

Contents

List of focus elements	page ix
List of tables	xi
Preface to the second edition	xv
Preface to the first edition	xvii
Principal units	xxv

Part 1 Changing views and fundamental concepts

1 Evolving perspectives: a historical prologue	1
1.1 Moving points of light	3
1.2 Telescopes reveal the hitherto unseen	13
1.3 What holds the solar system together?	23
1.4 Physical properties of the Sun	26
1.5 Terrestrial and giant planets	33
1.6 What is inside the major planets?	34
2 The new close-up view from space	36
2.1 Flybys, orbiters, probes and landers	38
2.2 Impact craters	52
2.3 Volcanism	60
2.4 Water	71
3 Atmospheres, magnetospheres and the solar wind	80
3.1 Fundamentals	82
3.2 Atmospheres of the terrestrial planets	87
3.3 Atmospheres of the giant planets	93
3.4 Titan, a satellite with a substantial atmosphere	96
3.5 The planets are inside the expanding Sun	98
3.6 Magnetized planets and magnetospheres	102
3.7 Aurora	111

Part 2 The inner solar system: rocky worlds

4 Restless Earth: third rock from the Sun	117
4.1 Fundamentals	119
4.2 Journey to the center of the Earth	119

4.3	Remodeling the Earth's surface	124
4.4	The Earth's changing atmosphere	138
4.5	Space weather	151
5	The Earth's Moon: stepping stone to the planets	158
5.1	Fundamentals	159
5.2	Eclipses of the Moon and Sun	160
5.3	The Moon's face	163
5.4	<i>Apollo</i> expeditions to the Moon	169
5.5	Inside the Moon	177
5.6	The lunar surface	179
5.7	Return to the Moon	186
5.8	The Moon's history	188
5.9	Tides and the once and future Moon	191
5.10	Origin of the Moon	196
6	Mercury: a dense battered world	201
6.1	Fundamentals	202
6.2	A tiny world in the glare of sunlight	202
6.3	Space-age investigations of Mercury	203
6.4	Radar probes of Mercury	204
6.5	A modified Moon-like surface	207
6.6	An iron world	214
6.7	A mysterious magnetic field	215
6.8	Einstein and Mercury's anomalous orbital motion	217
7	Venus: the veiled planet	220
7.1	Fundamentals	221
7.2	Bright, beautiful Venus	221
7.3	Penetrating the clouds of Venus	224
7.4	Unveiling Venus with radar	230
7.5	Volcanic plains on Venus	235
7.6	Highland massifs on Venus	237
7.7	Tectonics on Venus	239
8	Mars: the red planet	247
8.1	Fundamentals	249
8.2	Planet Mars	250
8.3	The space-age odyssey to Mars	252
8.4	The atmosphere, surface conditions and winds of Mars	253
8.5	The polar regions of Mars	259
8.6	Highs and lows on Mars	262
8.7	Flowing water on Mars long ago	266
8.8	Mars is an ice planet	273
8.9	The search for life on Mars	276
8.10	The mysterious moons of Mars	280

Part 3 The giant planets, their satellites and their rings: worlds of liquid, ice and gas

9	Jupiter: a giant primitive planet	283
9.1	Fundamentals	285
9.2	Stormy weather on Jupiter	286
9.3	Beneath Jupiter's clouds	293
9.4	Introduction to the Galilean satellites	296
9.5	Jupiter's volcanic moon Io	299
9.6	Jupiter's water moon Europa	305
9.7	Jupiter's battered moons, Ganymede and Callisto	309
9.8	Jupiter's mere wisp of a ring	311
10	Saturn: lord of the rings	317
10.1	Fundamentals	319
10.2	Winds and clouds on Saturn	321
10.3	Beneath Saturn's clouds	324
10.4	The remarkable rings of Saturn	326
10.5	Introduction to Saturn's moons	335
10.6	Saturn's active water moon Enceladus	337
10.7	Hidden methane lakes and organic dunes on Saturn's moon Titan	341
10.8	Alien worlds, distant ring	345
11	Uranus and Neptune	348
11.1	Fundamentals	349
11.2	Storm clouds on the outer giants	351
11.3	Interiors and magnetic fields of Uranus and Neptune	354
11.4	Rings of Uranus and Neptune	355
11.5	The large moons of Uranus and Neptune	358

Part 4 Remnants of creation: small worlds in the solar system

12	Asteroids and meteorites	365
12.1	The orbits of asteroids	367
12.2	Origin of the asteroids	369
12.3	Viewing asteroids from a distance	371
12.4	Spacecraft view asteroids close up	375
12.5	Meteorites	381
13	Colliding worlds	391
13.1	A comet hits Jupiter	392
13.2	Consumed by the Sun	393
13.3	Impacts of asteroids with the Earth	395
13.4	Demise of the dinosaurs	399
13.5	Assessing the risk of death from above	402
13.6	Breaking a date with doomsday	403

14	Comets	408
14.1	Unexpected appearance of comets	410
14.2	The return of comet Halley	411
14.3	Where do comets come from?	413
14.4	Anatomy of a comet	419
14.5	Two comet tails	422
14.6	Spacecraft glimpse the comet nucleus	423
14.7	Rotating comet nucleus	428
14.8	Comet decay and meteor showers	428
15	Beyond Neptune	435
15.1	Pluto: a small frozen world with companions	436
15.2	Small cold worlds in the outer precincts of the planetary system	439
15.3	Edge of the solar system	442
	Part 5 Origin of the solar system and extrasolar planets	
16	Brave new worlds	445
16.1	How the solar system came into being	446
16.2	Newborn stars with planet-forming disks	448
16.3	The plurality of worlds	449
16.4	The first discoveries of exoplanets	451
16.5	Hundreds of new worlds circling nearby stars	455
16.6	Searching for habitable planets	457
	Author index	461
	Subject index	463