

# Contents

<b>1 Introduction: Discerning the Real, the Possible, and the Impossible . . . . .</b>	<b>1</b>
1.1 The First Sci-fi Movie . . . . .	2
1.1.1 Exploring the Science in <i>Le Voyage dans la Lune</i> . . . . .	4
1.2 Exploration Topic: Is It Safe to Launch Humans into Space from a Giant Gun? . . . . .	7
1.3 The First Literary Work of Science Fiction . . . . .	8
1.4 Reference Frames, Revisited . . . . .	9
1.5 Roadmap to the Rest of the Book . . . . .	10
References . . . . .	11
<b>2 What Is the Nature of Space and Time?: (<i>The Physics of Space Travel and Time Travel</i>) . . . . .</b>	<b>13</b>
2.1 Changing Perspectives Through History . . . . .	13
2.2 Newton’s Laws . . . . .	14
2.3 Einstein and Relativity . . . . .	21
2.3.1 Special Relativity and Time Dilation . . . . .	23
2.3.2 General Relativity and Distortion of Spacetime . . . . .	26
2.3.3 Gravitational Waves . . . . .	29
2.3.4 Faster Than Light, But Not Faster Than Light . . . . .	29
2.4 Stephen Hawking, Black Holes, Wormholes, and Quantum Gravity . . . . .	31
2.4.1 Black Holes . . . . .	31
2.4.2 The Multiverse Hypothesis . . . . .	34
2.4.3 Wormholes . . . . .	35
2.5 Other Time Travel Scenarios . . . . .	36
2.6 Exploration Topics . . . . .	38
References . . . . .	39

**3 What Is the Universe Made of?: (*Matter, Energy, and Interactions*)** . . . . . 43

3.1 The Standard Model of Particle Physics . . . . . 43

3.2 The Atomic Nucleus: Protons, Neutrons, Isotopes, and Radioactivity . . . . . 46

3.3 Gases . . . . . 47

3.4 Solid-State Materials . . . . . 52

3.5 Phase Transitions . . . . . 54

3.6 Transparency and Invisibility: Optical Properties of Solids . . . . . 60

3.6.1 Transparent Solids . . . . . 61

3.6.2 Camouflage . . . . . 63

3.6.3 Stealth Technology . . . . . 64

3.6.4 Metamaterials and Cloaking . . . . . 64

3.7 Energy and Power . . . . . 67

3.7.1 Kinetic and Potential Energy . . . . . 67

3.7.2 Chemical Energy . . . . . 70

3.7.3 Distinguishing Between Power and Energy . . . . . 71

3.7.4 Nuclear Energy . . . . . 72

3.7.5 Matter–Antimatter Annihilation . . . . . 73

3.8 Exploration Topics . . . . . 74

References . . . . . 78

**4 Can a Machine Become Self-Aware?: (*The Sciences of Computing and Cognition*)** . . . . . 81

4.1 Computer Hardware Performance Specifications . . . . . 82

4.2 Analog Computers . . . . . 83

4.3 Digital Computers . . . . . 84

4.4 Beyond Digital Computers . . . . . 87

4.5 Information Storage . . . . . 88

4.6 Robotics . . . . . 93

4.7 Robot Behavior . . . . . 95

4.8 Toward the Creation of Artificial Consciousness . . . . . 97

4.9 Exploration Topics . . . . . 100

References . . . . . 101

**5 Are We Alone in the Universe?: (*The Search for Extraterrestrial Intelligence*)** . . . . . 105

5.1 Major Considerations . . . . . 106

5.2 Searching for ET: Government Agency or Private Industry? . . . . . 107

5.3 Listening for ET: What Form of Communication Might We Expect? . . . . . 108

5.4 Conditions Necessary for Intelligent Life to Arise . . . . . 111

5.4.1 The Origin and Diversity of Life on Earth . . . . . 112

- 5.5 Cinema and the Science of the SETI Project . . . . . 113
- 5.6 Where Might First Contact Occur and How Will Humans  
and Aliens Interact? . . . . . 116
- 5.7 Exploration Topics . . . . . 118
- References . . . . . 120
  
- 6 What Does It Mean to Be Human?: (*Biological Sciences,  
Biotechnology, and Other Considerations*) . . . . . 123**
  - 6.1 Bodies with Replaceable Parts . . . . . 123
  - 6.2 Resistance to Disease . . . . . 126
  - 6.3 Cell Structure and Radiation Damage . . . . . 129
    - 6.3.1 Detection of Ionizing Radiation . . . . . 130
    - 6.3.2 Biological Effects of Exposure  
to Ionizing Radiation . . . . . 131
    - 6.3.3 UV Radiation and Skin Cancer . . . . . 134
  - 6.4 DNA and the Human Genome . . . . . 135
    - 6.4.1 DNA Sequencing and Genetic Engineering . . . . . 138
  - 6.5 Cloning . . . . . 140
  - 6.6 Human Teleportation: A Complex,  
Interdisciplinary Problem . . . . . 141
    - 6.6.1 The Problem of Duplication . . . . . 142
    - 6.6.2 Getting All the + and – Signs  
in the Right Place . . . . . 143
    - 6.6.3 The Uncertainty Principle: Limitations  
on Precision of Quantum Measurement . . . . . 144
  - 6.7 Teleportation Estimations . . . . . 144
  - 6.8 Beyond Biology . . . . . 145
  - 6.9 What Can We Learn from an Android About  
What It Means to Be Human? . . . . . 146
  - 6.10 Exploration Topics . . . . . 148
  - References . . . . . 151
  
- 7 How Do We Solve Our Problems: (*Science, Technology,  
and Society*) . . . . . 155**
  - 7.1 The Public Perception of Science and Scientists . . . . . 156
    - 7.1.1 Science as Obsession . . . . . 156
    - 7.1.2 Science and Arrogance . . . . . 157
    - 7.1.3 Science as an Act of Futility . . . . . 157
    - 7.1.4 The Model Scientist . . . . . 158
  - 7.2 The Methodology of Science . . . . . 158
  - 7.3 Science, Pseudoscience, and Nonsense . . . . . 159
  - 7.4 Problems to Be Solved . . . . . 161
    - 7.4.1 How Can We Increase Public Awareness  
of Science? . . . . . 161
    - 7.4.2 How Do We Respond to Threats or Attacks? . . . . . 162

- 7.4.3 How Can We Feed the Hungry? . . . . . 165
- 7.4.4 How Can We Conserve Our  
Natural Resources? . . . . . 165
- 7.4.5 How Can an Unstable Government Avoid  
Total Collapse? . . . . . 167
- 7.4.6 How Can We Provide Better Health Care? . . . . . 167
- 7.4.7 How Can a Company Sell More Products? . . . . . 168
- 7.4.8 How Do We Establish Justice? . . . . . 170
- 7.5 Exploration Topics . . . . . 172
- References . . . . . 174
- 8 What Lies Ahead?: (*The Future of Our Technological Society*) . . . . . 177**
  - 8.1 Accurate Predictions . . . . . 177
    - 8.1.1 Space and Time . . . . . 178
    - 8.1.2 Matter and Energy . . . . . 178
    - 8.1.3 Robotics . . . . . 179
    - 8.1.4 Planets in Other Star Systems . . . . . 180
    - 8.1.5 Biomedical Technology . . . . . 181
    - 8.1.6 Communication Technology . . . . . 181
    - 8.1.7 Brain–Computer Interfacing . . . . . 182
  - 8.2 Coming Soon: Possibilities  
for the Not-Too-Distant Future . . . . . 183
    - 8.2.1 Space Exploration . . . . . 183
    - 8.2.2 Dark Matter and Dark Energy . . . . . 184
    - 8.2.3 Real Adaptive Camouflage . . . . . 185
    - 8.2.4 Room-Temperature Superconductivity . . . . . 185
    - 8.2.5 Quantum Computers . . . . . 185
    - 8.2.6 Robots in the Home . . . . . 186
    - 8.2.7 Cybernetic Devices . . . . . 186
    - 8.2.8 Artificial Heart . . . . . 187
  - 8.3 Science Fiction in Historical Context . . . . . 187
    - 8.3.1 The Island of Dr. Moreau . . . . . 187
    - 8.3.2 The War of the Worlds . . . . . 188
    - 8.3.3 The Day the Earth Stood Still . . . . . 188
  - 8.4 Visions of the Future . . . . . 190
    - 8.4.1 Defining Culture in Terms of Technology . . . . . 190
    - 8.4.2 Social Divisions . . . . . 191
    - 8.4.3 Technophiles and Technophobes . . . . . 191
    - 8.4.4 Turning Over Too Much Control  
to Technology . . . . . 193
    - 8.4.5 The Rise of AI . . . . . 193
    - 8.4.6 What Is Real? . . . . . 193
    - 8.4.7 Sentient VR Characters . . . . . 195
    - 8.4.8 Civilization Destroyed by Its Own  
Technology . . . . . 196

8.5 Responsible Technology . . . . .	196
8.6 Exploration Topics . . . . .	197
References . . . . .	198
<b>Appendix A: Catalog of Movies Cited . . . . .</b>	<b>201</b>
<b>Appendix B: Television Series Episodes Cited . . . . .</b>	<b>217</b>
<b>Appendix C: Youtube Videos Cited . . . . .</b>	<b>223</b>
<b>Appendix D: Solutions to Estimation Problems . . . . .</b>	<b>225</b>
<b>Author Biography . . . . .</b>	<b>233</b>
<b>Index . . . . .</b>	<b>235</b>



<http://www.springer.com/978-1-4614-7890-4>

Exploring Science Through Science Fiction

Luukkala, B.B.

2014, XIX, 241 p. 27 illus., 20 illus. in color., Softcover

ISBN: 978-1-4614-7890-4