

Contents

Part I A Historical Perspective

1	What Are the Stars?	3
	Globes of Gas	3
	The Temperature of the Sun	4
	Hydrostatic Equilibrium	5
	Radiative Equilibrium	6
	Eddington's Theory of Stars	9
	The Mass–Luminosity Relation	10
	Why Do the Stars Shine?	11
	Can Stars Find Peace?	13
2	Stars in Their Youth	15
	The Hertzsprung–Russell Diagram	15
	Energy Generation in the Main Sequence	17
	Convection in Stars	20
	The Lifetime of Stars	21
	The Ultimate Fate of the Stars	23
3	White Dwarf Stars	25
	The Strange Companion of Sirius	25
	Gravitational Redshift	27
	Experimental Verification of Gravitational Redshift	30
	A Stellar Paradox: Have the Stars Enough Energy to Cool?	31
4	The Principles of Statistical Mechanics	33
	Classical Mechanics	33
	Statistical Mechanics	33
	Quantum Mechanics	39
	Quantum Statistical Mechanics	42
	Quantum Statistics	46
	Spin and Statistics	50

5	Fermi–Dirac Distribution	55
	Pauli’s Exclusion Principle	55
	The Fermi–Dirac Distribution	56
	The Degenerate Electron Gas	58
	Fermi Momentum	60
6	Quantum Stars	67
	Fowler to the Rescue of White Dwarfs	67
	Enter Chandra	69
	Chandrasekhar’s Theory of the White Dwarfs	71
	All Stars will Ultimately Find Peace	77
7	The Chandrasekhar Limit	79
	Relativistic Stars	79
	A Startling Discovery by Chandrasekhar	84
	The Chandrasekhar Limit	87
	Can All Stars Find Peace?	90
8	The Absurd Behaviour of Stars: Not All Stars will have Energy to Cool	95
	Some Remarkable Assertions	95
	Eddington’s Tirade	96
9	Guest Stars	101
	The Oriental Astronomers	101
	The Guest Star of AD 1006	101
	The Guest Star of AD 1054	102
	De Nova Stella of AD 1572	103
	Kepler’s Nova Stella of AD 1604	104
	The Guest Star in the Andromeda Nebula	104
	The Great Debate	105
	A Super Nova?	107
10	Supernovae, Neutron Stars and Black Holes	109
	The Discovery of the Neutron	109
	The Origin of Supernovae	110
	Neutronization of Matter	116
	Neutron Cores of Massive Stars	118
	The Maximum Mass of Neutron Stars	121
	Black Holes	126
	A Profile of Chandra	129

Part II The Life History of Stars: A Modern Perspective

11 To Burn or Not to Burn	139
Nuclear Cycles	139
Quantum Tunnelling.	139
Helium Burning	144
Carbon Burning and Oxygen Burning.	145
Beyond Oxygen Burning.	146
The Onion Skin Model.	148
To Burn or Not to Burn	148
12 What Does the Future Hold for the Sun?	157
Early Evolution	157
The Star Becomes a Red Giant	158
The Ultraluminous Giant Star	159
The Helium Bomb	162
Helium Burning in the Core	164
The Supergiant Star	165
The Observational Hertzsprung-Russell Diagram	166
Thermal Pulses and Mass Ejection.	169
13 Life History of Intermediate Mass Stars	171
The Helium Core	171
The Schönberg–Chandrasekhar Limit	171
Central Helium Burning	174
The Carbon–Oxygen Core.	175
To Be or Not to Be!.	175
14 Diamonds in the Sky	185
The Population of White Dwarfs	185
Masses of White Dwarfs.	187
Magnetic White Dwarfs	187
Cooling of White Dwarfs	189
Diamonds in the Sky	192
Lucy in the Sky with Diamonds	194
Astero-seismology.	195
15 Exploding Stars	197
The Fate of Massive Stars.	197
The Final Day!	200
The Collapse of the Core	201
The Trapping of the Neutrinos!	205
The Neutrino Bomb!	208
A Guest Star is Born!.	209

Diamonds are not for Ever!	211
Coalescence of White Dwarfs	213
Gravitational Radiation	214
Black Holes	216
Epilogue	217
Suggested Reading	221
Index	223

Life and Death of the Stars

Srinivasan, G.

2014, XVII, 225 p. 113 illus., Softcover

ISBN: 978-3-642-45383-0