

Contents

1	A Place Like Home	1
	The Nebular Theory of Planetary Formation	3
	The Spiral Nebulae: Small and Close or Large and Distant?	4
	Hello Out There	6
	Homes for ET	8
	Someone to Talk To	9
2	Early Ideas and Lessons from Our Own Backyard	11
	Moving Off the Center	11
	Getting the Message Across	14
	The Goldilocks Principle	17
	Migrating Habitable Zones	19
	Starring Roles	20
	M Dwarfs	22
	K-Type Stars	23
	G-Type Stars	23
	F-Type Stars	24
	A-Type Stars	24
	B-Type Stars	25
	O-Type Stars	25
	From Supernova to Black Holes	25
	Habitable Zone Types	26
	Past Lives of Our Earth	28
	The Great Dyings	32
	Earthlike Planets in Our Solar System	32

Isn't That Special?	36
A Really Big Habitable Zone?	39
Applying Lessons to Exo-Earths	39
3 The Search for and Discovery of Exoplanets	43
Finding Invisible Worlds	44
Direct Imaging	44
Radial Velocity	45
Timing Technique	47
Gravitational Microlensing	47
Autocorrelation Function Timescale Technique	49
Transits	49
Astrometry	52
The New Age of Discovery: Orbiting Observatories	55
51 Pegasi b...and Beyond	59
Chilled Giants	62
Earths, Mega-Earths, Sub-Neptunes and Super-Earths	63
4 Strange Solar System Architectures	67
Migrating Planets and the Search for Life	70
5 Zeroing in on Earth 2.0	75
Sub-Neptunes	75
Giant Planets and Earth-Moons	82
Other Super-Earth Types	82
Assorted Super-Earths	85
What's the Forecast?	89
Zeroing in on Earth 2.0	94
Super-Habitable Places	97
Giants Inside the Habitable Zone: The Promise of the Moons	103
6 Looking for Life in All the Right Places	105
Life Based on What?	105
Life in Our Own Image	105
A Martian Invasion of a Different Sort	107
Is Carbon the Only Game in Town?	114
Extreme Biomes	115
Under the Surface: Extremophiles Galore	116

Europa	118
Enceladus: Europa on Steroids	121
Titan: The Alien World Next Door	124
Habitable Sub-Zones	129
Deep Sea Astrobiology Beyond Europa and Enceladus	129
Life with a Few Suns	132
In the Beginning, Life	133
Life's 'Tells' in the Poker Game of Astrobiology	136
Finding Exo-Veggies	140
The Stars Are Out, But Is Anyone Home?	141
7 Could We Make Contact?	145
Fermi's Paradox	146
Answer #1: A "Special" Rare Earth	146
Answer #2: Extinction	147
Answer #3: Not Interested, Thank You!	147
Answer #4: We've Moved On	148
Answer #5: Sentient Suicide	148
Answer #6: Natural Quarantine	149
Answer #7: Cosmic Menagerie	149
Answer #8: Spectator Sport	150
Answer #9: Missed It By That Much	150
Using Waves	150
What Are the Odds?	152
Amoebas to Technology	157
Reaching Out	159
Transmission in a Bottle	164
Calls for Caution	168
Undertakings in the Search for Extraterrestrial Intelligence	169
A Different Kind of Message	173
If I Could Talk With the Animals...	176
Assumptions	180
UFOs	181
Civilization's Fingerprints Here and Beyond	184
8 Could We Visit Earths of Distant Suns?	193
Interstellar Vacations	195
Roadblock to Faster-Than-Light Travel	198
Project Orion	200

x Contents

Project Daedalus: To the Stars	202
Project Icarus	204
Non-Nuclear Options for Star Travel	206
Arrival	211
Interstellar Exploration's Human Component	213
Generation Ships	215
Why Go?	217
9 First Contact: What Will It Mean?	219
Life's Rich Pageantry	221
Visualizing World SETI	222
Why Bother?	224
SETI All Grown Up	225
Culture Clash	226
Dreams of Distant Earths	228
Engaging with the Others	228
Index	231

Earths of Distant Suns

How We Find Them, Communicate with Them, and
Maybe Even Travel There

Carroll, M.

2017, XI, 234 p. 65 illus., 62 illus. in color., Softcover

ISBN: 978-3-319-43963-1