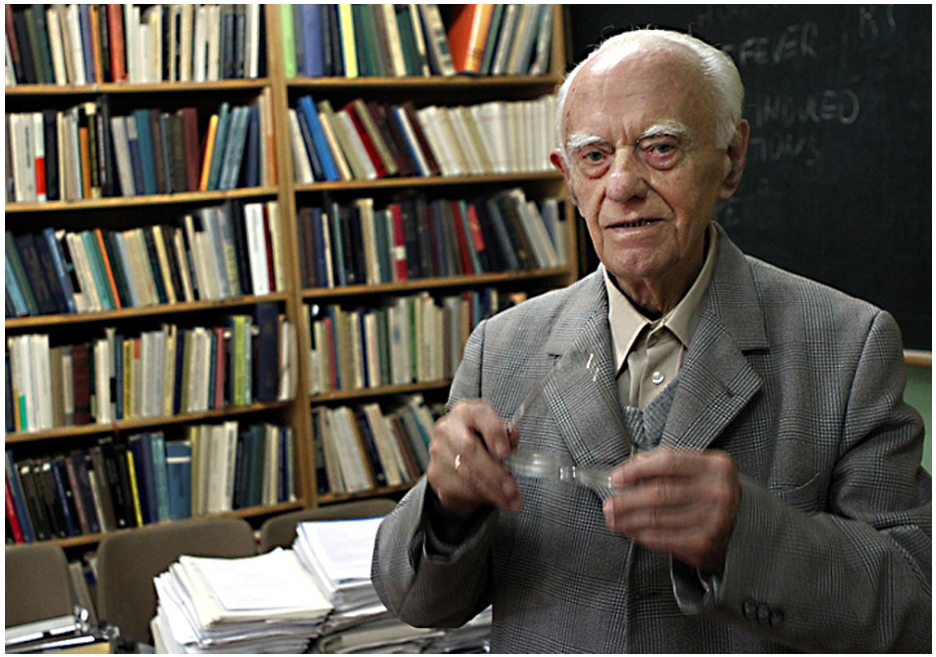
MY MEMORIES OF ROMAN STANISŁAW INGARDEN

Andrzej Jamiołkowski

Institute of Physics, Nicolaus Copernicus University

III Roman S. Ingarden Memorial Session
KCIK, Gdańsk, 30.11.2022

Roman S. Ingarden, 1.10.1920 – 12.07.2011



1. Theory of open systems
2. Journals
   - Reports on Mathematical Physics
   - Open Systems & Information Dynamics
3. Monograps and textbooks
4. Japanese culture and language
5. Recognition

Theory of open systems and quantum information

QUANTUM INFORMATION THEORY

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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 of channel capacity which is the most important for Shannon's coding theorems. In the case of quantum systems the probability theory has to be essentially generalized, cf. [4], [18], [63], [64], [65], and the concepts of joint and conditional probability appear to be very specialized, i.e., cannot be defined for the general case, except in principle for the trivial case, i.e., for the commuting observables; for details cf. [63]. This circumstance caused that when it was necessary to consider communication problems for the needs of quantum electronics and optics, this had to be done by other means, not those of Shannon's information theory, e.g., by the so-called signal detection theory, cf. [24], [25], by Fourier analysis methods, cf. [13], [14], or by combination of these methods with some other heuristic physical arguments, cf. [21], [61], [36]. Finally, however, it has been realized that, because of the lack of the quantitative concept of information in these methods, they

Reports on Mathematical Physics

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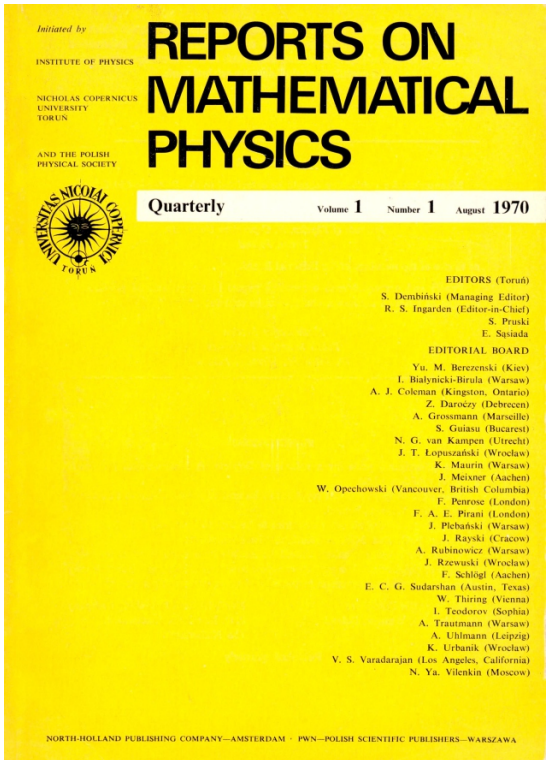
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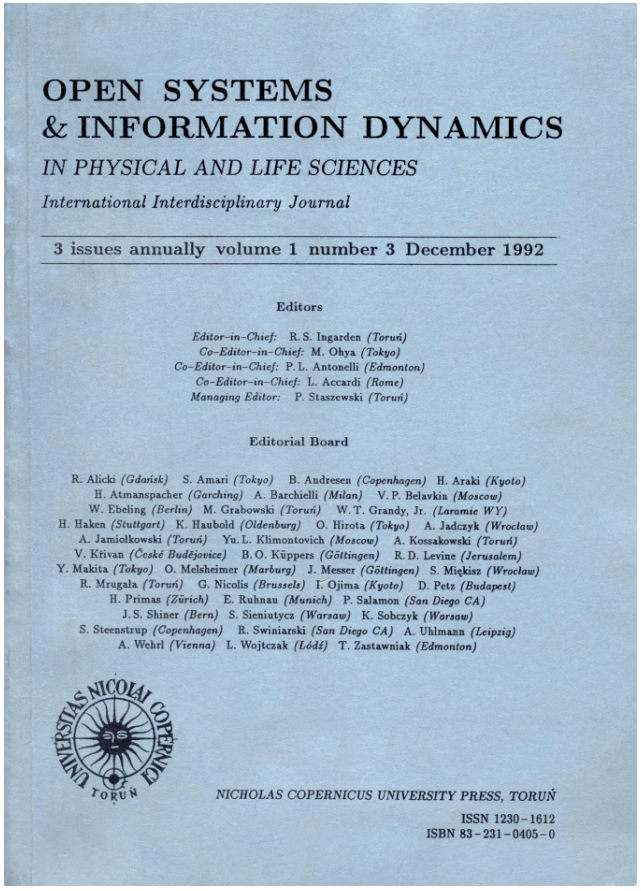

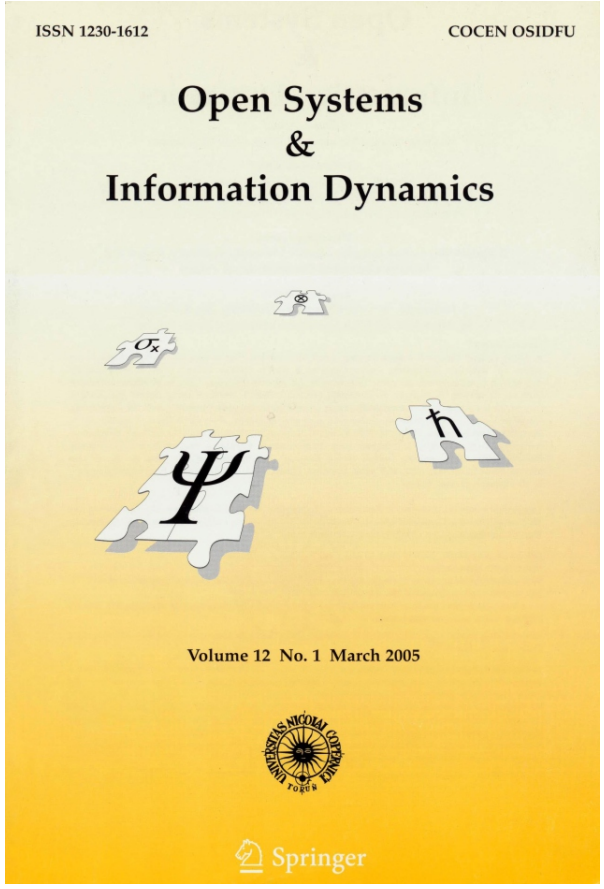

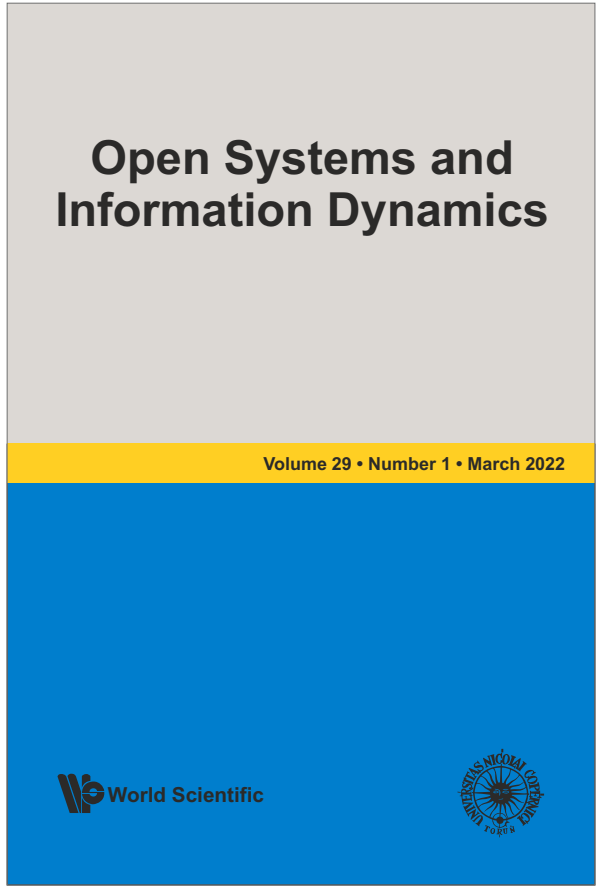

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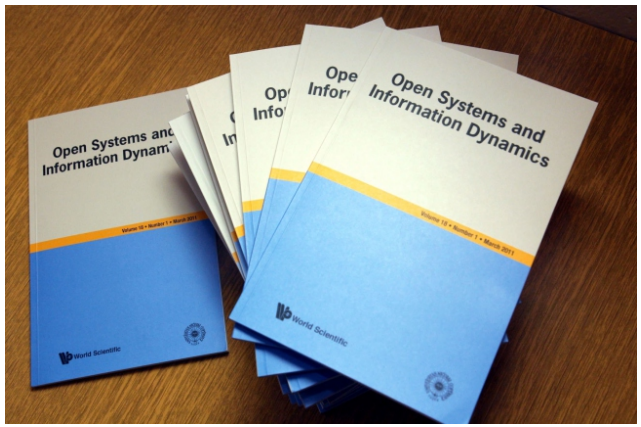

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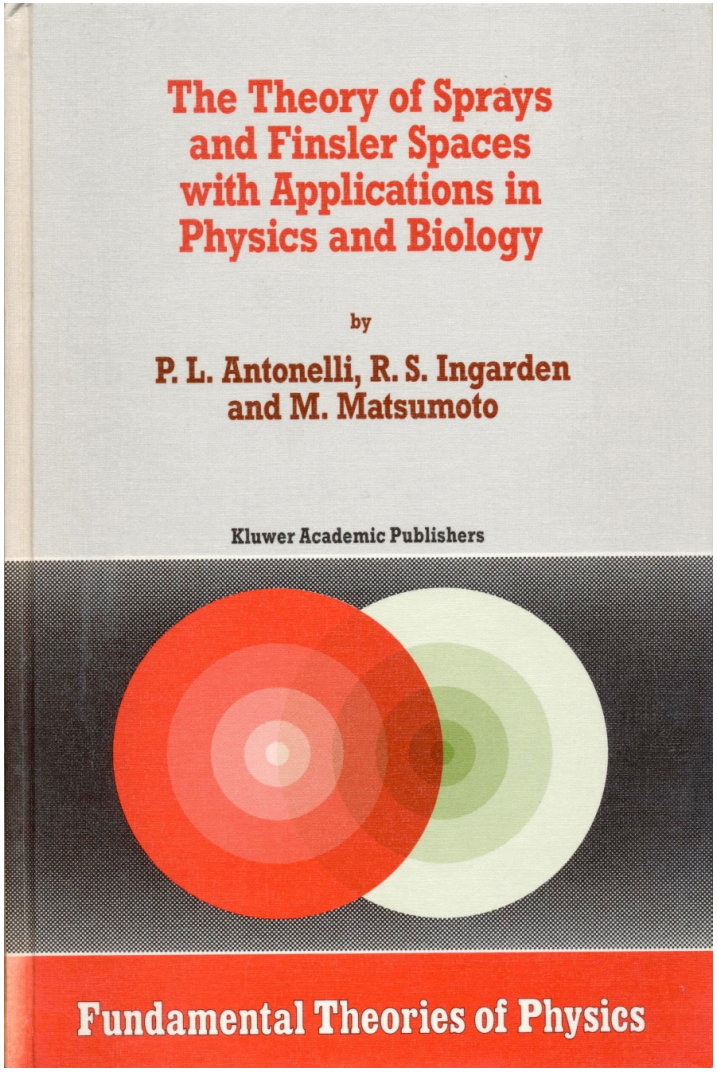
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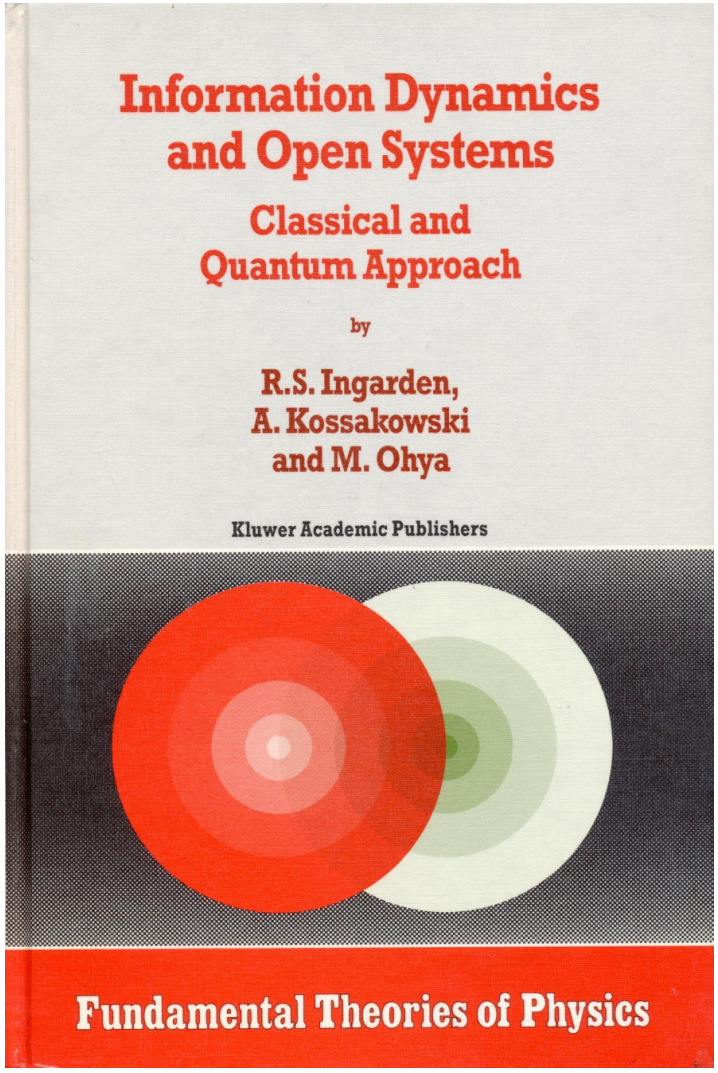
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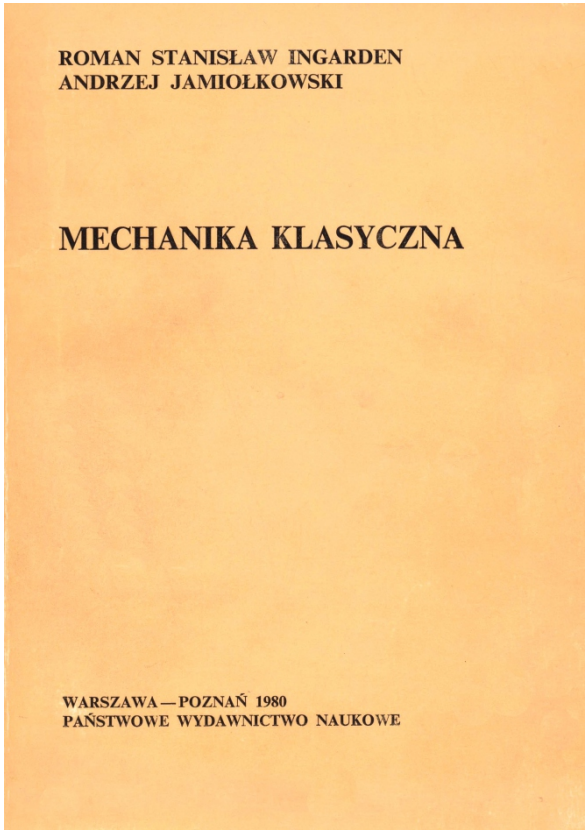
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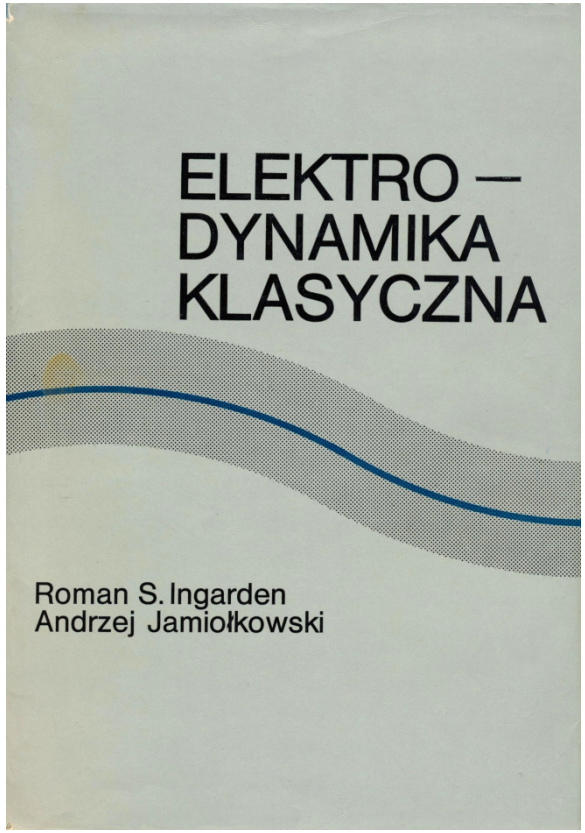
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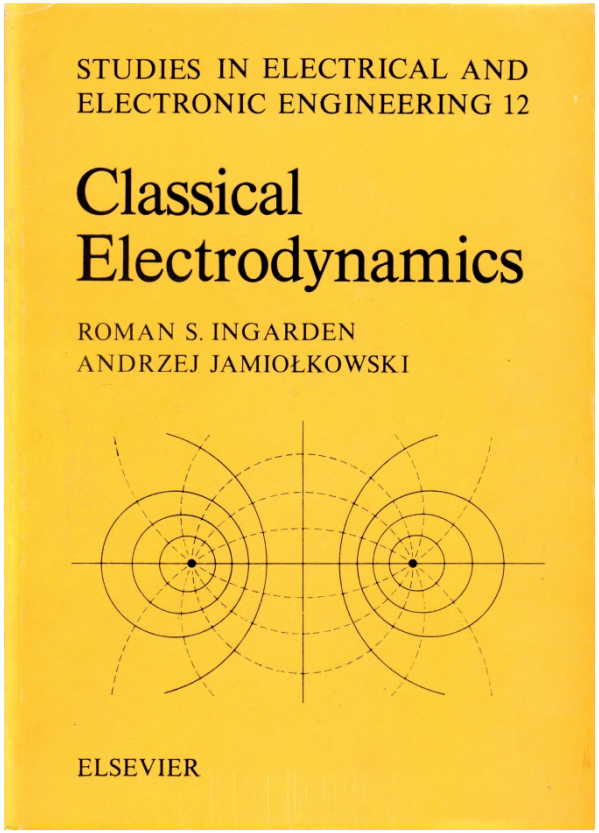
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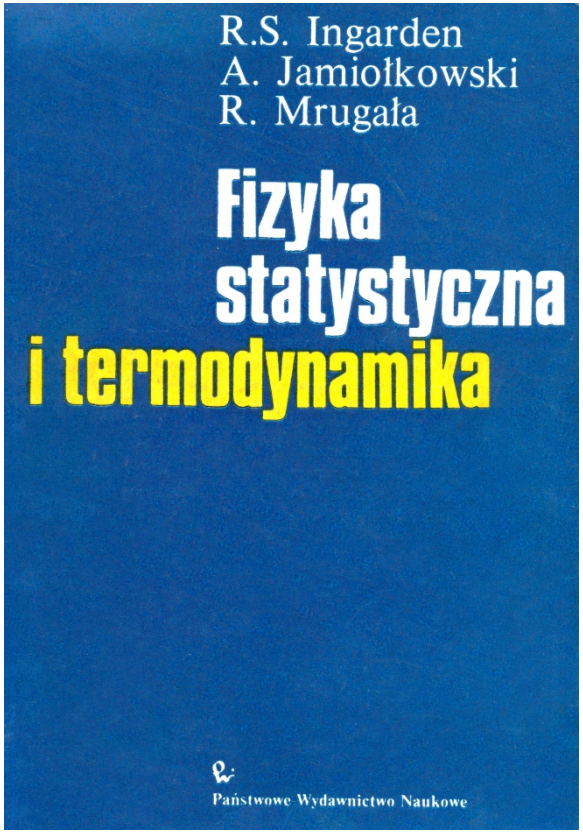
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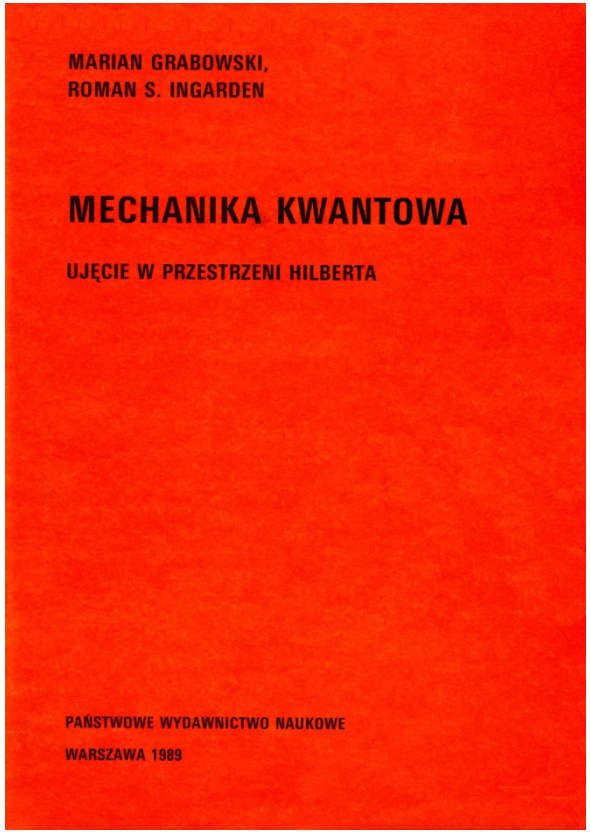
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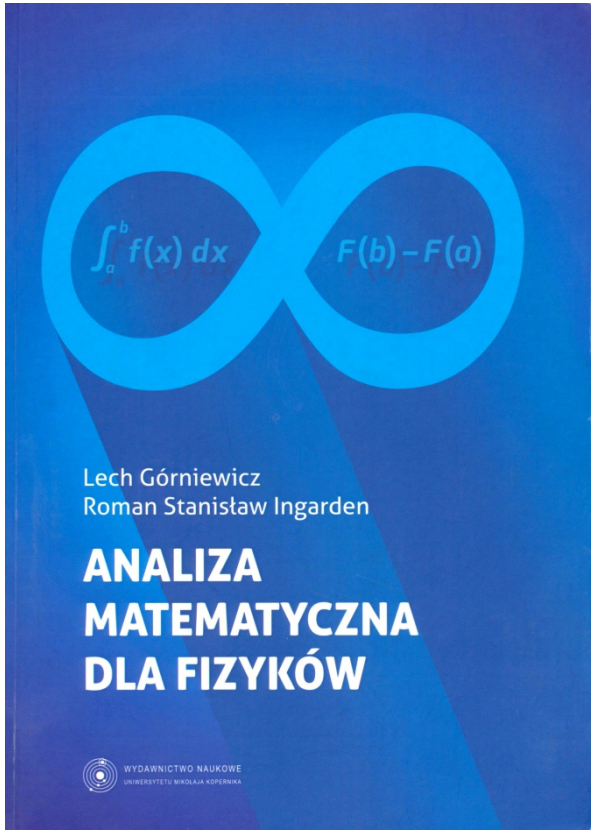
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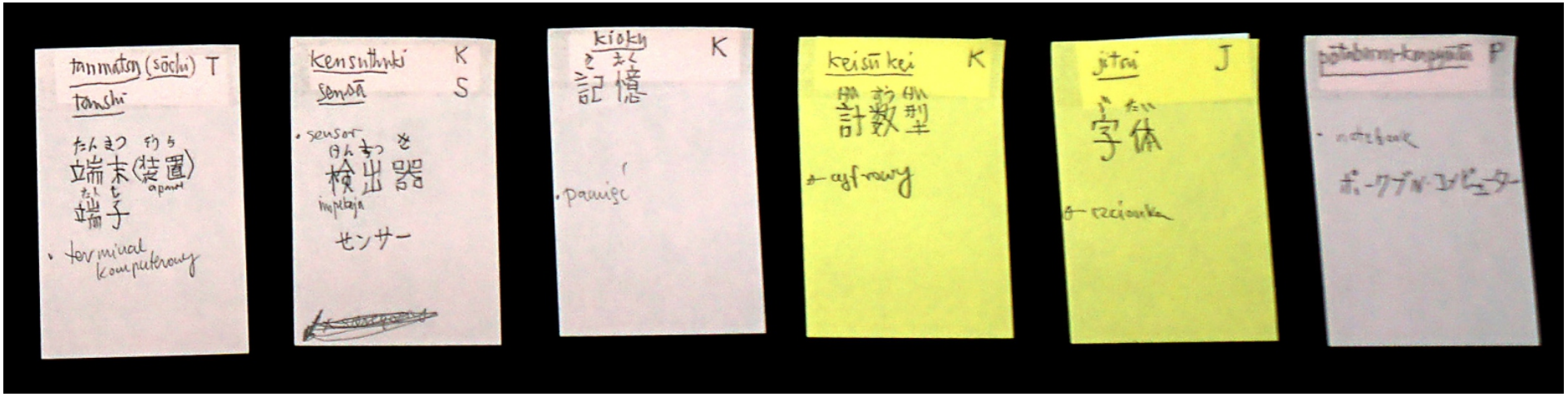
Collaboration with Japan

The Japanese culture and language in Toruń



Recognition

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