

Table of Contents

| | |
|-------------------------------------|----|
| Introduction | 1 |
| Comments on Units and Notation..... | 3 |
| 1. A Universal Problem | 5 |
| Dealing with Fermi..... | 6 |
| The Drake Equation | 9 |
| “Hey! Over Here!” | 11 |
| Caveat..... | 13 |
| Types of Civilizations | 14 |
| Moving Forward..... | 15 |
| 2. It’s a Matter of Time | 23 |
| Time and Transformation | 24 |
| The Deadly Earth..... | 26 |
| The Deadly Solar System | 28 |
| The Deadly Stars..... | 33 |
| Deadly Novae..... | 38 |
| GRBs and Hypernovae..... | 44 |
| The Embrace of Andromeda | 47 |
| Deep Time..... | 49 |
| The Doomsday Event | 49 |
| The Long and the Short of It..... | 50 |
| Making the Best of It | 51 |
| Dyson Spheres..... | 52 |
| Terraforming..... | 53 |
| Space Structures..... | 57 |
| Thinking Long-Term | 58 |
| 3. The Sun, Inside and Out | 71 |
| Star Basics | 72 |
| The Dynamical Timescale | 73 |
| Hydrostatic Equilibrium..... | 75 |
| The Pressure Law..... | 76 |

| | |
|--|---------|
| The Central Temperature | 78 |
| Photon Diffusion Time | 78 |
| Energy Transport | 80 |
| The Surface Temperature of a Star | 82 |
| Stellar Luminosity | 83 |
| Energy Generation | 83 |
| Nuclear Fusion..... | 85 |
| The Mass Luminosity Law | 87 |
| A Journey Through the HR Diagram | 88 |
| The Journey of the Canonical Sun | 90 |
| The Reasons for Gigantism..... | 95 |
| A Negative Feedback System..... | 97 |
| Fundamental Constants | 99 |
| The Quantum World of the Electron | 101 |
| Collapsing Gas Clouds | 102 |
| Why Stars Are Massive | 103 |
| A Constraint on Planet Building | 105 |
| 4. The Price of Doing Nothing..... | 113 |
| The Habitability Zone..... | 113 |
| The Ocean on Europa | 115 |
| A Brief Aside: Utilizing Europa | 117 |
| Moon Life | 117 |
| Synchronization and the Moon Effect..... | 118 |
| The Upper Limit | 119 |
| A Moving Habitability Zone..... | 120 |
| The Beginning of the End..... | 122 |
| The Fate of Venus and Earth..... | 123 |
| The Outer Planets..... | 125 |
| Orbital Engineering | 127 |
| Waving the Flag | 130 |
| End Games and Exotic Worlds..... | 131 |
| A Moving Imperative..... | 134 |
| 5. Rejuvenating the Sun | 147 |
| The Engineering Options | 147 |
| Mixing and Mass Loss | 148 |
| Adding to the Pressure | 150 |
| The Opacity Effect..... | 152 |
| The Tools of the Trade..... | 153 |
| A Homogeneous Star Model | 154 |
| Introducing Mass-Loss..... | 155 |
| The Fate of the Ejected Material | 156 |
| An Outline Scenario for Rejuvenating the Sun | 157 |
| The UV Problem | 159 |

| | |
|--|---------|
| The Extended Solar System Lifetime | 160 |
| Mixing It Up..... | 162 |
| Black Hole Mixing | 163 |
| A Steady Stellar Diet | 165 |
| Brave New Worlds | 169 |
| An Alien Beast Within | 171 |
| Solar Wrap Control | 173 |
| What the Future Holds | 175 |
| 6. Stars Transformed..... | 181 |
| Revisiting Carter..... | 181 |
| An Exoplanet Review | 181 |
| The Case of the Blue Stragglers | 184 |
| The Time of Their Lives | 189 |
| Under Construction..... | 190 |
| On the Threshold..... | 191 |
| 7. Between Now and Then..... | 197 |
| Do We Have a Near-Term Future? | 197 |
| What Price the Future? | 198 |
| Thinking Long-Term | 201 |
| Taking the Next Step | 202 |
| Future Earth | 205 |
| Epilogue | 209 |
| Glossary of Terms..... | 213 |
| Appendix A: A Homogeneous Star Model | 217 |
| Appendix B: An Accreting Black Hole Model..... | 221 |
| Index | 223 |

Rejuvenating the Sun and Avoiding Other Global
Catastrophes

Beech, M.

2008, XII, 228 p. 40 illus., Softcover

ISBN: 978-0-387-68128-3