

Contents

<i>Preface</i>	xi
1. Introduction	1
1.1. Individuality, Distinguishability, and Identity	4
1.2. 'Bundle' Individuality	8
1.3. Transcendental Individuality	11
1.4. Self-Identity	14
1.5. Distinguishability	15
1.6. Haecceitism	17
1.7. Trans-temporal Identity	19
1.8. Summary	21
2. Individuality in Classical Physics	22
2.1. A Brief History of Classical Statistical Mechanics	24
2.2. Classical Statistical Mechanics and Individuality Revisited	40
2.3. A Field-Theoretic Approach	51
2.4. Individuality and Space-Time	65
2.5. Conclusion: The Metaphysics of Classical Physics	81
3. Quantum Statistics and Non-Individuality	84
3.1. The Early History of Quantum Statistics	85
3.2. The Later History of Quantum Statistics	94
3.3. The Impact of Quantum Statistics: Quantum Non-Individuality	104
3.4. Bohr's View of Particle Individuality	107
3.5. Born and Structural Invariants	115
3.6. Schrödinger and the Loss of Identity	119
3.7. Weyl and the Analysis of Aggregates	127
3.8. Back to the History: Parastatistics	131
4. Individuality and Non-Individuality in Quantum Mechanics	139
4.1. Indistinguishability and Individuality	140
4.1.1. Challenge No. 1: Classical Particles as Non-Individuals	144

4.1.2. Challenge No. 2: Quantum Particles as Individuals	146
4.1.3. The Indistinguishability Postulate as an Initial Condition	148
4.2. The Individuality of Quantum Particles	149
4.2.1. Quantum Mechanics and the Principle of Identity of Indiscernibles	150
4.3. Space-Time Individuality and Configuration Space	173
4.4. Individuality, Bell and Non-Supervenient Relations	179
4.5. The Underdetermination of Metaphysics by Physics	189
5. Names, Nomological Objects and Quasets	198
5.1. The Role of Names in Science	199
5.2. Names and the Practice of Physics	210
5.3. Names, Possible Worlds and Particle Statistics	212
5.4. Names and Nomological Objects	221
5.5. Quasets	232
5.5.1. Quaset Theory	233
5.6. Conclusion	237
6. A Problem for Present-Day Mathematics	238
6.1. The Statement of the Problem	239
6.2. The Use of 'Standard Languages'	245
6.2.1. The Lack of Identity	247
6.3. Identity in Classical Logic and Mathematics	250
6.3.1. Identity in First-Order Classical Logic	251
6.3.2. Identity in Higher-Order Logic	254
6.4. Set Theory and Individuation	258
6.5. Characterizing Indistinguishability	260
6.5.1. Weyl's Strategy	261
6.5.2. Indiscernibility and Structures	264
6.5.3. The Implications for the Philosophy of Quantum Theory	267
7. The Mathematics of Non-Individuality	272
7.1. The Name of the Game	273
7.2. The Quasi-Set Theory Ω	275

7.2.1. Relations and Quasi-Functions	281
7.2.2. Quasi-Cardinals	284
7.2.3. ‘Weak’ Extensionality	290
7.2.4. Replacement Axioms	291
7.2.5. The Strong Singleton	292
7.2.6. Permutations are not Observable	295
7.2.7. The Axiom of Choice	297
7.2.8. Remark on the Existence of Atoms: The Theory Ω^m	297
7.3. Relative Consistency	298
7.4. Quaset Ideas within Quasi-Set Theory	303
7.5. Changes in Time: The Theory Ω^t	306
7.6. Quantum Statistics within Ω	310
7.7. On Justifying Quasi-Set Theory	317
7.7.1. Quasi-Sets and Quasets: A New Look	318
8. Non-Reflexive Quantum Logics	321
8.1. Motivation	322
8.2. First-Order Systems	324
8.3. Higher-Order Schrödinger Logics	326
8.3.1. Identity and Absolute Indistinguishability	328
8.4. A ‘Classical’ Semantics for S_ω	329
8.4.1. Identity and Indistinguishability Revisited	334
8.5. The Intensional System $S_\omega\mathcal{I}$	334
8.6. Generalized Quasi-Set Semantics	336
8.6.1. The Theory $S_\omega\mathcal{I}$	340
8.6.2. Soundness and Generalized Completeness	340
8.6.3. Comprehension and Other Axioms	342
8.6.4. General Discussion	343
8.7. Quantum Sortal Predication	344
8.7.1. Sortal Predication	344
8.7.2. Quantum-Sortal Predicates	347
8.7.3. Sortal Logics	351
8.8. Semantical Analysis	352
9. The Logic of Quanta	354
9.1. The Nature of QFT	355
9.2. Metaphysical Options	365

9.3. Models and the Fock Space Formalism	370
9.3.1. A Suppes Predicate for QFT	374
9.4. Quasi-Sets and the Objectivity of Quanta	379
<i>References</i>	385
<i>Index</i>	415