

CONTENTS

FOREWORD	xi
-----------------------	----

PREFACE	xiii
----------------------	------

PROLOGUE

A TALE THAT BEGINS ON THE MOON	1
---	---

The Story of Kaguya-hime.....	10
-------------------------------	----

Cosmic Myths	18
--------------------	----

Ancient India's View of the Universe	18
--	----

Ancient Egypt's View of the Universe	18
--	----

Ancient Babylonia's View of the Universe	19
--	----

In China, Where Astronomy Was Originally Developed.....	19
---	----

In Ancient Greece, Where the Size of Earth Was Calculated	20
---	----

Eratosthenes' Calculation Method.....	20
---------------------------------------	----

If Earth Is Round, the Moon Must Be Round Too.....	21
--	----

1

IS EARTH THE CENTER OF THE UNIVERSE?	23
---	----

A Mysterious Light Appeared in the Sky.....	24
---	----

Close Encounters	27
------------------------	----

Does the Sun Revolve Around Earth?	34
--	----

A Heliocentric Model Was Proposed 2,300 Years Ago	40
---	----

From the Geocentric Theory to the Heliocentric Theory	50
---	----

Galileo's Discoveries—and Trial	56
---------------------------------------	----

Putting Things in Perspective.....	59
------------------------------------	----

What Is the Approximate Distance to the Horizon?	66
--	----

Measuring the Size of the Universe: How Far to the Moon?	67
--	----

Corner Cube Mirrors	67
---------------------------	----

How a Corner Cube Mirror Works.....	67
-------------------------------------	----

Before the Corner Cube Prism	68
------------------------------------	----

Geocentric Theory vs. Heliocentric Theory—the Outcome of a Battle Royale	69
--	----

What Kind of Orbit Did a Planet Trace in the Geocentric Theory?	70
---	----

The Tychonic System That Embellished the Geocentric Theory.....	70
---	----

Just How Progressive Was Copernicus?	71
--	----

Kepler Completed the Heliocentric Theory	72
--	----

What Did Galileo Do?	72
----------------------------	----

What Has the Heliocentric Theory Taught Us?	73
---	----

A Somewhat Complicated Explanation of Kepler's Laws	73
---	----

First Law: The Orbit of Every Planet Is an Ellipse with the Sun at the Focus	73
--	----

Second Law: A Line Joining a Planet and the Sun Sweeps Out Equal Areas	75
--	----

During Equal Intervals of Time.....	75
-------------------------------------	----

Third Law: The Square of the Orbital Period of a Planet Is Directly Proportional	77
to the Cube of the Semimajor Axis of Its Orbit.....	77

2

FROM THE SOLAR SYSTEM TO THE MILKY WAY	79
What If Kaguya-hime Came from a Planet in Our Solar System?	80
Kaguya-hime and the Solar System.	82
Mercury.	83
Venus	84
Mars	85
Jupiter.	86
Saturn.	87
Uranus	88
Neptune	89
Pluto	90
Earth.	91
The Moon	92
The Sun	95
The Size of the Milky Way Galaxy.	104
What's in the Middle of the Galaxy?	106
Top Five Mysteries of the Galaxy That Have Not Yet Been Explained!	108
What Is the Galaxy's Shape, and How Did It Form?	108
What's at the Center?	108
How Are Supermassive Black Holes Formed?	109
What Is the Galaxy Made Of?	109
What Will Happen When We Collide with the Andromeda Galaxy?	109
The Milky Way Galaxy Is One of Many Galaxies	110
The Universe Is Steadily Getting Larger.	116
Why Can We See the Milky Way?	116
A Disc-Shaped Galactic Model Is the Easiest to Understand	117
Results of Scientific Observation Also Prove a Disc-Shaped Universe	118
An Idea from Kant Enlarged the Perceived Universe in a Flash.	119
How Did Technology for Observing the Universe Progress?	120
Famous Telescopes	122
What Can a Radio Telescope Observe?	124
Another Way to Measure the Size of the Universe: A Triangulation Trick	125
Triangulation Can Give Us the Distance to Stars Beyond the Solar System	126
How Big Is the Solar System?	127

3

THE UNIVERSE WAS BORN WITH A BIG BANG	129
Galaxies Are Islands of Light in the Void of Space	130
The Winning Team Learns a Lesson.	133
What Is the Large-Scale Structure of the Cosmos?	140
Planetary System	140
Galaxy	140
Group of Galaxies or Cluster of Galaxies.	140
Supercluster of Galaxies	141

Hubble's Great Discovery	142
The Origins of the Universe: "Hubble's Great Discovery—Act I"	143
Back to the Play: "Hubble's Great Discovery—Act II".	146
If the Universe Is Expanding...	151
Everything Started with the Big Bang	161
Hubble's Theory of the Expansion of the Universe Was Imperfect.	162
Three Pieces of Evidence for the Big Bang Theory	166
Do Aliens Exist?	180
Calculating the Number of Extraterrestrial Civilizations	180
Extraterrestrial Life and a World-Renowned Physicist.	181
Has Life Been Created Often?	182
Which Is the Closest Star System That Could Support Extraterrestrial Life?	183
Can We Contact an Extraterrestrial Civilization?	184
Tardigrades (Water Bears) Are the Toughest Astronauts	185
A Third Method of Measuring the Size of the Universe: If You Know the Properties of a Star,	
Can You Figure Out How Far Away It Is?	186
Stars with Varying Brightness Are "Lighthouses of the Universe"	188
Methods of Measuring Even Greater Distances	189

4

WHAT IS IT LIKE AT THE EDGE OF THE UNIVERSE?	191
---	-----

Where Is the Universe Going?	192
The Closest Earthlike Planet.	203
The Kaguya-go Journey Board Game	206
Arrival at the "Edge" of the Universe	208
Professor Sanuki's Soliloquy	209

5

OUR EVER-EXPANDING UNIVERSE	213
--	-----

The Big Show	215
The Multiverse Contains Numerous Universes	219
The Edge, Birth, and End of the Universe...	219
Why Might Space Be Curved?	219
Will You Return to the Same Location in a Plane, a Cylinder, and a Sphere?	220
Negative Curvature	221
Friedmann's Dynamic Universe.	222
What Will Ultimately Become of the Universe?	227
WMAP and Our Flat Universe.	229
The True Age of the Universe.	232

INDEX	235
------------------------	-----

GALLERY OF ASTRONOMICAL MARVELS	following page 242
--	--------------------