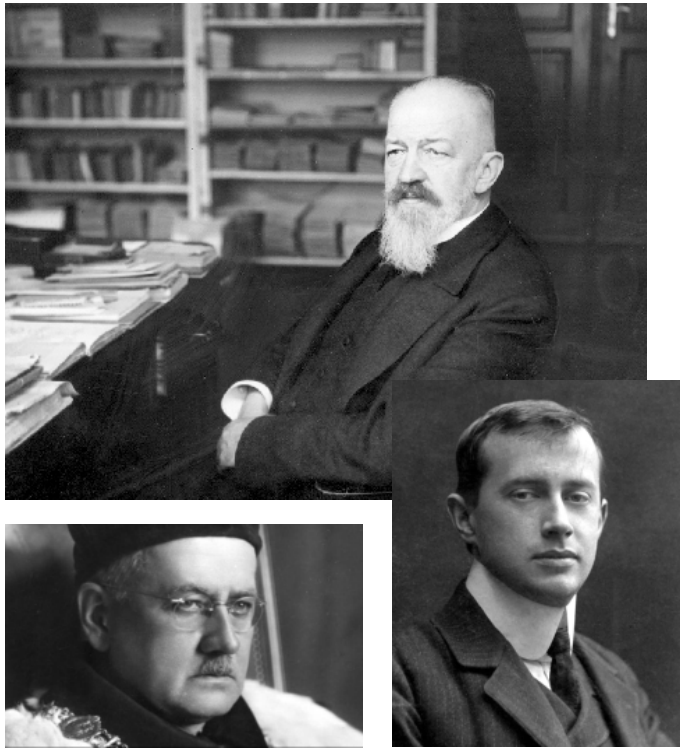
Konfraternia Artystów in Toruń

Stanisław Ignacy Witkiewicz

Witkacy

Moving to Lwów 1926

Jan Kazimierz University in Lwów

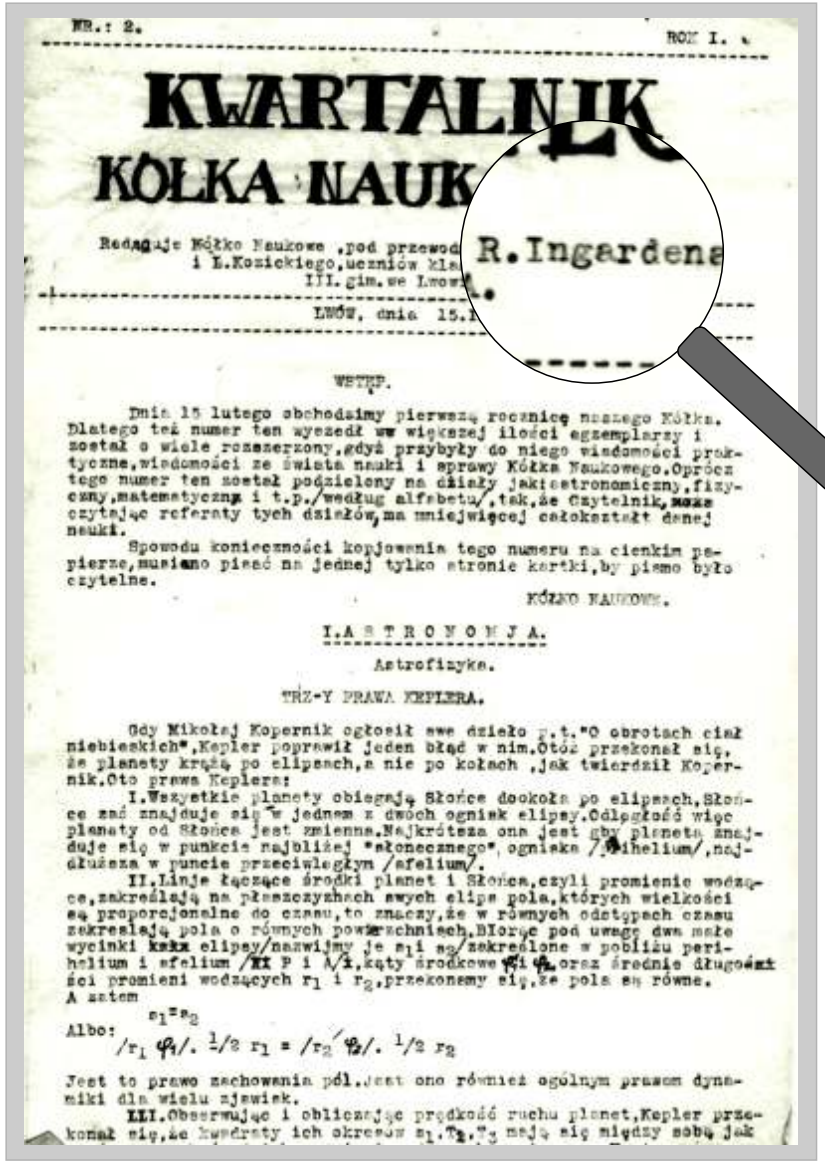


Lwów philosophy school
K. Twardowski, K. Ajdukiewicz
L. Chwistek

Gymnasium years 1930-38

Roman S. Ingarden jako harcerz, zdjęcie z 1934 r. Lwów

Zakopane, summer 1938



NR.: 2. ROK I.

KWARTALNIK

KÓŁKA NAUK

Redagują Kółko Naukowe ,pod przewod
i L.Kozickiego,uczniów kl
III.gim.we Lwow

LWÓW, dnia 15.I

R.Ingardena

WSTĘP.

Dnia 15 lutego obchodzimy pierwszą rocznicę naszego Kółka. Dlatego też numer ten wyszedł w większej ilości egzemplarzy i został o wiele rozszerzony,gdyż przybyły do niego wiadomości praktyczne,wiadomości ze świata nauki i sprawy Kółka Naukowego.Oprócz tego numer ten został podzielony na działy jak:astronomiczny,fizyczny,matematyczny i t.p./według alfabetu/,tak,że Czytelnik,mogąc czytając referaty tych działów,ma mniejwięcej całokształt danej nauki.

Spowodu konieczności kopjowania tego numeru na cienkim papierze,musiano pisać na jednej tylko stronie kartki,by pismo było czytelne.

KÓŁKO NAUKOWE.

I.A S T R O N O M J A.

Astrofizyka.

TRZ-Y PRAWA KEPLERA.

Gdy Mikołaj Kopernik ogłosił swe dzieło p.t."O obrotach ciał niebieskich",Kepler poprawił jeden błąd w nim.Otóż przekonał się, że planety krążą po elipsach,a nie po kołach ,jak twierdził Kopernik.Oto prawa Keplera:

I.Wszystkie planety obiegają Słońce dookoła po elipsach,Słońce zaś znajduje się w jednem z dwóch ognisk elipsy.Odległość więc planety od Słońca jest zmienna.Najkrótsza ona jest gdy planeta znajduje się w punkcie najbliżej "słonecznego" ogniska /perihelium/,najdłuższa w puncie przeciwległym /afelium/.

II.Linje łączące środki planet i Słońca,czyli promienie wodzące,zakreślają na płaszczyznach swych elips pola,których wielkości są proporcjonalne do czasu,to znaczy,że w równych odstępach czasu zakreślają pola o równych powierzchniach.Biorąc pod uwagę dwa małe wycinki ~~kołka~~ elipsy/nazwijmy je s_1 i s_2/zakreślone w pobliżu perihelium i afelium /P i A/,kąty środkowe φ_1 i φ_2 oraz średnie długości promieni wodzących r_1 i r_2,przekonamy się,że pola s_1 i s_2 są równe.

A zatem

$$s_1 = s_2$$

Albo:

$$/r_1\ \varphi_1/ \cdot {}^1/_2\ r_1 = /r_2\ \varphi_2/ \cdot {}^1/_2\ r_2$$

Jest to prawo zachowania pól.Jest ono również ogólnym prawem dynamiki dla wielu zjawisk.

III.Obserwując i obliczając prędkość ruchu planet,Kepler przekonał się,że kwadraty ich okresów s_1, T_2, T_3 mają się między sobą jak

Studies at Jan Kazimierz University 1938–41, 1944–45


Stanisław Loria


Wojciech Rubinowicz


Juliusz Schauder


Stefan Banach


Hugo Steinhaus

physics


Roman S. Ingargen in 1938

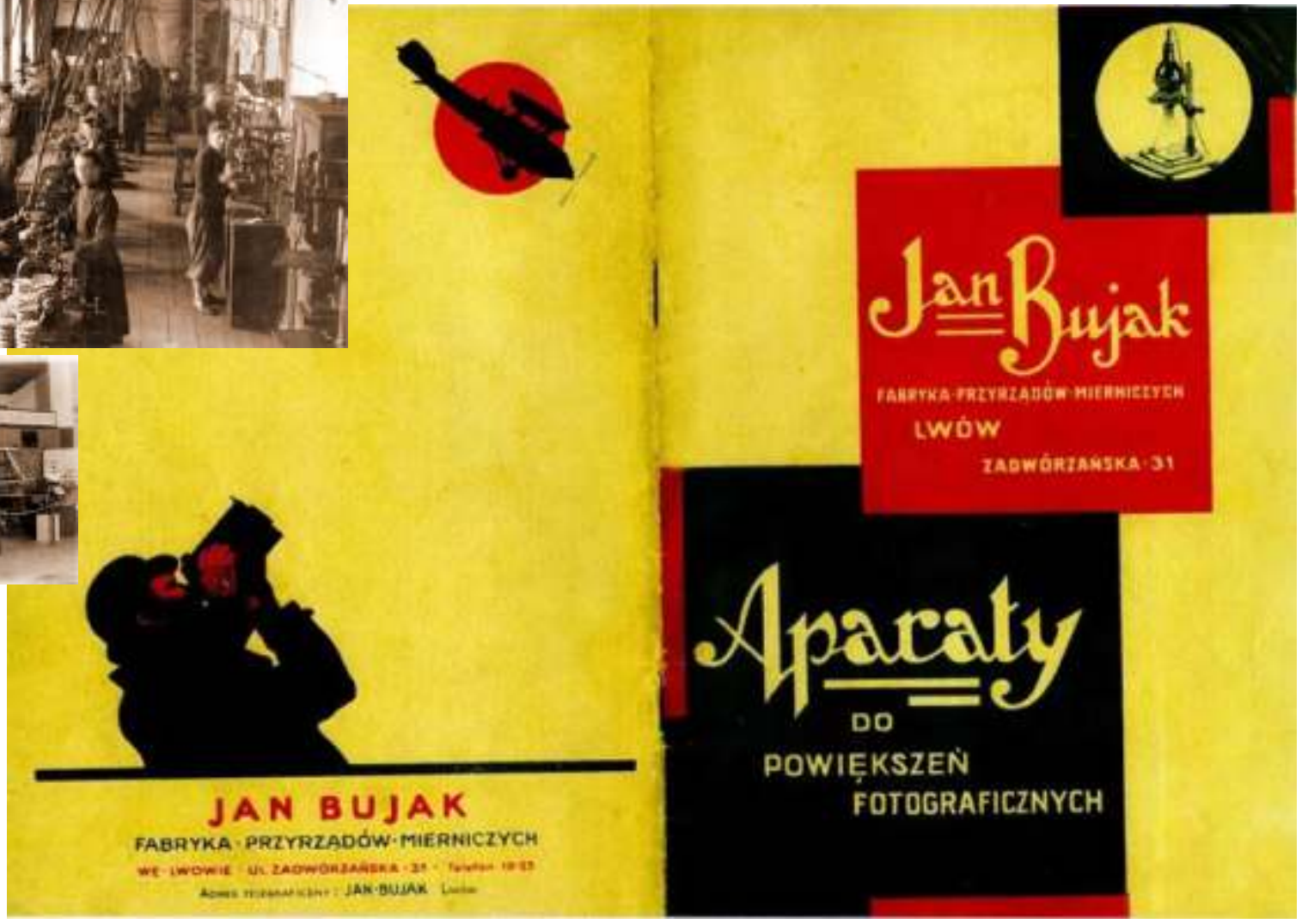

Stanisław Saks


Edward Marczewski

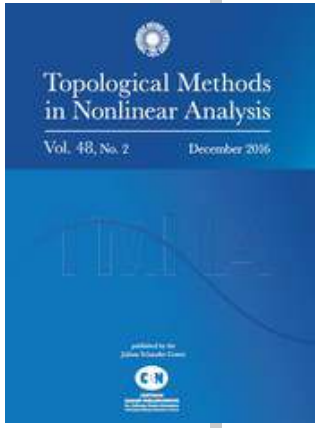
mathematics

... and philosophy

Jan Bujak optical factory 1941-44



Juliusz P. Schauder 1899–1943



Topological Methods in Nonlinear Analysis
Journal of the Juliusz Schauder Center
Volume 2, 1993, 1–14

JULIUSZ SCHAUDER PERSONAL REMINISCENCES

R. S. INGARDEN

Dedicated to the memory of my teacher, Juliusz Schauder.

Juliusz Schauder was my teacher of mathematics in secondary school and also at the University of Lwów where I studied theoretical physics. I knew him during a period of about 10 years, but his tragic death interrupted this acquaintance just at the moment when it seemed that it might have been the beginning of a period of fruitful collaboration. Schauder looked to me as a prospective collaborator on mathematical problems of physics and for this reason he invited me to his advanced seminar about continuous groups. In these notes I would like to say what I remember about my dear teacher, who gave me the first impulse in the direction of mathematical physics (an impulse which I followed without his guidance and not necessarily in his direction). It occurred only recently, and completely independently of the present paper, that I came back to Pontryagin's book, which we studied at the seminar, in order to use it directly in my current work.

Before I give my personal reminiscences I would like to recall briefly what is known about Schauder's life (cf. [1] and [2]). I will not write here about his work, since this would take us too much aside (for this cf., e.g., [3] and [4]; unfortunately, neither text is in English: one is in French and the other in Japanese !). I will begin by quoting his friend and collaborator, Jean Leray (cf. [5], p. 11):

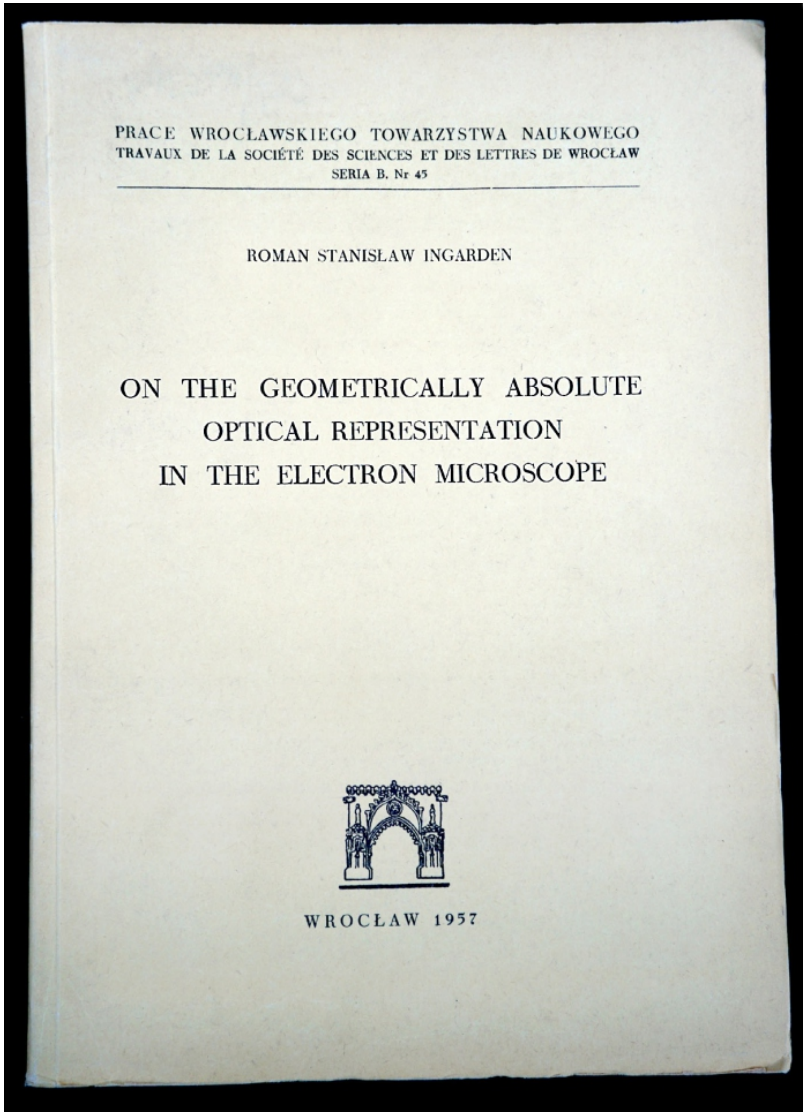
Cette œuvre est en apparence diverse: elle apporte des contributions souvent fondamentales à quatre branches des mathématiques, qu'on a coutume d'étudier indépendamment l'une de l'autre. En fait, c'est une œuvre d'une

Wrocław 1945




- Origins of mathematics and physics in Wrocław
  – H. Steinhaus, E. Marczewski, B. Knaster, S. Hartman
  – S. Loria, H. Niewodniczański, Sz. Szczeniowski (premanently in Poznań)
- R. Ingarden – assistant of S. Loria, MSc. 1945 in Kraków (Weyssenhoff), doctorate in 1949 in Warsaw (Rubinowicz)
- 1946 – creation of the chairs of experimental (Loria) and theoretical physics (temporarily vacant)

Doctorate 1949

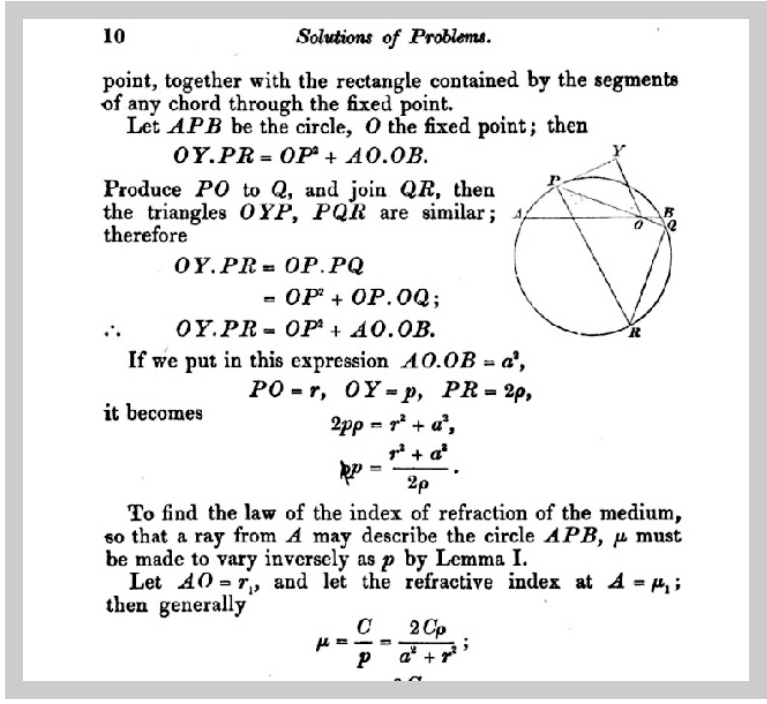


PRACE WROCŁAWSKIEGO TOWARZYSTWA NAUKOWEGO
TRAVAUX DE LA SOCIÉTÉ DES SCIENCES ET DES LETTRES DE WROCŁAW
SERIA B. Nr 45

ROMAN STANISŁAW INGARDEN

ON THE GEOMETRICALLY ABSOLUTE
OPTICAL REPRESENTATION
IN THE ELECTRON MICROSCOPE

WROCŁAW 1957



10 *Solutions of Problems.*

point, together with the rectangle contained by the segments of any chord through the fixed point.

Let APB be the circle, O the fixed point; then

$$OY.PR = OP^2 + AO.OB.$$

Produce PO to Q, and join QR, then the triangles OYP, PQR are similar; therefore

$$OY.PR = OP.PQ$$
$$= OP^2 + OP.OQ;$$
$$\therefore \quad OY.PR = OP^2 + AO.OB.$$

If we put in this expression $AO.OB = a^2$,

$$PO = r, \quad OY = p, \quad PR = 2\rho,$$

it becomes

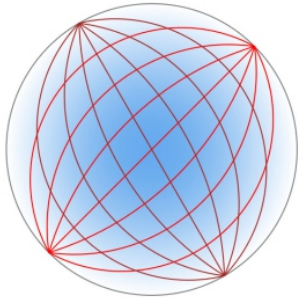
$$2p\rho = r^2 + a^2,$$
$$p = \frac{r^2 + a^2}{2\rho}.$$

To find the law of the index of refraction of the medium, so that a ray from A may describe the circle APB, μ must be made to vary inversely as p by Lemma I.

Let $AO = r_1$, and let the refractive index at $A = \mu_1$; then generally

$$\mu = \frac{C}{p} = \frac{2C\rho}{a^2 + r^2};$$

The Cambridge and Dublin Mathematical Journal, IX (1854), 9-11.



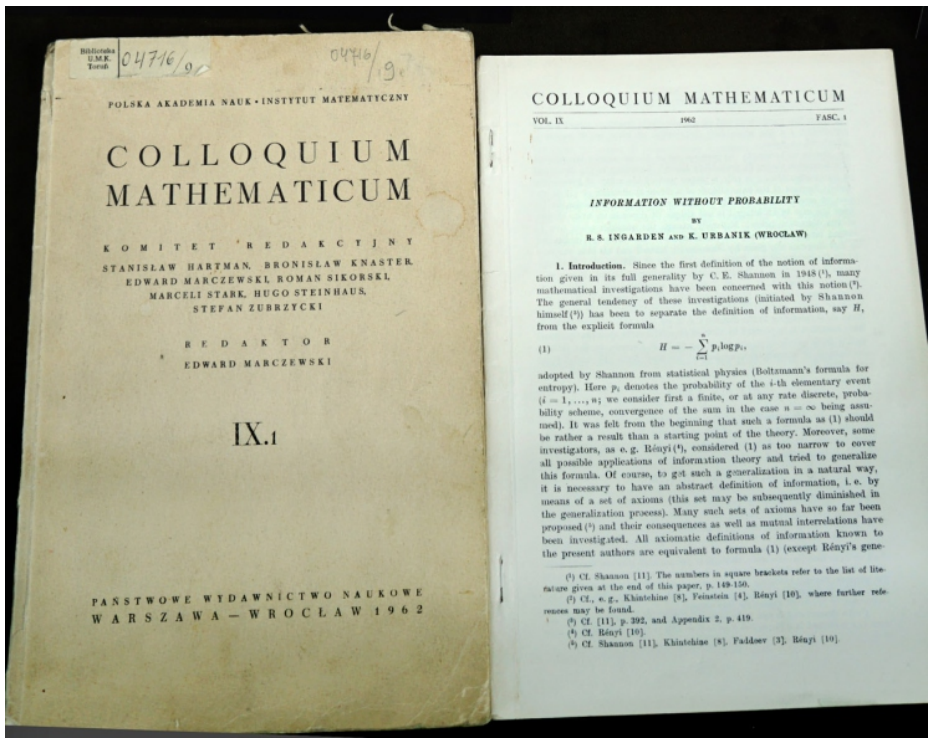
Wrocław, the 1950-s and 60-s




- Head of the Chair of Theoretical Physics (1949-52, later J. Rzewuski)
- students: J. Łopuszański, Z. Galasiewicz, W. Szczurówna-Rybarska, A. Pawlikowski (geometric and diffraction optics, quatnum mechanics, solid state theory)
- assoc. professor since 1954, 1960 – head of the Chair Solid State and Low-Temperature Physics
- in 1955 organizes Laboratory for Low-Temperatures, a unit of the Inst. Physics of the Academy of Sciences
- 1961 a scholarship at Courant Institute in NY., generalization of Rubinowicz's edge wave ideas in diffraction optics

Information theory, collaboration with Kazimierz Urbanik

"I did not read Shannon papers until the end of the 1950s. His main work appeared in 1948. Having heard of information theory while developing that of optical instruments, which actually are nothing more than transmitters of information, I realised that it was my fate or maybe a curse that was going to haunt me, and sooner or later I would have to delve into the subject. And so I did one day." RSI interwiev, 1993.



POLSKA AKADEMIA NAUK · INSTYTUT MATEMATYCZNY

COLLOQUIUM MATHEMATICUM

KOMITET REDAKCYJNY

STANISŁAW HARTMAN, BRONISŁAW KNASTER, EDWARD MARCZEWSKI, ROMAN SIKORSKI, MARCELI STARK, HUGO STEINHAUS, STEFAN ZUBRZYCKI

REDAKTOR

EDWARD MARCZEWSKI

IX.1

PAŃSTWOWE WYDAWNICTWO NAUKOWE

WARSZAWA — WROCŁAW 1962

COLLOQUIUM MATHEMATICUM

VOL. IX 1962 FASC. 1

INFORMATION WITHOUT PROBABILITY

BY

R. S. INGARDEN AND K. URBANIK (WROCŁAW)

1. Introduction. Since the first definition of the notion of information given in its full generality by C. E. Shannon in 1948 (1), many mathematical investigations have been concerned with this notion (2). The general tendency of these investigations (initiated by Shannon himself (3)) has been to separate the definition of information, say H, from the explicit formula

$$(1) \qquad H = -\sum_{i=1}^{n} p_i \log p_i,$$

adopted by Shannon from statistical physics (Boltzmann's formula for entropy). Here p_i denotes the probability of the i-th elementary event ($i = 1, \ldots, n$; we consider first a finite, or at any rate discrete, probability scheme, convergence of the sum in the case $n = \infty$ being assumed). It was felt from the beginning that such a formula as (1) should be rather a result than a starting point of the theory. Moreover, some investigators, as e. g. Rényi (4), considered (1) as too narrow to cover all possible applications of information theory and tried to generalize this formula. Of course, to get such a generalization in a natural way, it is necessary to have an abstract definition of information, i. e. by means of a set of axioms (this set may be subsequently diminished in the generalization process). Many such sets of axioms have so far been proposed (5) and their consequences as well as mutual interrelations have been investigated. All axiomatic definitions of information known to the present authors are equivalent to formula (1) (except Rényi's gene-

(1) Cf. Shannon [11]. The numbers in square brackets refer to the list of literature given at the end of this paper, p. 149-150.

(2) Cf., e. g., Khintchine [8], Feinstein [4], Rényi [10], where further references may be found.

(3) Cf. [11], p. 392, and Appendix 2, p. 419.

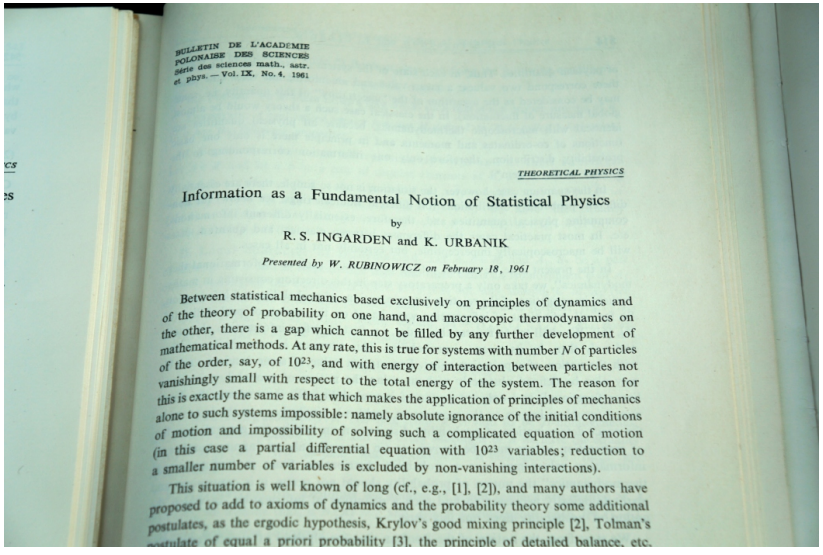
(4) Cf. Rényi [10].

(5) Cf. Shannon [11], Khintchine [8], Faddeev [3], Rényi [10].

R.S. Ingarden, K. Urbanik, *Information without probability*, Colloquium Mathematicum IX (1962), 131-150.

Information theory...

Information as a Fundamental Notion of Satistical Physics, Bull. Acad Pol. Sci, 1961



BULLETIN DE L'ACADÉMIE POLONAISE DES SCIENCES série des sciences math., astr. et phys. — Vol. IX, No. 4, 1961

THEORETICAL PHYSICS

Information as a Fundamental Notion of Statistical Physics

by

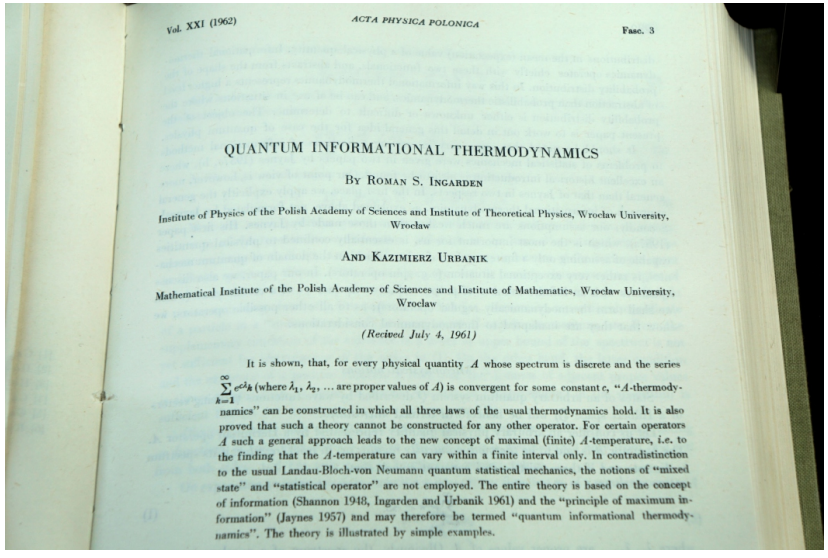
R. S. INGARDEN and K. URBANIK

Presented by W. RUBINOWICZ on February 18, 1961

Between statistical mechanics based exclusively on principles of dynamics and of the theory of probability on one hand, and macroscopic thermodynamics on the other, there is a gap which cannot be filled by any further development of mathematical methods. At any rate, this is true for systems with number N of particles of the order, say, of 10^{23}, and with energy of interaction between particles not vanishingly small with respect to the total energy of the system. The reason for this is exactly the same as that which makes the application of principles of mechanics alone to such systems impossible: namely absolute ignorance of the initial conditions of motion and impossibility of solving such a complicated equation of motion (in this case a partial differential equation with 10^{23} variables; reduction to a smaller number of variables is excluded by non-vanishing interactions).

This situation is well known of long (cf., e.g., [1], [2]), and many authors have proposed to add to axioms of dynamics and the probability theory some additional postulates, as the ergodic hypothesis, Krylov's good mixing principle [2], Tolman's postulate of equal a priori probability [3], the principle of detailed balance, etc.

Quantum Informational Thermodynamics, Acata Phys. Polon. 1962



Vol. XXI (1962) ACTA PHYSICA POLONICA Fasc. 3

QUANTUM INFORMATIONAL THERMODYNAMICS

By Roman S. Ingarden

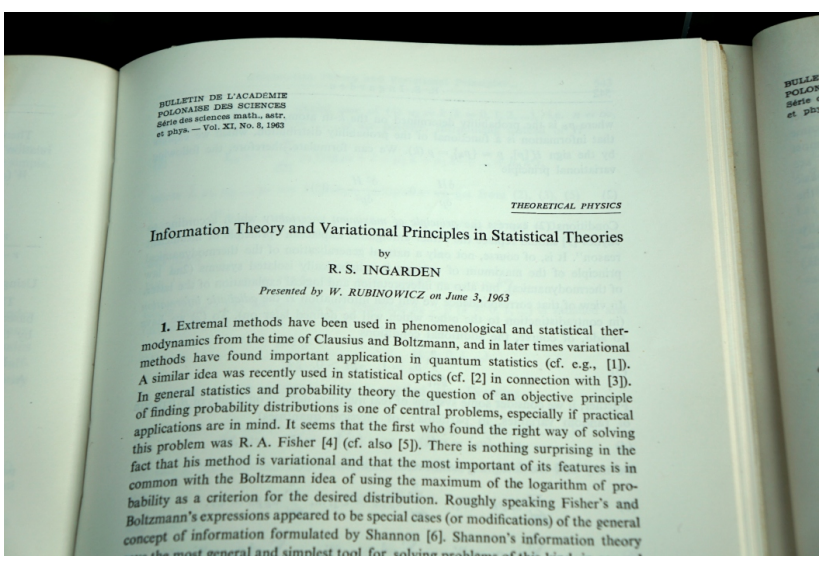
Institute of Physics of the Polish Academy of Sciences and Institute of Theoretical Physics, Wrocław University, Wrocław

And Kazimierz Urbanik

Mathematical Institute of the Polish Academy of Sciences and Institute of Mathematics, Wrocław University, Wrocław

(Recived July 4, 1961)

It is shown, that, for every physical quantity A whose spectrum is discrete and the series $\sum_{k=1}^{\infty} e^{c\lambda_k}$ (where $\lambda_1, \lambda_2, \ldots$ are proper values of A) is convergent for some constant c, "A-thermodynamics" can be constructed in which all three laws of the usual thermodynamics hold. It is also proved that such a theory cannot be constructed for any other operator. For certain operators A such a general approach leads to the new concept of maximal (finite) A-temperature, i.e. to the finding that the A-temperature can vary within a finite interval only. In contradistinction to the usual Landau-Bloch-von Neumann quantum statistical mechanics, the notions of "mixed state" and "statistical operator" are not employed. The entire theory is based on the concept of information (Shannon 1948, Ingarden and Urbanik 1961) and the "principle of maximum information" (Jaynes 1957) and may therefore be termed "quantum informational thermodynamics". The theory is illustrated by simple examples.



BULLETIN DE L'ACADÉMIE POLONAISE DES SCIENCES série des sciences math., astr. et phys. — Vol. XI, No. 8, 1963

THEORETICAL PHYSICS

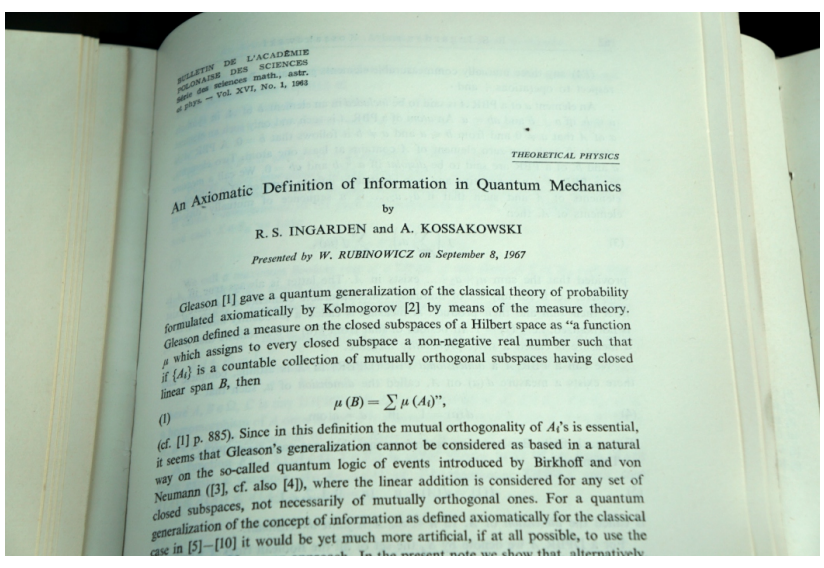
Information Theory and Variational Principles in Statistical Theories

by

R. S. INGARDEN

Presented by W. RUBINOWICZ on June 3, 1963

1. Extremal methods have been used in phenomenological and statistical thermodynamics from the time of Clausius and Boltzmann, and in later times variational methods have found important application in quantum statistics (cf. e.g., [1]). A similar idea was recently used in statistical optics (cf. [2] in connection with [3]). In general statistics and probability theory the question of an objective principle of finding probability distributions is one of central problems, especially if practical applications are in mind. It seems that the first who found the right way of solving this problem was R. A. Fisher [4] (cf. also [5]). There is nothing surprising in the fact that his method is variational and that the most important of its features is in common with the Boltzmann idea of using the maximum of the logarithm of probability as a criterion for the desired distribution. Roughly speaking Fisher's and Boltzmann's expressions appeared to be special cases (or modifications) of the general concept of information formulated by Shannon [6]. Shannon's information theory



BULLETIN DE L'ACADÉMIE POLONAISE DES SCIENCES série des sciences math., astr. et phys. — Vol. XVI, No. 1, 1968

THEORETICAL PHYSICS

An Axiomatic Definition of Information in Quantum Mechanics

by

R. S. INGARDEN and A. KOSSAKOWSKI

Presented by W. RUBINOWICZ on September 8, 1967

Gleason [1] gave a quantum generalization of the classical theory of probability formulated axiomatically by Kolmogorov [2] by means of the measure theory. Gleason defined a measure on the closed subspaces of a Hilbert space as "a function μ which assigns to every closed subspace a non-negative real number such that if $\{A_i\}$ is a countable collection of mutually orthogonal subspaces having closed linear span B, then

$$\mu(B) = \sum \mu(A_i)\text{''}, \tag{1}$$

(cf. [1] p. 885). Since in this definition the mutual orthogonality of A_i's is essential, it seems that Gleason's generalization cannot be considered as based in a natural way on the so-called quantum logic of events introduced by Birkhoff and von Neumann ([3], cf. also [4]), where the linear addition is considered for any set of closed subspaces, not necessarily of mutually orthogonal ones. For a quantum generalization of the concept of information as defined axiomatically for the classical case in [5]–[10] it would be yet much more artificial, if at all possible, to use the

Information Theory and Variational Principles in Statistical Physics, Bull. Acad Pol. Sci, 1963

An Axiomatic Definition of Information in Quantum Mechanics, Bull. Acad Pol. Sci, 1967

Information theory...

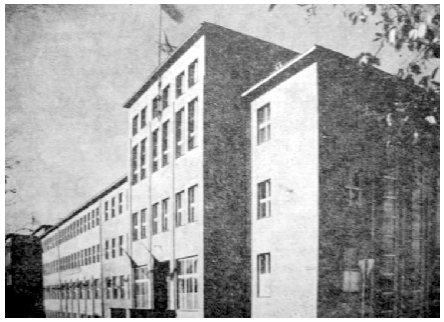
ROCZNIKI POLSKIEGO TOWARZYSTWA MATEMATYCZNEGO
Seria I: PRACE MATEMATYCZNE IX (1965)

R. S. INGARDEN (Wrocław)

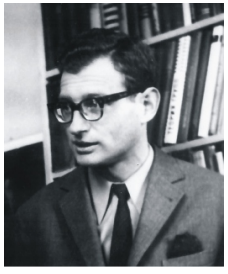
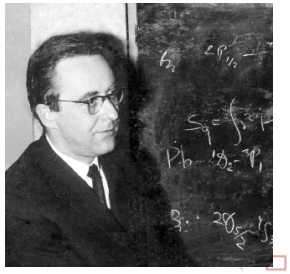
Simplified axioms for information without probability

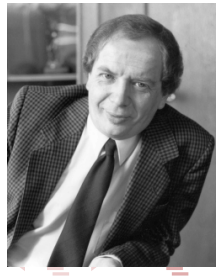
1. Introduction. In paper *Information without probability* by K. Urbanik and the present author (see [5] and also [4]) a system of axioms for the concept of information was given without the explicite use of the concept of probability. In the same paper the theorem was proved that if information is fully given, then probability is also uniquely determined and between the two concepts the well-known Boltzmann relation holds. Because the latter relation was used by Shannon for definition of information (see [7]), it follows from the mentioned theorem that our definition is exactly equivalent to Shannon's one as well as to all its known equivalents, among them also to axiomatic formulations using hitherto the

1966 – Toruń again...

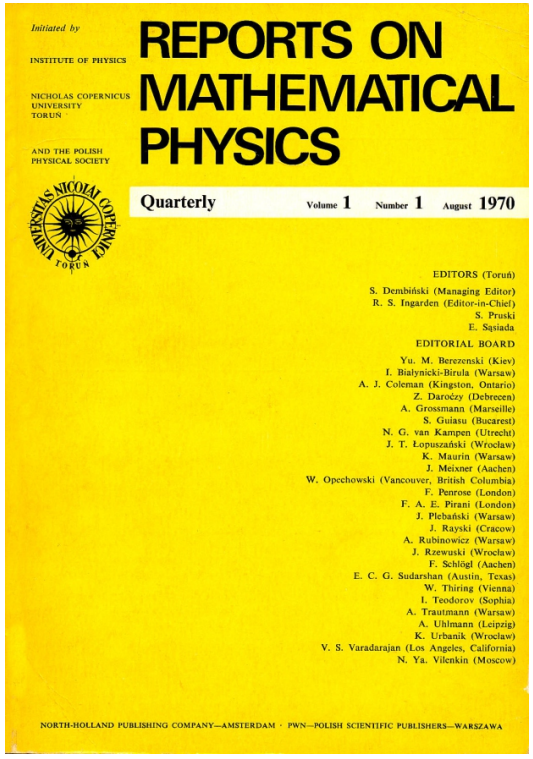



- Invitation to Toruń by prof. Aleksander Jabłoński 1966
- Full professor position
- Head of the newly established Chair of Thermodynamics and Theory of Radiation
- Since 1969 to 1978 director of the Institute of Physics
- Collaborators: A. Kossakowski, S. Dembiński, G. Czajkowski, A. Jamiołkowski (since 1969)

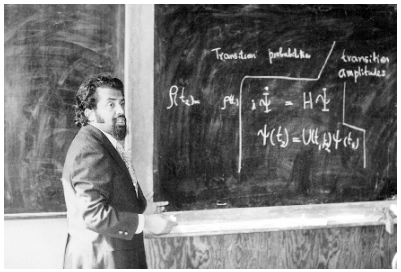



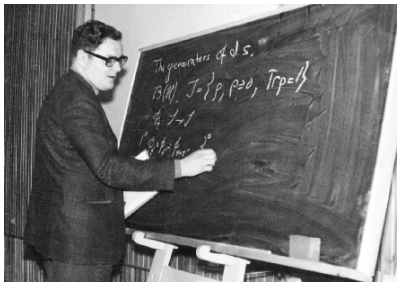
ROMP and Symposium on Mathematical Physics



- In December 1969 the first meeting of the Editorial Board of ROMP
- In 1970 first issue of ROMP is published and presented at the 2nd SMP
- SMP is organized annually (about December 6) under the nickname “imieniny Kopernika”

Visitors, collaboration, symposia





International guests of the SMP in the 1970-80s

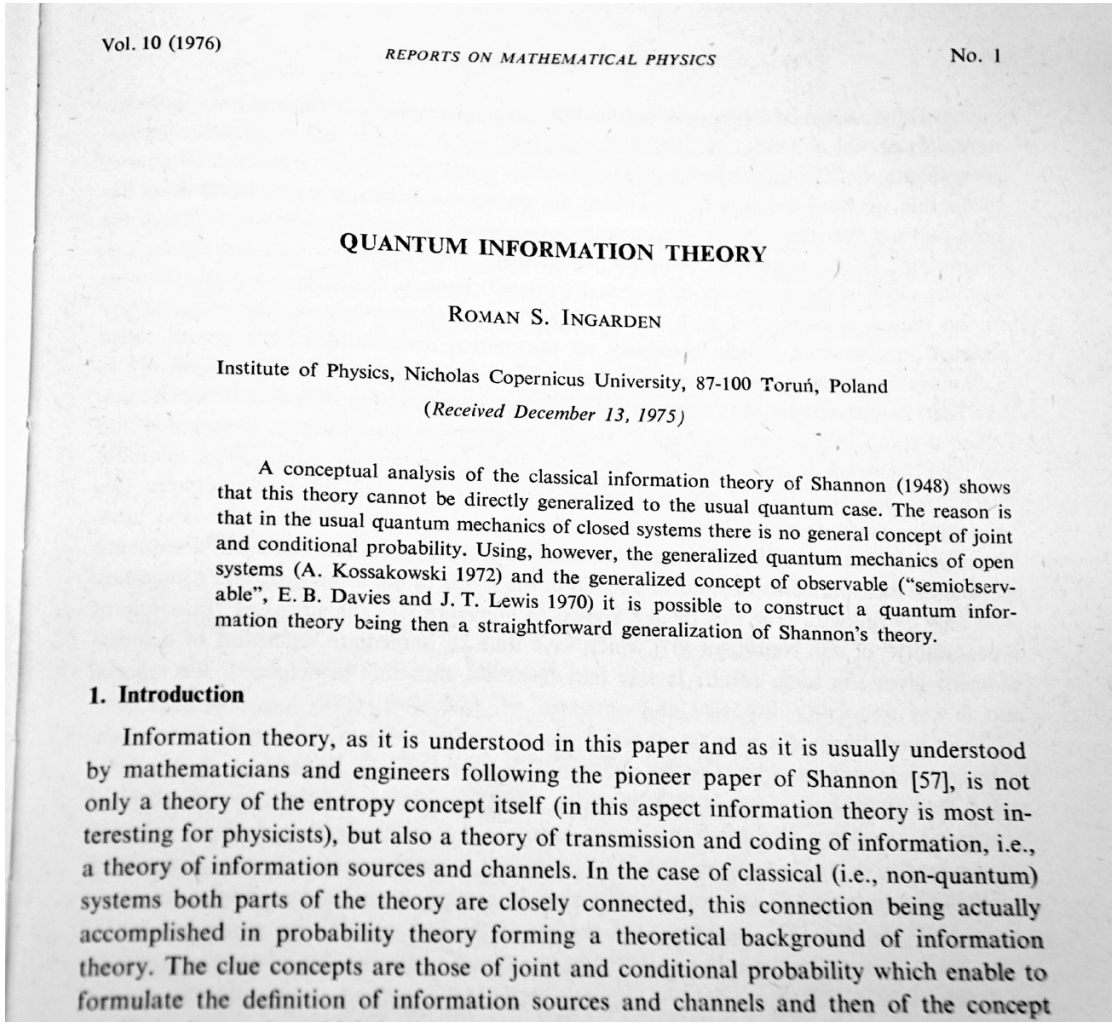
A. Holevo
G. Lindblad
G. Sudarshan
V. Gorini
A. Wehrl
O. Melsheimer
H-D. Doebner
Yu. Berezanski
V. Belavkin
A. Uhlmann
R. Streater
S. Pulmannova
P. Lahti
C. Piron
.... and many others

Clarifying the basic ideas behind open quantum systems

- A. Jamiołkowski, *Linear transformations which preserve trace and positive semidefiniteness of operators*, ROMP 3(4), 1972, 275-278.
- A. Kossakowski, *On quantum statistical mechanics of non-Hamiltonian systems*, ROMP 3, 1972, 247.
- V. Gorini, A. Kossakowski, G. Sudarsahan, *Completely positive semigroups of n-level systems*, JMP 17, 1976, 821.

The quantum information theory paper

Reports on Mathematical Physics **10**, 1976, 43–72.



Vol. 10 (1976) REPORTS ON MATHEMATICAL PHYSICS No. 1

QUANTUM INFORMATION THEORY

ROMAN S. INGARDEN

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(*Received December 13, 1975*)

A conceptual analysis of the classical information theory of Shannon (1948) shows that this theory cannot be directly generalized to the usual quantum case. The reason is that in the usual quantum mechanics of closed systems there is no general concept of joint and conditional probability. Using, however, the generalized quantum mechanics of open systems (A. Kossakowski 1972) and the generalized concept of observable ("semiobservable", E. B. Davies and J. T. Lewis 1970) it is possible to construct a quantum information theory being then a straightforward generalization of Shannon's theory.

1. Introduction

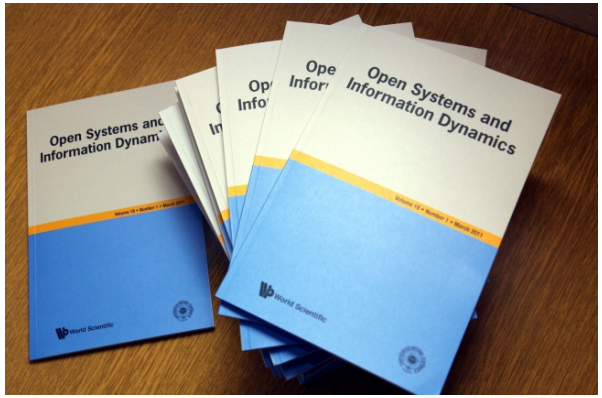
Information theory, as it is understood in this paper and as it is usually understood by mathematicians and engineers following the pioneer paper of Shannon [57], is not only a theory of the entropy concept itself (in this aspect information theory is most interesting for physicists), but also a theory of transmission and coding of information, i.e., a theory of information sources and channels. In the case of classical (i.e., non-quantum) systems both parts of the theory are closely connected, this connection being actually accomplished in probability theory forming a theoretical background of information theory. The clue concepts are those of joint and conditional probability which enable to formulate the definition of information sources and channels and then of the concept

Japan – M. Matsumoto and Finsler geometry



- 1975 first journey to Japan on invitation of Makoto Matsumoto (Kyoto University)
- subsequent long term visits at Tsukuba, Kyoto, Nagoya and Tokyo
- mid 1980-s – beginning of collaboration with Masanori Ohya (Tokyo University of Science)

Masanori Ohya, Luigi Accardi, OSID



- Open Systems & Information Dynamics — since 1992, current vol. 27 (2019 impact factor 1.96)
- New impulse to the Symposia on Mathematical Physics

Textbooks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Lech Górniewicz
Roman Stanisław Ingarden
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ALGEBRA Z GEOMETRIĄ DLA FIZYKÓW
ROMAN STANISŁAW INGARDEN
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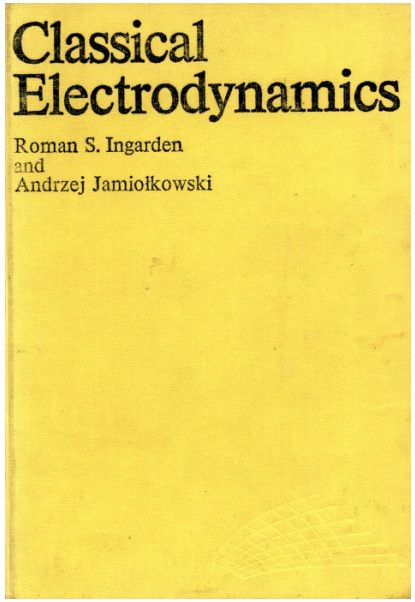
Classical Electrodynamics
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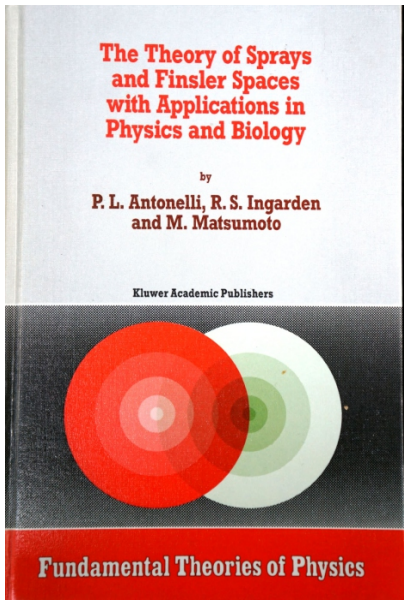
and
Andrzej Jamiołkowski


The Theory of Sprays and Finsler Spaces with Applications in Physics and Biology
by
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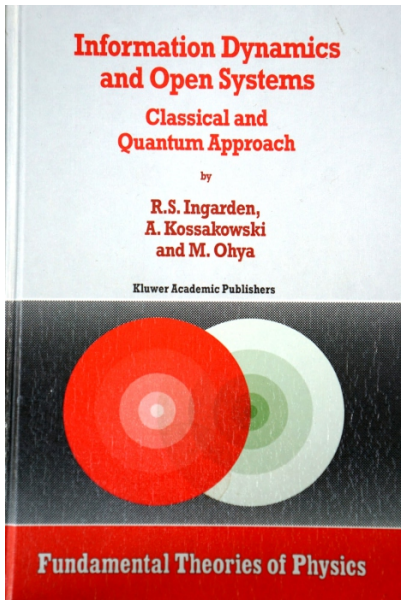
Kluwer Academic Publishers
Fundamental Theories of Physics


Information Dynamics and Open Systems
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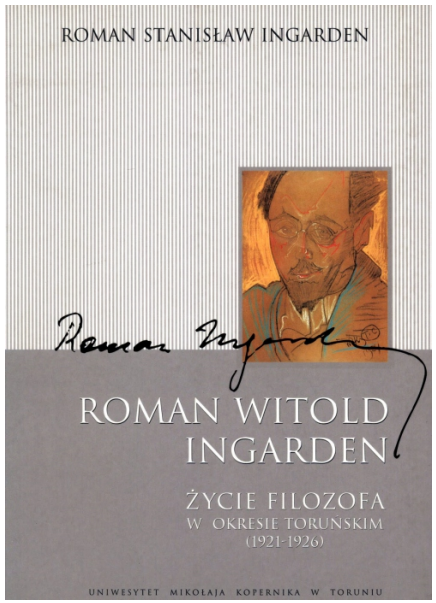
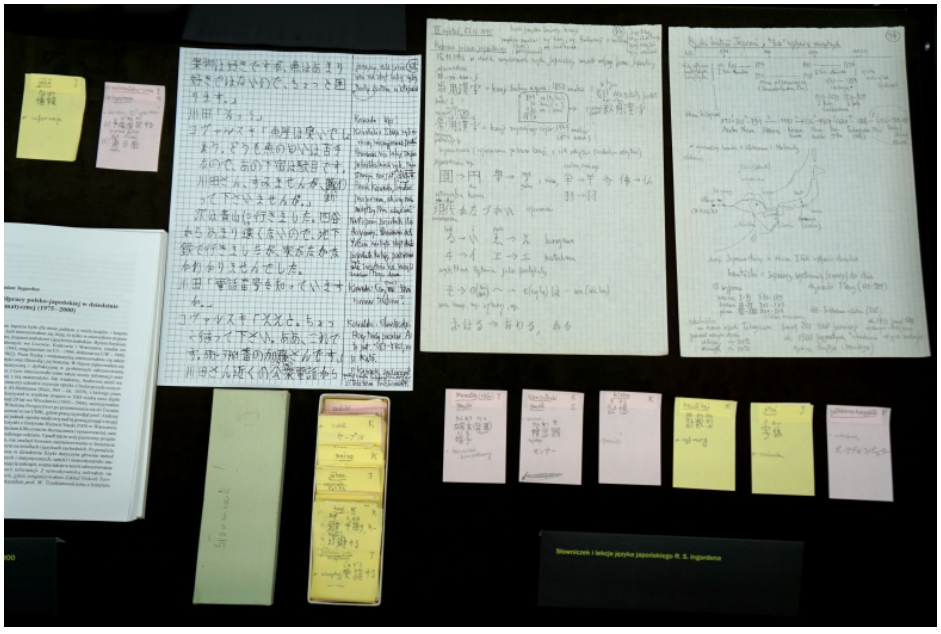
by
R.S. Ingarden, A. Kossakowski and M. Ohya
Kluwer Academic Publishers
Fundamental Theories of Physics


ROMAN STANISŁAW INGARDEN
ROMAN WITOLD INGARDEN
ŻYCIE FILOZOFA
W OKRESIE TORUŃSKIM
(1921-1926)
UNIWESYTET MIKOLAJA KOPERNIKA W TORUNIU

Retirement, Centre for Japanese Culture and Language



90th birthday – 42 Symposium on Mathematical Physics

October 2010 – a sentimental journey...