Table of Contents

Abstract iii
Preface v
Table of Contents vii

1. Introduction 1
   1.1 Beyond Time 1
   1.2 The Rosetta Stone 1
   1.3 Overview 3

2. Experimental Background 5
   2.1 Phenomena and Terminology 5
   2.2 History of Free-Run Studies 9

3. Data Bank 11
   3.1 Subject 1 18
   3.2 Subject 2 21
   3.3 Subject 3 24
   3.4 Subject 4 27
   3.5 Subject 5 31
   3.6 Subject 6 34
   3.7 Subject 7 36
   3.8 Subject 8 38
   3.9 Subject 9 40
   3.10 Subject 10 43
   3.11 Subject 11 45
   3.12 Subject 12 47
   3.13 Subject 13 49
   3.14 Subject 14 51
   3.15 Subject 15 53
   3.16 Subject 16 55
   3.17 Subject 17 58
   3.18 Subject 18 60
   3.19 Subject 19 62
   3.20 Subject 20 64
   3.21 Subject 21 66
   3.22 Subject 22 68

4. Patterns 70
   4.1 Durations Vary with Circadian Phase of Sleep Onset 71
   4.2 Sleep Length and Prior Wake Length 73
4.3 Timing of Wake-Up  80 
4.4 Timing of Sleep Onset  82 
4.5 Wake-Maintenance Zones  90 
4.6 Estimating Circadian Parameters from Sleep Data Alone  102 
4.7 Phase-Trapping  104 
4.8 Slow Changes in Sleep-Wake Cycle Length  109 
4.9 Miscellany and Missing Patterns  113 
4.10 Napping and Split Sleep  118 
4.11 Summary: The Basic Patterns of Internal Desynchrony  124 

5. Theoretical Background  128 
5.1 Conceptual Model of Aschoff and Wever  128 
5.2 Wever’s Noninteractive Model  129 
5.3 Kronauer’s XY Model: Coupled Van der Pol Oscillators  129 
5.4 Conceptual Model of Borbély  135 
5.5 Winfree’s Half-Model  138 
5.6 Gated Pacemaker of Daan, Beersma, and Borbély  141 
5.7 Other Approaches  144 

6. Analysis of Models  148 
6.1 Introduction  148 
6.2 BEATS Model  149 
6.3 PHASE Model  157 
6.4 XY Model of Kronauer et al.  172 
6.5 Model of Daan et al.  177 

7. Simulations  183 
7.1 Transition from Synchrony to Desynchrony  183 
7.2 Napping and Split Sleep Simulations  184 
7.3 A Representative Simulation of Internal Desynchrony  186 
7.4 Overall Performance During Desynchrony  192 
7.5 Summary and Discussion  204 

8. Epilogue  208 
8.1 Contributions  208 
8.2 Directions for Future Research  209 

References  211 

Index of Authors  219 

Index  224