In memory of Professor Andrzej Kossakowski

Dariusz Chruściński

Nicolaus Copernicus University, Toruń, POLAND

SMP 52, Toruń June 14 2021

Andrzej Kossakowski (1938-2021)

Born in Lwów (Lviv)

Nicolaus Copernicus University (PhD 1966)

Scientific activity

- open quantum systems
- quantum statistical mechanics (3D Ising model)
- quantum chaos
- quantum entropies
- quantum information theory
- quantum probability
- ...

Markovian semigroups

Vol. 3 (1972) *REPORTS ON MATHEMATICAL PHYSICS* No. 4

ON QUANTUM STATISTICAL MECHANICS OF NON-HAMILTONIAN SYSTEMS

A. KOSSAKOWSKI

Institute of Physics, Nicholas Copernicus University, Toruń, Poland

(*Received November 9, 1971*)*

An axiomatic definition of time evolution (dynamical semi-group) of a physical system has been given. A dynamical semi-group is defined as a one-parameter semi-group of linear endomorphisms of the set of all density operators corresponding to the physical system in question. Some classes of dynamical semi-groups (quantum Poisson and Brownian processes) induced by Markov processes on topological groups are described. Examples of dynamical semi-groups for the harmonic oscillator are given.

Lindblad cited in his 1976 paper

Generators of Quantum Semigroups 129

As special cases we can mention the generators of Gaussian semigroups.

$$L(X) = VXV - \tfrac{1}{2}\{V^2, X\} \quad V \text{ s.a.},$$

and Poisson semigroups

$$L(X) = V^+XV - X \qquad V \text{ unitary}.$$

Kossakowski [8] treated these cases in detail.

Markovian semigroups

THEORETICAL PHYSICS

On Necessary and Sufficient Conditions for a Generator of a Quantum Dynamical Semi-Group

by

A. KOSSAKOWSKI

Presented by W. RUBINOWICZ on June 14, 1972

Summary. A dynamical semi-group has been defined as a one-parameter contracting semi-group of trace preserving linear operators on the real Banach space $L^1(\mathcal{H})$ of self-adjoint trace class linear operators on a separable complex Hilbert space $\mathcal{H}$. It has been proved that a linear operator L with the domain $D(L)$ and the range $R(L)$ both in $L^1(\mathcal{H})$ generates dynamical semi-group $\mathcal{S}(\mathcal{H}) = \{S_t; t \geq 0\}$ iff the domain $D(L)$ is dense in $L^1(\mathcal{H})$, $R(I-L) = L^1(\mathcal{H})$, L is a dissipative operator in the sense of Lumer and Phillips, and $\mathrm{Tr}(Lp) = 0$ for all $p \in D(L)$. The resulting master equation $d/dt(S_t p) = L(S_t p)$, $p \in D(L)$, satisfies the positivity and normalization requirements.

Positive trace-preserving semigroups

Theorem 2.1. In order for a linear map $L : M(N) \to M(N)$ to be the generator of a dynamical semigroup of $M(N)$ it is necessary and sufficient that the conditions

$$\mathrm{tr}[P_r(LP_s)] \geqslant 0, \quad r \neq s = 1, 2, \ldots, N \tag{2.1}$$

and

$$\sum_{r=1}^{N} \mathrm{tr}[P_r(LP_s)] = 0, \quad s = 1, 2, \ldots, N \tag{2.2}$$

hold for all $\{P_1, P_2, \ldots, P_N\} \in \mathcal{P}_N$. Condition (2.2) is necessary and sufficient for L to generate a trace preserving semigroup, whereas (2.1) expresses the positivity requirement.

Completely positive dynamical semigroups of *N*-level systems*

Vittorio Gorini† and Andrzej Kossakowski‡

Department of Physics, Center for Particle Theory, University of Texas at Austin, Austin, Texas 78712

E. C. G. Sudarshan

Department of Physics, Center for Particle Theory, University of Texas at Austin, Austin, Texas 78712 and Centre for Theoretical Studies, Indian Institute of Science, Bangalore 560012, India
(Received 19 March 1975)

We establish the general form of the generator of a completely positive dynamical semigroup of an N-level quantum system, and we apply the result to derive explicit inequalities among the physical parameters characterizing the Markovian evolution of a 2-level system.

I. INTRODUCTION

the gme does indeed go over into

GKS 1976

Theorem 2.2. A linear operator $L : M(N) \to M(N)$ is the generator of a completely positive dynamical semigroup of $M(N)$ if it can be expressed in the form

$$L : \rho \to L\rho = -i[H, \rho] + \frac{1}{2} \sum_{i,j=1}^{N^2-1} c_{ij} \{[F_i, \rho F_j^*] + [F_i \rho, F_j^*], \quad \rho \in M(N), \tag{2.3}$$

Open Systems & Information Dynamics
Vol. 24, No. 3 (2017) 1740001 (20 pages)
DOI:10.1142/S1230161217400017

World Scientific
www.worldscientific.com

A Brief History of the GKLS Equation

Dariusz Chruściński

Institute of Physics, Faculty of Physics, Astronomy and Informatics
Nicolaus Copernicus University, Grudziądzka 5/7, 87–100 Toruń, Poland

e-mail: darch@fizyka.umk.pl

Saverio Pascazio

Dipartimento di Fisica and MECENAS, Università di Bari, I-70126 Bari, Italy
Istituto Nazionale di Ottica (INO-CNR), I-50125 Firenze, Italy
INFN, Sezione di Bari, I-70126 Bari, Italy

e-mail: saverio.pascazio@ba.infn.it

Possibility of the total thermodynamic entropy production rate of a finite-sized isolated quantum system to be negative for the Gorini-Kossakowski-Sudarshan-Lindblad-type Markovian dynamics of its subsystem

Takaaki Aoki,[1,2,*] Yuichiro Matsuzaki,[2,†] and Hideaki Hakoshima[2,‡]

[1]*Department of Physics, The University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8574, Japan*

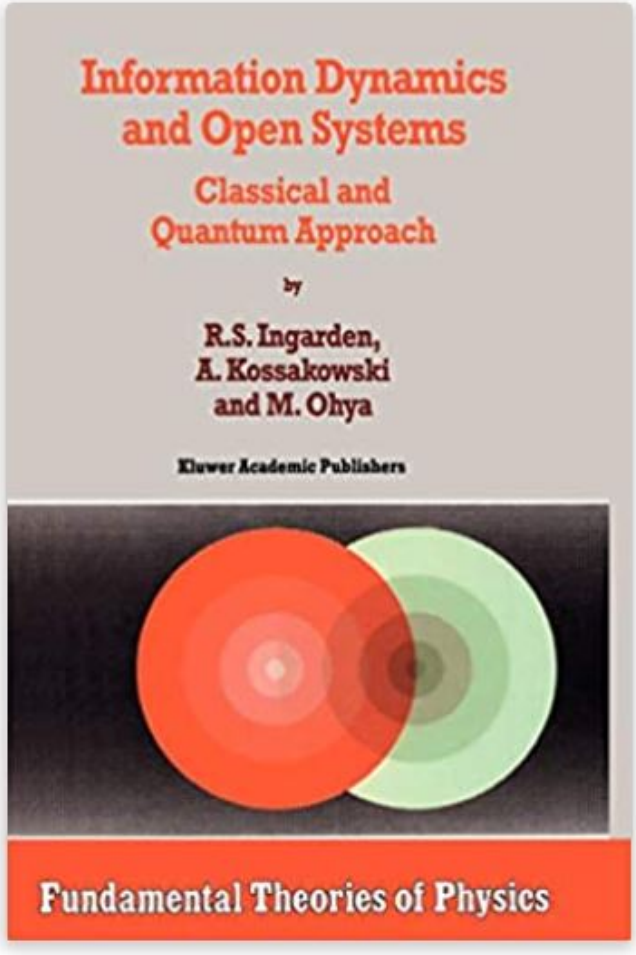
[2]*Research Center for Emerging Computing Technologies (RCECT), National Institute of Advanced Industrial Science and Technology (AIST), 1-1-1 Umezono, Tsukuba, Ibaraki 305-8568, Japan*

(Received 9 March 2021; accepted 27 April 2021; published 17 May 2021)

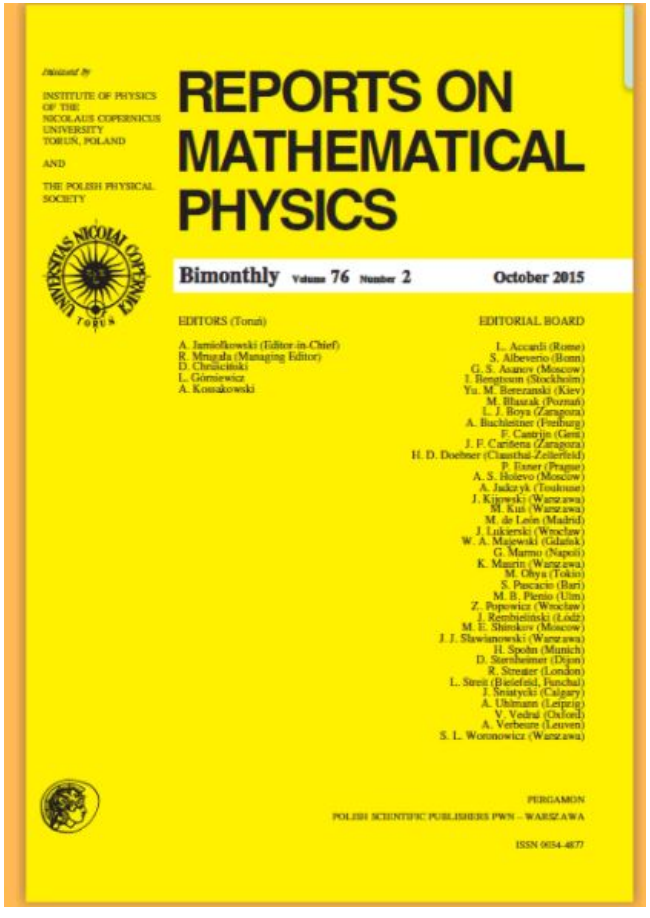
We investigate a total thermodynamic entropy production rate of an isolated quantum system. In particular, we consider a quantum model of coupled harmonic oscillators in a star configuration, where a central harmonic oscillator (system) is coupled to a finite number of surrounding harmonic oscillators (bath). In this model, when the initial state of the total system is given by the tensor product of the Gibbs states of the system and the bath, every harmonic oscillator is always in a Gibbs state with a time-dependent temperature. This enables us to define time-dependent thermodynamic entropy for each harmonic oscillator and total nonequilibrium thermodynamic entropy as the summation of them. We analytically confirm that the total thermodynamic entropy satisfies the third law of thermodynamics. Our numerical solutions show that, even when the dynamics of the system is well approximated by the Gorini-Kossakowski-Sudarshan-Lindblad (GKSL)-type Markovian master equation, the total thermodynamic entropy production rate can be negative, while the total thermodynamic entropy satisfies the second law of thermodynamics. This result is a counterexample to the common belief that the total entropy production rate is non-negative when the system is under the GKSL-type Markovian dynamics.

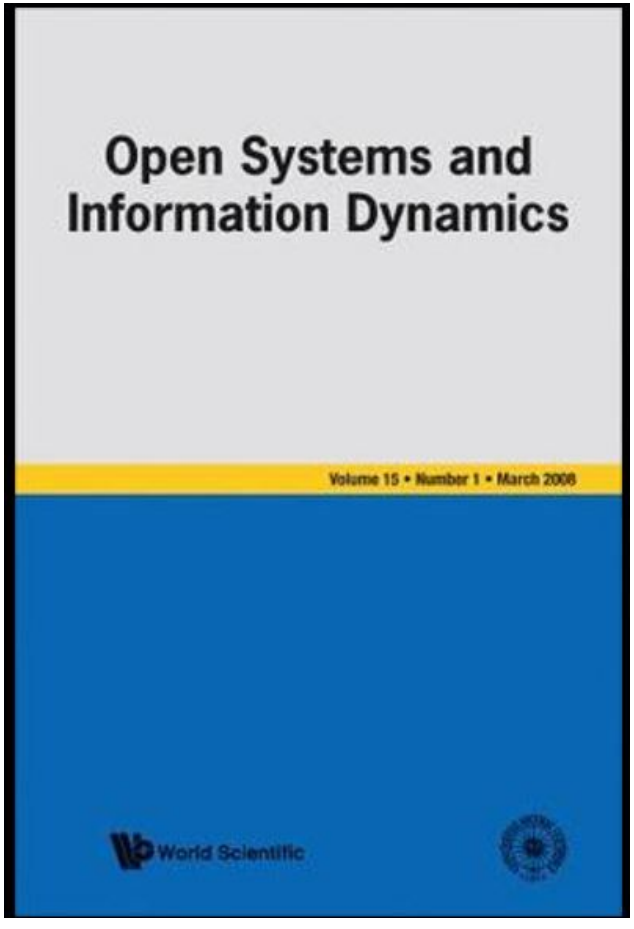
Ingarden-Kossakowski-Sudarshan-Gorini

Ingarden-Kossakowski-Ohya



ROMP & OSID


REPORTS ON MATHEMATICAL PHYSICS
Bimonthly Volume 76 Number 2 October 2015
EDITORS (Toruń)
A. Jamiołkowski (Editor-in-Chief)
R. Mrugała (Managing Editor)
D. Chruściński
L. Górniewicz
A. Kossakowski
EDITORIAL BOARD
PERGAMON
POLISH SCIENTIFIC PUBLISHERS PWN – WARSZAWA

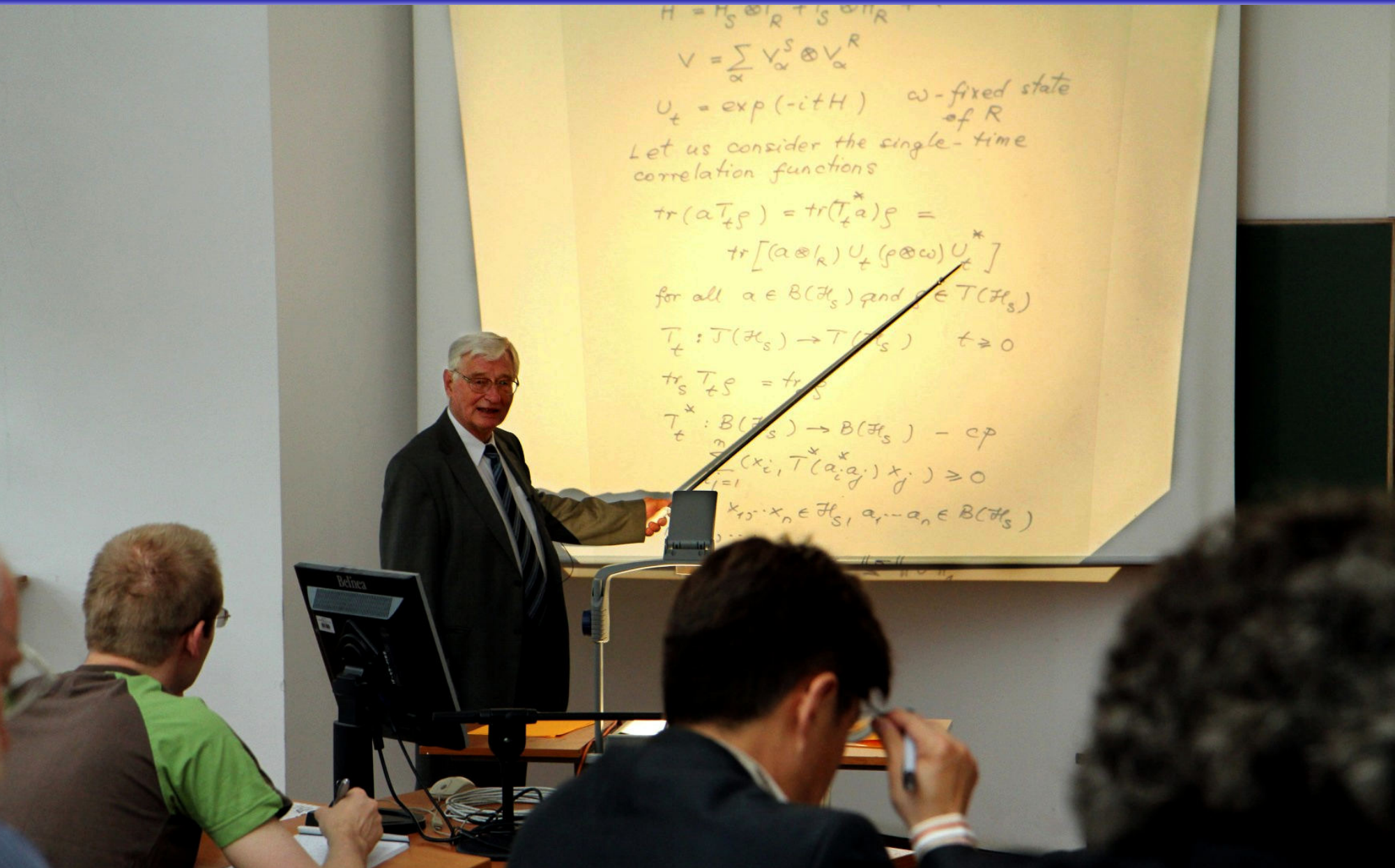

Open Systems and Information Dynamics
Volume 15 • Number 1 • March 2008
World Scientific


M. Ohya
A. Kossakowski

40 SMP (Toruń 2008)

40 SMP (Toruń 2008)

44 SMP (Toruń 2012)



40 years after (Toruń 2016)

40 years after (Toruń 2016)

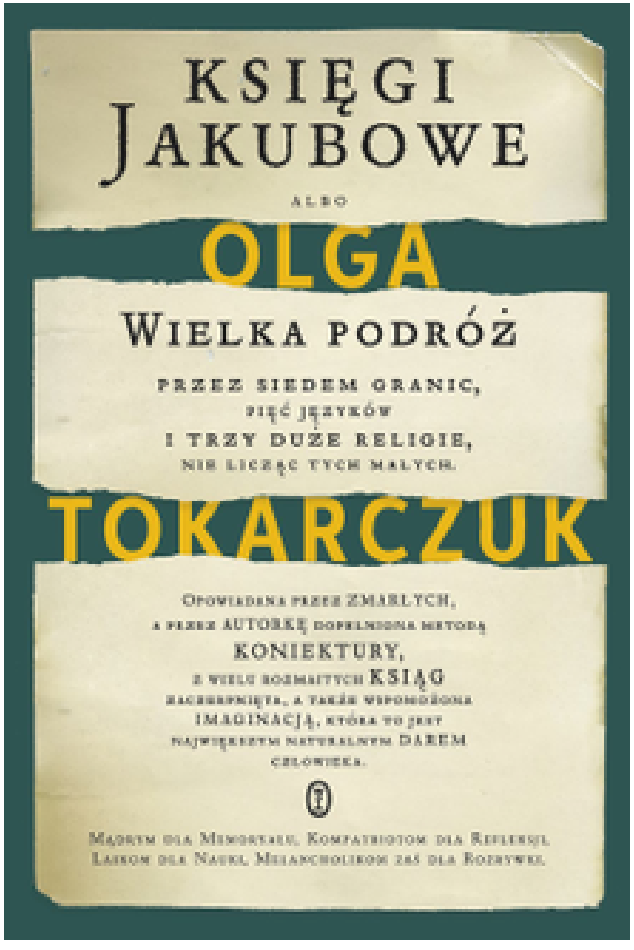
Polish Nobel Prize

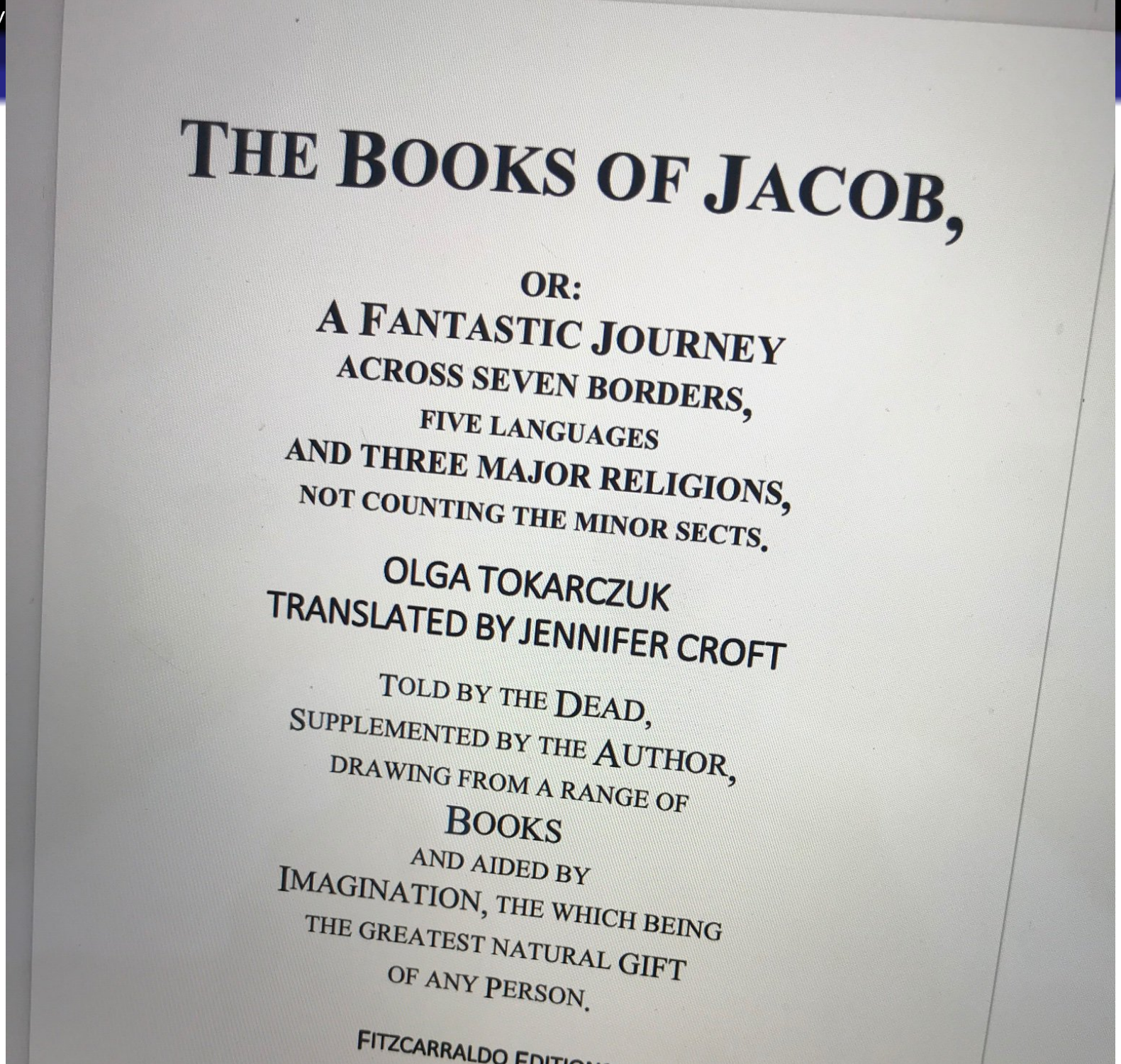
PROF. ANDRZEJ KOSSAKOWSKI – FNP PRIZE LAUREATE 2019


PROF. KOSSAKOWSKI HURRAY


THE NOBEL PRIZE IN LITERATURE 2018
THE NOBEL PRIZE IN LITERATURE 2019
Illustrations: Niklas Elmehed
Olga Tokarczuk
"for a narrative imagination that with encyclopedic passion represents the crossing of boundaries as a form of life."
Peter Handke
"for an influential work that with linguistic ingenuity has explored the periphery and the specificity of human experience."
THE SWEDISH ACADEMY

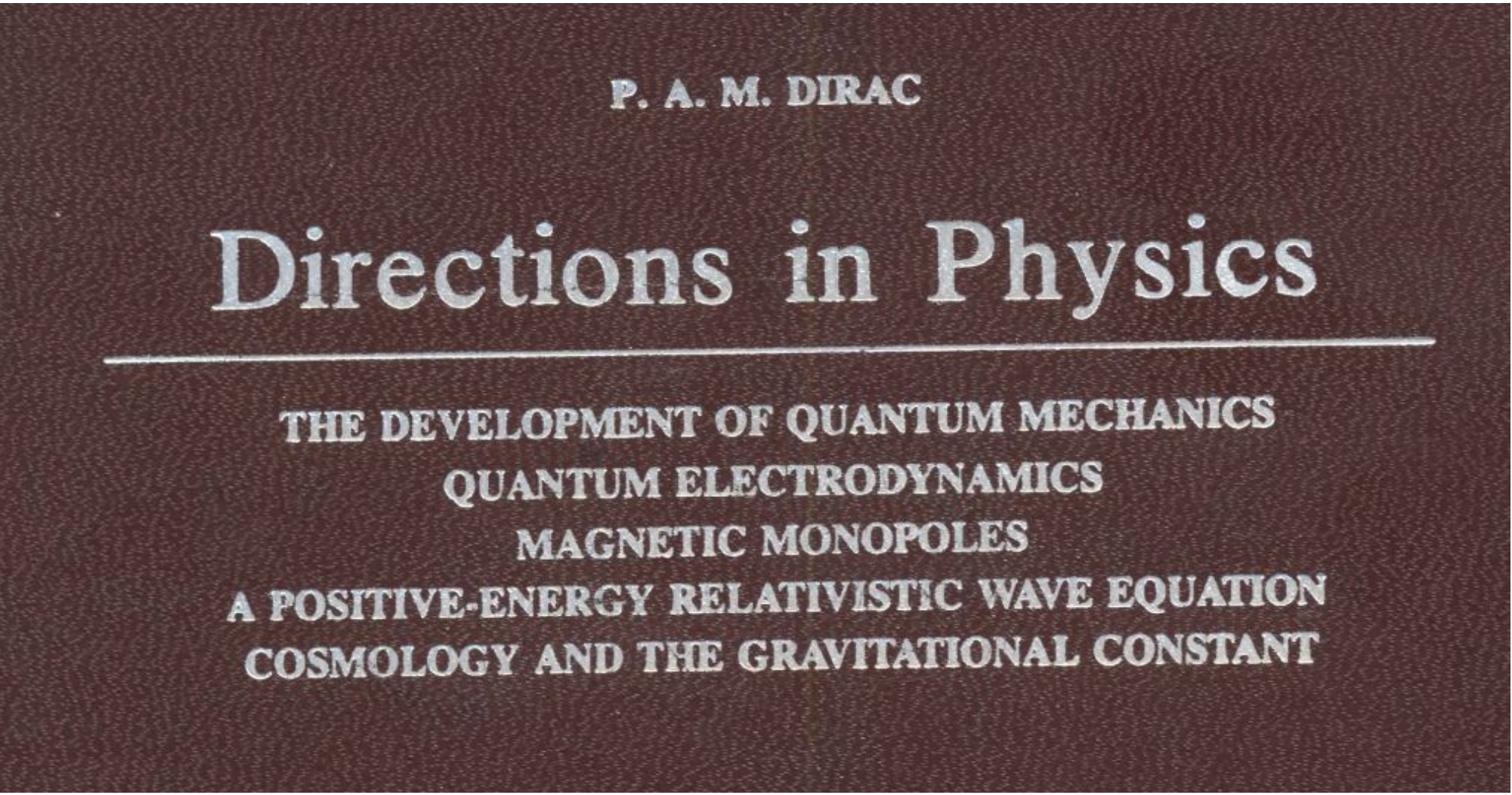
Olga Tokarczuk "The Books of Jacob"




THE BOOKS OF JACOB,
OR:
A FANTASTIC JOURNEY
ACROSS SEVEN BORDERS,
FIVE LANGUAGES
AND THREE MAJOR RELIGIONS,
NOT COUNTING THE MINOR SECTS.
OLGA TOKARCZUK
TRANSLATED BY JENNIFER CROFT
TOLD BY THE DEAD,
SUPPLEMENTED BY THE AUTHOR,
DRAWING FROM A RANGE OF
BOOKS
AND AIDED BY
IMAGINATION, THE WHICH BEING
THE GREATEST NATURAL GIFT
OF ANY PERSON.
FITZCARRALDO

Honorary citizen of Toruń (2020)


Andrzej Kossakowski
2020
ANDRZEJ KOSSAKOWSKI
PROFESOR NAUK FIZYCZNYCH


P. A. M. DIRAC
Directions in Physics
THE DEVELOPMENT OF QUANTUM MECHANICS
QUANTUM ELECTRODYNAMICS
MAGNETIC MONOPOLES
A POSITIVE-ENERGY RELATIVISTIC WAVE EQUATION
COSMOLOGY AND THE GRAVITATIONAL CONSTANT

from "Directions in Physics"by Dirac (1978)

It was a game, a very interesting game one could play. Whenever one solved one of the little problems, one could write a paper about it. It was very easy in those days for any second-rate physicist to do first-rate work. There has not been such a glorious time since then. It is very difficult now for a first-rate physicist to do second-rate work.

Andrzej Kossakowski managed to do the first-rate work