

Making Everything Easier!™

Space Exploration

FOR
DUMMIES®

Learn to:

- Relive the greatest discoveries, challenges, and triumphs of space programs
- Celebrate the scientific advancements that can be attributed to space exploration
- Appreciate life in space — whether in a capsule or on a space station
- Peek at future missions

Cynthia Phillips, PhD

Scientist at the SETI Institute

Shana Priwer

Professional writer



Table of Contents

Introduction 1

About This Book	1
Conventions Used in This Book.....	2
What You're Not to Read.....	2
Foolish Assumptions.....	3
How This Book Is Organized	3
Part I: Space Exploration: Where, Who, and How	4
Part II: The Great Space Race	4
Part III: Second-Generation Missions.....	4
Part IV: Current Space Exploration.....	4
Part V: The Future of Space Exploration.....	5
Part VI: The Part of Tens	5
Icons Used in This Book	5
Where to Go from Here.....	6

Part I: Space Exploration: Where, Who, and How 7

Chapter 1: Space Exploration in a Nutshell9

A Quick Spin around the Universe	9
A Crash Course on Rocket Science	10
An Astronaut's Life and Times.....	10
Accidents in Space	11
In the Beginning: The Great Space Race.....	12
A duo of firsts: Sputnik 1 and animals in space	12
The first people in space.....	12
Robots to the Moon.....	13
Human exploration of the Moon.....	13
Missions to other parts of the solar system.....	13
The end of the Space Race.....	14
The Second Generation of Missions.....	14
The Space Shuttle and Mir.....	14
Journeys to Mars	15
Exploration of the inner solar system.....	15
Missions to the outer solar system	15
Modern Space Exploration	16
Space telescopes.....	16
The International Space Station.....	16
The latest views of Mars	16
Space Exploration in the Future	17
The next space missions to watch out for.....	17
Increased access to space	17
Reasons for continuing to explore space	18

Chapter 2: A Tour of the Universe19

Planets as Wanderers: How Early Humans Viewed the Sky	19
Constellations: Pictures in the sky	20
Is Earth the center of the universe? Early discoveries about the solar system	22
The Organization of the Solar System	23
Rock on: The inner solar system	25
Asteroids: Filling in the gaps	26
Great balls of gas (and ice): The giants of the outer solar system	27
Talk about drama: The great <i>Pluto debate</i>	28
Extrasolar Planets and Stars and Galaxies, Oh My!	30
Extrasolar planets	30
Homes of the stars	31
Galaxies galore	32

Chapter 3: Yes, It's Rocket (And Spacecraft) Science After All33

Back in Time: A Quick Tour of Rockets in History	34
The earliest creations and uses	35
Advances in the 1950s, 1960s, and 1970s	35
Starting to recycle in the 1980s	37
Let's Get Physics-al: How Rockets Lift Off and Travel through Space	37
Understanding the main thrust of the issue	38
Examining the forces of nature that affect liftoff	39
Escaping Earth and navigating the cosmos	40
Start It Up: Different Sources of Rocket Power	41
Fueling the fire	41
Forecasting the future of rocket propulsion	43
Keeping the Lights On in Orbit: Spacecraft Power	45
Harnessing the Sun's power	45
Processing plutonium for Pluto	46
Phone Home: Communicating via Radio Telescopes	47

Chapter 4: The Life and Times of an Astronaut51

Preparing to Become an Astronaut	51
Educational and physical requirements	52
Training programs	52
International programs	55
Introducing the Crew of a Space Mission	55
Commanders and pilots are at the wheel	56
Mission and education specialists bring additional expertise	56
Payload specialists meet specific technical needs	56
Living and Working in Space	57
Eating and drinking	57
Sleeping soundly	59
Staying clean	59
Exercising in orbit	60
Dressing well	61
Taking spacewalks and doing other work	62

Chapter 5: Tragedies in Space63

Mercury-Redstone 4 (1961): A Flooded Capsule	64
Grissom's narrow escape.....	65
The hatch release changes that followed Liberty Bell 7.....	65
Apollo 1 (1967): A Lethal Fire.....	66
Death on the ground.....	66
A tangle of flaws that contributed	67
Spacecraft design changes made in the aftermath.....	68
Soyuz 1 (1967) and Soyuz 11 (1971): Failures on Landing and in Orbit.....	69
Soyuz 1	69
Soyuz 11	71
Apollo 13 (1970): A Successful Failure	72
"Houston, we've had a problem"	72
The causes of the explosion.....	73
The consequences of Apollo 13	74
The Space Shuttle Challenger (1986): A Launch Ending in Disaster	75
The disaster's cause: An O-ring seal	75
The repercussions: A shutdown of the Space Shuttle program	76
The Space Shuttle Columbia (2003): Reentry Disintegration.....	77
Airborne foam creates a hole in the left wing.....	77
The Space Shuttle program stops again	78

Part II: The Great Space Race 81

Chapter 6: A Small Beeping Sphere and the Dawn of the Space Age83

Cold War Tensions and the Space Race	83
Sputnik 1: The First Satellite in Orbit (1957).....	84
Developing the little metal ball that changed history.....	85
Celebrating success.....	87
Explorer 1: The U.S. Response (1958).....	87
Racing to create an American satellite	88
Exploring the results	89
Animals in Space.....	89
The Soviet Union: Dogs in space.....	90
The United States: Primates in space.....	91

Chapter 7: What a Ride! The First People in Space93

The Vostok Spacecraft and Its Pioneers (1961–1963).....	93
Yuri Gagarin, the first human in space	94
Valentina Tereshkova, the first woman in space.....	95
Project Mercury and Its Lofty Goals (1959–1963)	96
A little snug: The Mercury spacecraft.....	97
The missions of Alan Shepard, John Glenn, and the rest of the Mercury 7	97
Voskhod 2 and the First Spacewalk (1965)	100

The Gemini Program Proves Its Case (1965–1966).....	101
Two-person crews and longer flights	103
Rendezvous and docking in space.....	104
Soyuz: The Space Program That Keeps on Running (1967–Present)....	106
Chapter 8: Sending Robots to the Moon	109
First to the Moon with Luna (1959–1976).....	109
Early Luna missions: Setting the stage (1959–1968).....	110
Luna 16, 20, and 24: Sending samples to Earth (1970 and 1976)	111
Lunokhod 1 and 2 aboard Luna 17 and 21:	
Driving robots (1970 and 1973)	112
The Ranger Program: Hard Lunar Landings (1961–1965).....	113
The Lunar Orbiter Project: Prepping the Way	
for Human Spaceflight (1966–1967)	113
Mapping the Moon from a distance.....	114
Seeing a whole Earth	115
The Lunar Surveyor Program: Landing on the Moon (1966–1968)	116
Testing soft-landing techniques.....	117
Capturing the details of the Moon's surface	117
Making the Apollo 12 connection	118
Chapter 9: Man on the Moon: Project Apollo	119
In the Beginning: The Politics of Manned Lunar Exploration	119
President John F. Kennedy's goal: Winning	
the race to the Moon	120
NASA's first task from the president: Coming	
up with an efficient flight design	121
The Components of an Apollo Mission.....	122
The Saturn V rocket: Blasting off toward the Moon.....	123
The Command/Service Module: Sustaining the mission	123
The Lunar Module: Designed to land	124
Laying the Groundwork for the Manned Apollo Missions	125
Developing the first flight computer	126
Launching robotic flights: Apollo 4, 5, and 6.....	126
Apollo 7–10: Preparing for the Moon	
with Manned Missions (1968–1969).....	128
Apollo 7: Testing the Command/Service Module (1968)	128
Apollo 8: Orbiting the Moon (1968).....	129
Apollo 9: Docking in Earth orbit (1969).....	130
Apollo 10: Setting the stage for the first lunar landing (1969)	131
Apollo 11: Doing the Moonwalk (1969)	132
Landing on the Moon.....	132
“One giant leap for mankind”	133
Working and walking in Moon dust	134
Planting the flag and heading home	135
Chapter 10: Continued Lunar Exploration after Apollo 11	137
Apollo 12: Achieving a Second Successful Lunar Landing (1969)	138

Apollo 14: Making Up for Lost Research (1971)	139
Apollo 15: Testing the Limits of Lunar Exploration (1971)	142
Landing on the rugged terrain of the Hadley-Apennine region ...	143
Driving the first Lunar Roving Vehicle	144
Embracing new life-support systems for extended space work....	145
Apollo 16: Breaking Records (1972)	146
Apollo 17: Presenting Project Apollo's Grand Finale (1972)	149
Traveling around varied terrain.....	150
Setting up complex science experiments	151
Scoping Out the Soviets' Lunar Exploration Preparations.....	152
Preparing the N1 rocket.....	152
Building the LK lunar lander	153

Chapter 11: Going on a Grand Tour of the Solar System155

Early Soviet Mars Probes: Mixed Results (1960–1973)	156
There were some successes	156
. . . But even more failures	157
The Soviet Venera and Vega Programs: Reaching	
Venus Successfully (1961–1986)	158
Venera 7 (1970): Landing accomplished.....	159
Venera 9 and 10 (1975) and Venera 13 and 14 (1981):	
Taking historic pictures	160
Venera 15 and 16 (1983): Mapping Venus.....	161
Vega 1 and 2 (1984–1986): Landers, balloons,	
and a comet flyby.....	162
The Mariner Program: Visiting Mercury,	
Venus, and Mars (1962–1975).....	163
Missions of the 1960s	164
Missions of the 1970s	165
Pioneer 10 and 11: Exploring the Outer Solar System (1972–2003)	166
Providing the first views of Jupiter and Saturn.....	166
Staying in touch for more than 20 years	167
Bearing plaques for alien encounters	167
Viking 1 and 2: Embarking on a Mission to Mars (1975–1982).....	168
Orbiting and landing on Mars	169
Searching for Martian life.....	170
Voyager 1 and 2: To Jupiter and Beyond (1977–Present)	172
Voyager 1: Whizzing by Jupiter and Saturn.....	173
Voyager 2: Making discoveries everywhere.....	174
Carrying the gold(-plated) record	174
Still checking in	175

Chapter 12: The First Space Stations and the End of the Space Race177

Shrouded in Secrecy: The Early Salyut Program (1971–1973).....	178
Salyut 1: Launching and docking with Soyuz 11 (1971)	178
Salyut 2 and Cosmos 557 (1973)	179

Skylab: NASA's First Home in the Sky (1973–1979)	180
Launching Skylab	180
Living in the sky	181
Making a splash	184
Building on Experience: Later Salyut Missions (1974–1991)	185
Salyut 3: Controlling its own orientation (1974–1975)	185
Salyut 4: Three visits from Soyuz (1974–1977)	187
Salyut 5: The last military station (1976–1977)	188
Salyut 6: Undergoing many upgrades (1977–1982)	189
Salyut 7: Expeditions for repair and additions (1982–1986)	190
Apollo-Soyuz: Friends in Space (1975)	191
Mission planning	191
A docking and a handshake	192

Part III: Second-Generation Missions 195

Chapter 13: The Space Shuttle and Mir Space Station: The Dawn of Modern Space Exploration 197

The Birth of the American Space Shuttle Program	198
Welcome Aboard: The Typical Course of a Space Shuttle Mission	200
Surveying the safety requirements for launch	201
Launching the Space Shuttle	202
Living and working aboard the Shuttle	203
Landing 101	204
The Early Days of the Space Shuttle Program	206
The orbiter fleet	206
The first flight: Columbia (1981)	207
Sally Ride, the first American woman in space (1983)	208
Notable early missions	208
Mir, the Soviet/Russian Space Station (1986–2001)	209
Building Mir, module by module	210
Welcoming American astronauts	211
Discovering how Mir residents spent their time	213
Observing the end of an era	214

Chapter 14: Prime Time for the Space Shuttle: From the 1980s into the 21st Century 215

Launching Massive Missions from the Space Shuttle	215
Atlantis gives Galileo a lift (1989)	216
Discovery launches the Hubble Space Telescope (1990)	216
Other notable launches	217
Doing Science aboard the Space Shuttle	219
Spacelab (1983–2000)	219
U.S. Microgravity Payloads (1992–1997)	220
The Wake Shield Facility (1994–1996)	221
The Shuttle Radar Topography Mission (2000)	221

Chapter 15: Revenge of the Red Planet: Successes and Failures in Mars Exploration	223
Stumbles on the Road to Mars	223
Computer failures for Phobos 1 and 2 (1988–1989)	224
Mars Observer goes missing in action (1992)	225
Success at Last! Mars Pathfinder and Mars Global Surveyor	226
Mars Pathfinder: Innovative design meets the little rover that could (1996–1998)	226
Mars Global Surveyor: Pictures and topography from orbit (1996–2006)	228
Additional Flops in Mars Exploration in the Late 1990s	230
Russia's Mars 96 fails to leave Earth's orbit (1996)	230
Mars Climate Orbiter and Mars Polar Lander embarrass NASA (1998–1999)	231

Chapter 16: Exploring the Inner Solar System	233
Magellan Peeks through the Veil of Venus (1989–1994)	233
Mapping with radar	234
Uncovering details of Venus's surface	235
Dedicated Spacecraft Visit the Moon and the Sun	236
Investigating the Moon	236
Sending SOHO to spy on the Sun (1995–present)	238
Venus Express Studies the Atmosphere (2005–Present)	240
Small Missions of Large Importance	241
NEAR orbits an asteroid (1996–2001)	241
Stardust brings home precious particles (1999–present)	242
Deep Impact crashes into a comet (2005–present)	243

Chapter 17: Voyages to the Outer Solar System	245
Galileo Journeys to Jupiter (1989–2003)	245
Kicking things off with priceless views and a broken antenna	247
Probing the atmosphere for a short while	247
Studying the satellites	248
Making a heroic sacrifice at mission's end	249
Cassini-Huygens Views the Saturn System (1997–Present)	250
Cassini's load of complex instruments	251
Cassini takes images of Saturn and its satellites (2004–present)	252
The Huygens probe lands on Titan (2005)	254

Part IV: Current Space Exploration 257

Chapter 18: What a View! Telescopes in Space	259
The Hubble Space Telescope Clears the Way (1990–Present)	260
How Hubble came to be	260
The telescope's technology	261
A few fixes for Hubble	262

The Compton Gamma Ray Observatory's High-Energy Mission (1991–2000)	265
The Chandra Observatory X-rays the Universe (1999–Present)	266
The Spitzer Space Telescope Heats Things Up (2003–2009)	268
Capturing heated images of the cosmos.....	269
Keeping Spitzer cool.....	270
Looking to the Future: The James Webb Space Telescope.....	270

Chapter 19: A Symbol of Global Cooperation:

The International Space Station 273

Planning the International Space Station	274
Touring the International Space Station.....	275
The piece-by-piece construction (1998–present).....	275
The newest (and biggest) addition: Japan's Kibo lab	277
Working aboard the International Space Station	280
Maintaining the station's and the astronauts' health	281
Conducting science experiments.....	282
Predicting the Future of the International Space Station	283

Chapter 20: New Views of Mars in the New Millennium. 285

Mars Odyssey: Searching for Water and Sending Signals (2001–Present).....	285
Mars Express: A Bittersweet European Effort (2003–Present)	287
Roving with Spirit and Opportunity (2003–Present).....	289
The Mars Reconnaissance Orbiter in Action (2005–Present).....	291
The Phoenix Mars Lander Visits the North Pole (2007–2008)	292

Part V: The Future of Space Exploration 295

Chapter 21: More in Store: Upcoming Space Missions 297

Recommitting to Human Exploration with NASA's Project Constellation	297
Transitioning from the Space Shuttle.....	298
Introducing Orion, the next-generation spacecraft for human exploration	298
Lifting off with the Ares I and Ares V rockets	299
Flying to the Moon (again).....	301
Revving Up Future Robotic Exploration.....	302
Rekindling interest in the Moon.....	302
Looking for signs of life directly on Mars	304
Sending the best to the outer planets	306
Keeping an Eye Open for Other Exciting Missions.....	307
Hayabusa looks at an asteroid	308
MESSENGER revisits Mercury	308
New Horizons encounters Pluto	310
Kepler tries to find Earth-like planets	310

MAVEN plans to study the upper atmosphere of Mars	311
BepiColumbo heads to Mercury	312
A few other notable space missions.....	312

Chapter 22: Increasing Access to Space313

The Emergence of China as a Space Power.....	313
The history of Chinese spaceflight.....	314
Future plans for Chinese space exploration.....	315
A Brief History of Space Tourism	316
The first space tourists	316
Recent innovations in commercial spaceflight	317
The Requirements and Realities of Current (And Future)	
Space Tourism.....	320
The necessary criteria for “regular people” to travel to space.....	320
What to expect from the future of space tourism	321

Chapter 23: Why Continue to Explore Space?.....323

Satisfying an Innate Curiosity about Space	323
Investigating the true “final frontier”	324
Looking “there” for answers “here”.....	324
The Future Necessity of Space Travel	325
Presenting the real deal with population overflow	325
Looking at space as a place for escaping disaster	326
Considering the future of the solar system	327
Space Lends a Hand to the Common Man.....	329
Applying space technology to everyday life on Earth	329
Finding new sources of natural resources in space	330

Part VI: The Part of Tens..... 331

Chapter 24: Ten Places to Look for Life beyond Earth.....333

Venus: (Potential) Life in the Clouds	333
Mars: Once a Warm and Wet Planet.....	334
Europa: An Ocean beneath the Surface	334
Ganymede: An Ocean Buried between Layers of Ice	335
Callisto: An Even Deeper Layer of Water.....	335
Titan: Swimming in Methane.....	336
Enceladus: Tiny but Active.....	336
Triton: Venting Plumes of Nitrogen.....	337
Comets: Filled with Life’s Building Blocks.....	337
Extrasolar Planets: Life around Other Suns	338

Chapter 25: Ten Ways Space Travel Isn’t Like Television or the Movies.339

A Cosmic Speed Limit Exists.....	339
Wormholes Aren’t On Call.....	340

Space Isn't Noisy.....	340
Asteroids Aren't Packed Together	341
Humans Can't Breathe "Air" on Another Planet	341
You Won't Explode in Space	342
People Float, Not Walk, in Space	342
Aliens Don't Look Like Humans	343
Aliens Don't Speak English	343
Space Invaders Aren't Among Us	344

Chapter 26: Ten Types of Everyday Items Brought to You Courtesy of NASA 345

Medical Diagnostics and Procedures.....	345
Medical Devices	346
Personal Health and Safety	346
Transportation Aids	347
Power Tools	348
Computing Power	348
Foods and Nutrition	349
Intelligent Clothing.....	349
Advanced Fabrics and Plastics	349
Entertainment Necessities.....	350

Index..... 351