

Ihor Lubashevsky

# Physics of the Human Mind

# Contents

<b>1 Modeling of Human Behavior as Individual Branch of Physics and Mathematics .....</b>	<b>1</b>
1.1 Can Physics Describe Human Behavior? .....	1
1.2 Humans as Multilevel Objects.....	4
1.3 Cooperative Social Systems .....	7
1.4 Characteristic Element and Local Self-Averaging .....	11
1.5 Ceteris Paribus Laws of Cooperative Social Systems .....	17
1.6 Formalism of Classical Physics and the Dominant Role of the Present .....	28
1.7 Effective Dualism of Human Mind and Social Systems .....	34
1.8 Holism of Social Systems and Effective Dualism .....	39
1.9 Conclusion .....	40
<b>2 Why Laws of Classical Physics Have Their Form .....</b>	<b>43</b>
2.1 Principle of Microscopic Level Reducibility .....	43
2.2 Thick Presentism and Formalism of Differential Equations in Classical Physics .....	46
2.2.1 Presentism and the Time Flow .....	46
2.2.2 Thick Presentism with Moving Window of Existence .....	51
2.2.3 Steady-State Laws of System Dynamics .....	55
2.2.4 Variational Formulation of Steady-State Dynamics.....	56
2.3 Notion of Phase Space .....	57
2.4 Energy Conservation and Newton's Second Law .....	61
2.5 Probability Theory and Newtonian Mechanics .....	67
2.6 Superposition Principle of Particle Interaction .....	71
2.7 Mesoscopic Level of Description and Effective Theories.....	76
2.8 Conclusion .....	81
<b>3 Fodor-Kim Dilemma.....</b>	<b>85</b>
3.1 Emergence and Mesolevel Fundamentals: Philosophical Aspects....	86
3.2 Multiple Realizability with Wild Disjunction: Fodor's Argument for Nonreductive Physicalism .....	90

3.3	Generalization of Downward Causation .....	92
3.4	Effective Theories and Inter-level Causality .....	95
3.5	Mesolevel Description and Its Characteristic Properties .....	98
3.6	Kim's Exclusion Problem .....	102
3.6.1	Premise 1 of Kim's Argumentation: Supervenience of the Mental upon the Physical.....	103
3.6.2	Alternative to Premise 1: Mental-Physical Supervenience Without Causality .....	105
3.6.3	Premise 2 of Kim's Argumentation: Causal Closure of the Physical .....	119
3.6.4	Alternative to Premise 2: Three Versions of the Causal Closure of the Physical .....	119
3.6.5	Premise 3 of Kim's Argumentation: Causal Exclusion .....	122
3.6.6	The Problem of Mental Causation: Kim's Argument .....	123
3.6.7	Mental Causation and Attractor-Caused Mental-Physical Supervenience .....	123
3.7	Other Approaches to the Fodor-Kim Dilemma .....	125
3.7.1	Santos's Account: Causation from a Relational Ontological Perspective .....	126
3.7.2	Campbell's Account: Causation from a Process Ontology Perspective .....	127
3.8	Conclusion .....	129
<b>4</b>	<b>Strong Emergence Via Constitutive Fields .....</b>	<b>133</b>
4.1	Entity-Relation Process Ontology .....	134
4.2	Architecture of Complex Systems from Entity-Relation Process Ontology Perspective .....	140
4.3	Emergence from Entity-Relation Process Ontology Perspective .....	142
4.4	Phase Transitions in Physical Systems and Entity-Relation Process Ontology .....	146
4.5	Supervenience from Entity-Relation Process Ontology Perspective .....	148
4.6	Reductionism and Entity-Relation Process Ontology .....	150
4.7	Nonlinear Meso-relational Media: Illustrating Model of Systems with Holistic Properties .....	155
4.7.1	Model Background: Maxwell's Equations .....	155
4.7.2	Model: Nonlinear Meso-relational Field .....	158
4.7.3	Strong Emergence of the Field $u$ .....	160
4.7.4	Self-Localization of the Field $u$ .....	166
4.8	Conclusion: Concept of Meso-relational Media .....	169
<b>5</b>	<b>Non-Cartesian Dualism and Meso-relational Media .....</b>	<b>171</b>
5.1	Dualism and Its Varieties .....	173
5.1.1	Brief History of Mind-Body Dualism .....	174
5.1.2	Predicate Dualism .....	178
5.1.3	Property Dualism .....	179

5.1.4 Substance Dualism: Cartesian Viewpoint .....	183
5.2 Non-Cartesian Dualism: Modern Versions .....	185
5.2.1 Lowe's Non-Cartesian Substance Dualism .....	186
5.2.2 Emergent Dualism .....	188
5.2.3 Actual Problems of Non-Cartesian Dualism .....	189
5.3 Process Dualism of Human Nature: Hypothesis.....	190
5.3.1 Background of Process Dualism .....	190
5.3.2 Physical and Non-physical .....	193
5.3.3 Process Dualism .....	198
5.4 Conclusion .....	208
<b>6 Modeling of Human Behavior Within the Paradigm of Modern Physics .....</b>	<b>213</b>
6.1 Nonlinear Dynamical Systems and Self-Organization .....	214
6.1.1 Phase Space of Physical Systems .....	214
6.1.2 The Concept of Stationary Point .....	215
6.1.3 Self-Organization of Spatio-Temporal Patterns .....	217
6.1.4 Stochastic Dynamics.....	221
6.2 Self-Driven Many-Element Ensembles .....	223
6.3 Statistical Social Systems with Probabilistic Dynamics .....	228
6.4 Intentional Human Movements.....	234
6.4.1 Computational Approach .....	235
6.4.2 Physical Approach .....	237
6.4.3 Dynamical Approach .....	239
6.5 Synergy of Brain Dynamics .....	243
6.6 Conclusion .....	248
<b>7 Emergent Phenomena Caused by Bounded Capacity of Human Cognition .....</b>	<b>251</b>
7.1 Space-Time Cloud of Complex Present .....	252
7.2 Fuzzy Points as Dynamical Traps .....	255
7.2.1 Notion of Dynamical Trap as Stationary Point Generalization.....	255
7.2.2 Model of Oscillator with Dynamical Trap.....	260
7.2.3 Fuzzy Rational Strategy of Behavior and Action Dynamical Trap .....	265
7.3 Phase Transitions Caused by Single Dynamical Trap .....	271
7.3.1 Oscillator with Dynamical Trap: Constructive Role of Noise .....	271
7.3.2 Oscillator with Action Dynamical Trap: Absolute Instability.....	276
7.4 Cooperative Phenomena Caused by Dynamical Traps .....	280
7.4.1 Chain of Oscillators with Dynamical Traps: Model .....	280
7.4.2 Chain of Oscillators with Dynamical Traps: Complexity of Dynamics .....	284

7.4.3	Chain of Oscillators with Dynamical Traps: Constructive Role of Noise .....	289
7.4.4	Chain of Oscillators with Action Dynamical Traps: Need for Collaboration .....	294
7.5	Balancing of Pendulum with Overdamped Dynamics and Complex Present .....	297
7.5.1	Human Intermittent Control: General Approach .....	298
7.5.2	Balancing of Virtual Pendulum: Experimental Setup .....	301
7.5.3	Balancing of Virtual Pendulum: Universality of Subject's Behavior .....	304
7.5.4	Inverted Pendulum with Over-damped Dynamics as a Nomological Machine .....	308
7.5.5	Inverted Pendulum with Over-damped Dynamics as a System with Dynamical Trap .....	310
7.5.6	Dynamical Trap Model of Stick Balancing and Action Points .....	315
7.5.7	Can Nomological Machines Describing Human Behavior Be Merged? .....	318
7.6	Human Intermittent Control in Car Driving .....	325
7.6.1	Car Driving Simulator and Experimental Setup .....	326
7.6.2	Phase Space of Car Dynamics and the Main Control Parameter .....	327
7.6.3	Mesolevel Intermittency of Subject's Action .....	334
7.6.4	Four-Dimensional Theory of Car-Following: Action Dynamical Trap Model .....	335
7.7	Conclusion .....	343
	<b>Epilog: Physics and Human Mind .....</b>	345
	<b>References .....</b>	347
	<b>Index .....</b>	377