

Contents

1	The Utility of Effective Theories	1
1.1	Definition of Effective Theories and Their Purpose	1
1.2	Galileo’s Law of Falling Bodies as an Effective Theory	2
	References	6
2	Harmonic Oscillator as an Effective Theory	7
2.1	Basics of the Harmonic Oscillator	7
2.2	Ubiquity of the Harmonic Oscillator	8
2.3	First Theory	9
2.4	Second Theory	10
2.5	Fancy Explanations	11
2.6	Third Theory	12
2.7	Deep Theory Conjecture	13
2.8	Ultimate Test?	14
3	Effective Theories of Classical Gravity	15
3.1	Introduction	15
3.2	Orbits in Newton’s Theory	16
3.2.1	Orbital Solution	17
3.2.2	The Hamiltonian and V_{eff} Description	18
3.3	Perihelion Precessions from Perturbations	20
3.3.1	$1/r^2$ Correction to the Central Potential	20
3.3.2	$1/r^3$ Correction to the Central Potential	22
3.4	Philosophical Challenges to Newton’s Theory	24
3.5	Effective Theories	26
3.5.1	Application to Newton’s Gravitation	28
3.5.2	Inevitable Perihelion Precession	29

3.6	Mercury's Anomalous Perihelion Precession	30
3.6.1	Analyzing Bob's $1/r^2$ Correction Theory.	31
3.6.2	Analyzing Alice's $1/r^3$ Correction Theory.	34
3.6.3	Gerber's "Utterly Worthless" Theory	35
3.7	Perturbation from General Relativity	37
3.8	Conclusions.	40
	References	41
4	Effective Theories and Elementary Particle Masses	43
4.1	Introduction.	43
4.2	The Problem of Mass in Chiral Gauge Theories	45
4.3	Standard Model Electroweak Theory	48
4.4	The Special Case of Neutrino Masses.	53
4.5	Natural Effective Theories, the Higgs Boson, and the Hierarchy Problem	55
	References	59
5	Effective Theories and Theory Choice.	61
5.1	Introduction.	61
5.2	The Standard Model's Triumphs and Woes.	62
5.3	Theory Choice Among Practitioners.	63
5.4	The Standard Model Versus the Effective Standard Model	64
5.5	Richter's IBE Criteria.	64
5.6	Thagard's IBE Criteria	66
5.7	Non-negotiable Attributes of a Best Explanation	67
5.8	Effective Field Theories and Consistency	69
5.9	Relation to Thagard's Analogy Criterion.	70
5.10	Summary: The Preeminence of Consistency	70
5.11	Implications for the LHC and Beyond	71
	References	72