Rules for Eternity

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DEDICATION

To my loving and devoted parents who established an environment that encouraged creativity.

John

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PREFACE

The desire to seek answers to the really big questions is not restricted to Philosophers, Scientists, Poets, or Dreamers. The prospect of never answering many of these questions does not detract from the joy of the journey while researching the possibilities. In Rules for Eternity, we are not searching for, or offering, ultimate answers. The aim is to identify a common thread running through all aspects of the natural Universe, and to reflect on how this knowledge might have practical application to human civilization.

Science and Philosophy record Humankind's imaginative interaction with its environment in the broadest terms. As history is written, our ideas and beliefs are subject to revision and verification. Wherever we happen to be sitting on the evolutionary time-line, we are always at the boundary between the known and the unknown. The future provides increasingly fertile ground for theoretical physicists to explore, but the demands they place on engineering for proof are becoming prohibitive. Eventually Science will reach the limits of verification at both the sub-atomic and outer cosmic level, where none of the competing theories can be deemed more acceptable than the rest.

The last several hundred years have presented the perfect environment for individuals of astounding intellect to create watershed moments in science. There was a time when the Law-of-Gravity could be postulated because of an apple that fell on the head of a great

mathematician. It now seems as though the 'easy' science has been done. To take our understanding to the next level requires an incredible investment in time, money, manpower, and cooperation. A perfect example of this is the Large Hadron Collider, which has so far yielded intriguing extensions to what was previously a simple concept involving gravitational-attraction between bodies with mass.

Rules for Eternity attempts to marry the science of the day with the unanswerable questions. Without wishing to spoil the plot, this book hopes to provide a convincing argument for what is stated on the front cover – "There is no beginning; There is no end". This presents a daunting challenge given our predisposition to think in terms of beginnings and endings, even when musing about Eternity.

ACKNOWLEDGEMENT

My most sincere thanks to Dr. Philip Rayment, a now retired mathematics and statistics academic. Without his enthusiastic encouragement and support during a lengthy gestation process, this book would never have become a reality.

Along with Philip's skill as a wordsmith honed over many years of assisting postgraduate students with the preparation of theses and publications, his 'attention to detail' has contributed greatly to the quality of Rules for Eternity.

However, it was not just Philip's skill with words that made him the ideal person to provide editorial guidance for this book. Some sections go into details that require a little background in basic physics. Philip was well qualified, not only to understand the physics at a basic level, but also to challenge some of the more esoteric concepts discussed.

He and I both fondly recall the inspirational lectures in cosmology delivered as part of university physics in Melbourne several decades ago.

John Hunter.

INTRODUCTION

Every aspect of our existence is controlled by Rules or Laws. Some of these Rules can be broken, with varying degrees of consequence. Invariably, these transient Rules are man-made. They can relate to a Continent, a State, or even attempt to define the minute constraints on where we might walk, sit, or smoke.

There are other Rules that must be obeyed without question, and there is not an opportunity to manoeuvre outside their restrictions, no matter how serious the intent. These unbreakable or Immutable Rules come from a higher authority, and are very much the focus of this book.

Many grey areas exist due to incomplete knowledge and understanding of the immutable rules. Identifying the exact scope of these rules will have a profound influence on the future directions available to Science. In the past, science-fiction writers have done a wonderful job of forecasting many advances in many fields of endeavour. Perhaps there is no better example than Arthur C. Clark, who first defined the Geostationary-Orbit, and clearly saw the place it would have in our technological future (ref: ***Geostationary Orbit***).

But, in some cases, these same writers may possibly have done a disservice in creating a bar that might be too high to reach. There is a growing expectation that, given enough time, humans can do anything. While that attitude is to be admired, is it realistic? The purpose to this exploration of the Rules is hopefully to

provide a reality-check on what is achievable, and what is pure fiction.

A requirement for seeing into the future is a solid understanding of the current rapidly expanding knowledge-base. It would be an utterly false expectation if we imagined we would ever be allowed or enabled to see the whole picture. Our entire world is but a pixel on the postage-stamp applied to an infinite universe. If we managed to eventually blow planet Earth back to a chaos of atoms and molecules, the effect would be less than a leaf-shake in the forest of our nearest galactic neighbours.

To examine the Rules to their fullest extent will require extrapolation way beyond our observable world. Once outside the observable event-horizon, we are squarely in the realms of Philosophy. In this book, we do go there, and make no pretence otherwise.

1. ENDLESS CONSTRAINTS ON EXISTENCE

As humans, every microsecond of our existence is governed by rules. At the lighter end of the spectrum, we create many of these rules ourselves, supposedly for the purpose of aiding the smooth running of society. At the other end of the spectrum sits a multitude of rules where we have no influence whatsoever. We are purely observers in this space, and one never-ending objective is to try to define the function and purpose for the rules of Nature. The intent of this book is to examine, perhaps philosophically, the way the natural rules interact with each other and ourselves.

In the broadest sense, Rules are either a description of, or a prescription for behaviour. As the Laws of Nature cannot be altered, scientific endeavour is confined solely to observing the results of the application of these laws, and devising endless experiments to test various hypotheses and models in an attempt to refine our understanding of the rules. In the case of man-made rules, they are meant to provide guidance for some desired behaviour. For these, there is often a voluminous written-record in the form of statutes and regulations. Rules-of-Nature are not available for ref-

erence in some earthbound library, and it is exceedingly difficult to imagine where the rules might actually reside. Although this presents a daunting challenge, there is something quite useful that does arise from exploring the thought. Much of the quest for mankind involves an investigation to discover origins. We have landed in a small slice of an infinite timeline. The 'origin of everything' occurred well outside anything that the human mind might imagine. Similarly, it is impossible to wrap the 'end of everything' in a way that has even a remote connection with our reality.

Much of the current human generation is immersed in the fruits of technology to an unprecedented extent. This can lead to a dangerous situation where we become collectively cocky about our place in the scheme of things. Because of the wonders technology has delivered thus far, we might be harbouring a belief that we could have complete control of our own destiny. However, it would be a fundamental mistake to ascribe to humans the power reserved for the gods. It is an interesting exercise to investigate how there will always be external constraints on human civilization. There is a need to ensure that we continue to play within the goalposts, and avoid spending fruitless effort in trying to change their location. This cockiness seems to be translating to a disrespect for our planet and a blasé attitude towards our long-term survival. It is hoped this book can bring some realistic perspective regarding our role in the giant scenario of life.

Firstly, a brief diversion into the history of man-made or transient rules, and a suggestion as to why

these have become so prolific in modern society. Sometime over the last several million years, mankind developed the characteristics that set us apart from our near-relatives in the animal world. During the early stages in the evolution of man, virtually all rules were provided and controlled by Nature. As our civilizations advanced, the need arose for a more complex set of rules to accommodate the increasing stresses and demands of society. Prior to this, our ancestors were driven purely by natural rules or instinct. These natural rules were closely related to survival – the necessity to eat and drink; the drive to find a partner and procreate; the honing of skills required to kill anything that was trying to kill them.

A human in isolation would be driven purely by instinct. As he starts to form part of a larger collective, a set of rules develops that defines an appropriate moral code for the group. Often, any disregard for moral-rules is classified as a Sin. In many cases, the rules of morality are just a detailed version of what we consider to be instinct. However, quite different moral codes can exist for different societies or tribes, even within the same animal species. For most human societies, killing of one's own species is not considered acceptable. In the animal kingdom, this behaviour might sometimes be not only acceptable practice, but may be an essential part of the life-cycle for that species. There is no moral code among animals, only survival instincts, although the distinction between the two is not always clear-cut. To illustrate this point, there are many reported cases where conditions that threaten

survival can turn animals into killers of their own species (ref: ***Animal Infanticide***).

Ancient Egyptian and Greek civilizations were no strangers to rules. Both maintained a basic set of man-made rules, all created by the RULERS – the clue is in their title. However, there was a twist. Fearing man-made rules may not have sufficient authority to impress the masses, many of the rules were packaged as dictates from the gods. This had the added benefit that no particular ruler would need to take responsibility for any rule that might have had negative consequences. Even though there was a lack of hard evidence for the existence of gods, it seemed justifiable to allow for the possibility as good insurance. The gods of the day were not just about making rules on how society should run. They also provided a convenient explanation for the many things that were not understood. This practice continues today where we tend to explain the unknown as work of the gods (ref: ***God of the Gaps***).

The basic tenet behind the creation of man-made rules was the assumption that they were essential to ensure the smooth functioning of society. That assumption is, in all likelihood, a valid one. In ancient times, there was little understanding of the natural rules that were already in place, guiding every step to maintain the health of the planet and to seek the best long-term outcomes for its inhabitants. In modern times, an important attempt to formally explain this process has been the Gaia Principle (ref: ***The Gaia Hypothesis***). More and more we are discovering a need

for global agreement, and rules, to ensure that collective human behaviour does not disrupt our planet's equilibrium. Currently, the obvious example is out-of-cycle warming of the Earth, caused by human population growth and industrialization.

The number of rules of society, or transient rules, has grown out of all proportion in modern times. The assumption is that every step must be controlled by bureaucratic processes. This dictum applies equally to all forms of government, from dictatorships to the most well-intentioned democracies. Almost invariably, these man-made rules become corrupted by alternative agendas, and develop a slant to sustaining those who make the rules, rather than seeking an ultimate benefit for society. One could be forgiven for making the cynical observation that there might always be in place a clearly defined set-of-rules solely to accommodate the whims of the ruling classes. That said, many of these rules are quite essential for the smooth running of society.

There are examples from history where the rules of man run into conflict with the natural laws. The Mayans and Incas developed extremely rich cultures, even though their civilizations were relatively short-lived. Study of cause-and-effect was in its infancy, and some interpretations suffered high error-rates. Natural laws usually provide an opportunity for graceful retirement from the population for the old and weak. Much has been written on the practice of offering as sacrifice the young and productive to placate the gods, and this would appear to run counter to the long-term-benefit

of a civilization. Perhaps this misguided attempt at formulating rules played some part in the ultimate decline of these ancient civilizations.

Societies are formed around common beliefs, desires, and objectives. These societies gain strength from rules that are both consistent and cohesive. If rules are to be accepted and obeyed without undue enforcement, there must also be a clear benefit to society as a whole. As societies change and grow so do the associated rules. There appears to be a strong correlation between the number of transient or man-made rules, the size of a population, and the ability of that population to communicate. The more we communicate, the more we generate rules. All man-made rules that govern society are experimental, and subject to change over time.

Our species on planet Earth is pushing the bounds on every front as to what the laws of Nature will allow. Any belief that humans now have total control of all factors governing our civilization, is really misguided and incredibly arrogant. Take the natural controls on population as an example. In nature, virtually all animal populations are regulated by the available resources and prevailing conditions. Thanks to Industrialization, Technology, and the sheer weight of numbers, mankind has reversed the situation. Humans are now consuming resources at an unsustainable level, rather than treating resources as a limitation on population growth. There are many natural forces that impose restrictions on population. The decision on where humans could live, and how many could popu-

late a given space, seemed to be one of free-choice. There is a general formula or rule that seems to apply to all life at a high level, both for plant and animal species. Natural mechanisms kick in when population trends are not in the best interests of the planet as a whole. Again, with reference to the Gaia Hypothesis, we are now bending those rules to the limit.

Despite our best efforts, it is very unlikely that these controls can be manipulated to fully satisfy the human inhabitants of Earth. Before we had any influence at all, we were at the mercy of plague and famine. These were large-scale demonstrations of the natural forces designed to limit population growth. Like beavers, we have the ability to terraform our environment and alter the delicate balance to the detriment of other lifeforms. It would seem we have the power of life or death over all life on Earth, except our own. It's quite possible the dominant species in the dinosaur-age developed a similar sense of superiority and arrogance at a time when they ruled the world and their survival seemed assured. Given the limited resources of our planet, we must look very carefully at the management of these resources. In ancient societies, our ancestors tended to live comfortably within the bounds of sustainability.

Many cultures saw a serious purpose in making things better for following generations. Viewed with the benefit of what we now know, some attempts to improve ancient civilizations may seem misguided. But the intent was there, nonetheless. There was no hint that mankind was actually quite insignificant on a Cos-

mic-scale. However, there is one thing that human civilizations of old agreed upon – they were being driven by external forces, the complexity of which was beyond comprehension. Invariably, as noted earlier, the gods were given all responsibility for the unexplained and the inexplicable.

Looking back a few centuries, there was a common belief that not much existed outside the view from the naked-eye. The stars in the sky were just specks on a canvas; they weren't seen as replications of our own Solar System or Galaxy. Because the conception was relatively self-contained, there was an innate respect for life and the delicate balance of things that control it. Perhaps as a result of a dramatically expanded understanding of the Cosmos over the last few decades, it may seem that our actions have no consequences or significance in the bigger picture. While that's absolutely true, we should not lose sight of the fact that the whole purpose to life is to make things better for the people who are living it, or have the potential to live it.

The above discussion relates to man-made rules. However, these rules pale into insignificance when compared with the far greater number of rules over which we have no control – the rules that govern our existence, the Rules-of-Nature. In defining transient rules, we have a reasonable degree of flexibility. We have no influence whatsoever on the rules-of-nature. In this space, we are mere observers with quite limited degrees of freedom. Although we have no influence on the rules themselves, we can seemingly affect the out-

come from the application of some of those rules by altering the situations to which the rules could apply.

Rules-of-nature are not experimental – they have been put in place to take account of all possible future contingencies. They are immutable. And that is an extremely important distinction between man-made rules and the rules-of-nature. From our vantage point in the cosmos, we can view the historical record back almost to the time when our Universe began. On examination of the record over that time, there is absolutely no evidence to show that any of the laws-of-physics have changed a single skerrick. Our model to explain observations of the big picture relies heavily on extrapolating physics from our everyday experience. One thing scientific investigation has established so far is that there is an incredibly complex and mathematically beautiful interconnection between all fundamental components of the physical world. The ultimate goal for science is to find a unifying theory that ties together seemingly unrelated elements. There are no guarantees that such a theory exists at all. We are driven in this direction by the success in the past at finding unexpected relationships between seemingly unrelated physical quantities.

Perhaps there is no better illustration of this than the ubiquitous equation $E = mc^2$. A couple of centuries ago, who could possibly have imagined that energy might be a function of mass and the speed-of-light? There are many more examples, but their examination lies outside the scope of this book. What we can take from knowing that these relationships exist is that

there is an extremely delicate balance required in maintaining precisely the environment of our existence. Imagine for a moment that the rules of nature were not immutable, and might still be evolving. Because of the interconnectivity involved, it is not possible to fiddle with one of the rules in isolation without upsetting the equilibrium which is an essential part of everything we know. The empirical evidence available at this time, leads to the realization that the rules we are observing, the rules that govern every aspect of our existence, have not changed since our Universe began. The inescapable conclusion is that the rules that existed at the start of our Universe, are the same rules we see in play today, and there is no evidence that they might change before its end.

We can look back to contemplate a time just prior to the Big Bang, and assume that the Rules simply sprang from some chance vibration in a void. Eventually they might have evolved into the complex set-of-rules that drive absolutely everything. If this was actually an evolutionary process, it would be reasonable to expect that there might be evidence of changes in some of these rules during the past 13.8 billion years. No such evidence has been discovered, even though that period of observation is quite substantial when considering our Universe as the frame of reference. The other thing to be taken into account is the intimate connection between all the constants and rules in the physical world. Any slight change in any one of these is likely to upset the incredibly delicate equilibrium that exists in basically everything – they are so beautifully inter-

twined and locked into each other that it's simply not possible to change one, even a tiny bit, without dramatic repercussions. What makes these immutable rules so astounding, is that they have remained in place, unchanged since our time began. There has been no necessity or opportunity to vary these rules due to unforeseen consequences in any of the untold numbers of planets that might sustain life throughout the Universe.

The only rules we can change are the rules we make. The suggestion here will be insulting to many – what we might think of as 'free will' can have no more consequence than any particular random result from any of the rules controlling us. On the other hand, we are not living out a predetermined destiny. The path we follow is fairly rigidly contained within the tolerance allowed by outcomes from the immutable rules, but there is comfort to be had from the illusion that we have more say in our destiny than we actually do. As an example, suppose an individual has decided to live to celebrate his 200th birthday. With the best will in the world, it is quite unlikely that this outcome will be achieved.

Humans, as with every other life-form, have a predetermined upper limit on lifespan that remains relatively constant throughout the period that our species exists. Many factors prevent any particular individual reaching the maximum possible age. Life-expectancy for humans has improved dramatically over the last couple of centuries as health and environmental issues are understood and addressed. Genetic

inheritance plays a large part in determining whether or not a human can survive to the limit allowed by the blueprint for our species. Although we can affect the outcome to a certain degree by lifestyle choices and medical intervention, the age to which we live without artificial assistance is by no means open-ended.

Many of the rules that seem to apply in our everyday world could possibly be far more complex than first-impressions might suggest. One interpretation is that these immutable rules might appear to vary depending on the scale of the situation to which they apply. Perhaps a more accurate way to view this is that the rules are not changed at all, but rather we failed in our initial observation to understand the full extent of the rule. When can we be sure that the rules have been particularized to the fullest extent into fundamental components? Answer – "We can't". And a similar frustration awaits particle-physicists as they delve ever deeper into the subatomic world.

A good example of how the same rule might have different consequences in micro and macro situations, relates to the most common force that impacts us all – Gravity. Popular science teaches about the phenomenon whereby objects with mass attract each other. Simple, yes? Well maybe not quite so simple. Dramatic experiments in recent times are just starting to reveal the complexities related to mass itself (ref: ***The Higgs Boson***). So the Rule or Law for Gravity is as the textbooks say when considering objects visible to the naked-eye. However, it is not valid to assume that the observations made within the limitations of our ex-

perience will automatically extrapolate to the subatomic or cosmic scale. We cannot be sure the Laws of Gravity scale up to cosmic levels without additional, as yet undiscovered, rules kicking in. Gravity is an extremely weak force when compared with other forces in Nature, and decays rapidly over distance. The jury is undecided on whether or not gravitational forces as we currently understand them, are sufficiently strong to draw together tiny particles of dust and gas from the far reaches of space, and create new galaxies. Undoubtedly there are many unknown rules awaiting discovery in this area.

As another example of a rule that appears to produce different results as the scale changes, consider the electrostatic repulsion between similarly charged objects in our everyday frame-of-reference. In physics, this phenomenon is known as Coulomb Force. If this electrostatic repulsion was the dominant force between charged particles at the subatomic level, protons would be unable to collaborate to form stable nuclei. One of the four fundamental forces of nature is known as Strong Nuclear Force. Until humans had the tools to provide an intimate view of internal atomic structures, this force remained hidden. It operates at exceedingly minute distances, and produces no discernible effect in the visible world. Although Coulomb Forces may be present at the atomic level, the effect they produce will be undetectable in any competition with Strong Nuclear Forces.

Rules can produce quite different outcomes as conditions change. Take as an example the rules that govern

elemental Carbon. At normal temperatures and pressures, pure Carbon exists in a state that we might find in burnt forests, or pencils. Under intense heat and pressure, diamonds are created from the same material. And we are just discovering the incredible properties of another form of Carbon – Graphene (ref: ***Graphene***). This Graphene is worthy of special mention for plaudits to the power of Science and Engineering. It does not occur naturally, and requires a very controlled manufacturing process. However, it is important to note that, even though the process does not occur in Nature, the rules that allowed for it to exist were already defined long ago. This was a 'discovery' by mankind, not an 'invention'.

A common theme throughout this book emphasizes that there are relatively few rules in nature we have identified that can be categorized with certainty as absolute. Like most common compounds, Water seems to follow the rule that it will expand as the temperature rises. The rule for water involving temperature and expansion, has qualifications attached. At both the high and low end of the temperature-scale, water changes state and thus needs a different set of rules to define its behaviour. As the temperature drops and water starts to turn to ice, it expands, in contravention of the previous rule that might have been applicable more broadly. This illustrates nicely that while some rules might appear to be flexible, that flexibility could in fact be the result of macro-rules being composed of very specific 'sub-rules' which have a more restricted application.

To illustrate the delicate interplay and interconnection of rules that determine the perfect conditions for life as we know it, we need look no further than the chemical properties of H_2O, and their role in what we know as "weather". Evaporation and precipitation result from properties of the water molecule, and ultimately control the distillation and distribution of this molecule that is so essential to life. It could be argued that the distillation inherent in the evaporation process is not an essential to life, but it is certainly essential to human life. Sea creatures have adapted to both freshwater and saltwater environments, and presumably humans would have evolved to fit with whatever the prevailing environment provided.

Many of the rules-of-nature are fuzzy rules, meaning they appear to have non-exact outcomes. Immutable rules are not necessarily exact rules – there is no guarantee that the same circumstances will result in the same outcome. Every rule in Nature has a probability of returning a certain result. Some results are quite constrained and predictable; others produce outcomes within a wide tolerance.

Quite different results can be obtained from the application of the same rules in quite similar situations. These variations can sometimes be attributed to a change of environment, or varying initial conditions and properties. Discovering what these influences might be, is the never-ending task for human science. Look to Chemistry for analogies on how these rules, properties, and environmental parameters might interact to produce a specific observable outcome. We

might note the result from a given experiment, and hypothesize that it may constitute a general rule that could apply in other situations. If empirical conformation supports the idea that the rule is reasonably definitive and could have wider implications, then that rule is offered as a permanent member of the science of the day. The ultimate success of such a procedure would come if a rule attains status to be recognized as one of the fundamental laws-of-physics.

The conventional way of conducting experiments in Chemistry is to combine various elements or compounds and search for patterns in the results. From those, it may be possible to define properties that can be associated with these elements or compounds. Not only can we vary the elements input to an experiment, we can change the environment substantially with variations in temperature and pressure. Thus, any rule we wish to formulate from the results, must specify the conditions for that rule to have a replicable function.

All physical objects in our Universe are composed of atoms, and hence these objects should be expected to at least obey the rules associated with their atomic components. As atoms combine to form larger and more complex entities, additional rules are necessary. For example, the rules identified as dictating behaviour on an atomic scale would not be sufficient to explain the physics related to black-holes. Nor would they be able to provide any meaningful contribution to our understanding of carbon-based life forms. At what point do the rules governing an object's behaviour extend beyond just an amalgamation of rules related to atoms?

And this poses the question as to where the rules might actually be stored. Is it possible that each atom possesses information about every conceivable outcome involving atoms? This concept is unlikely in the extreme, so we must seek an alternative explanation. One possible conclusion is that the rules must pre-exist outside any object, rather than being self-contained properties and functions belonging to that object. We will examine this concept in a later chapter.

As mentioned previously, mankind has the power to change the planet, for better or for worse. The issue of Global Warming has now shifted from debate, to one of conclusion. It would seem we are largely responsible for the out-of-cycle warming our planet is facing. As we have done in the past, we might look to technology to save the day. If we divert a large portion of the planet's resources to driving refrigeration-units, we might prolong human comfort for some time. Eventually, there will be no escaping the damage that such a temporary misuse of resources will have on the planet as a whole.

We would all like to believe that our species is in some way special. If we look at the timeline for our Solar System, and the eventual burn-out of our star, there will actually be many opportunities for human civilization to be obliterated, and completely replaced by a new dominant species. One can only guess whether these new civilizations start completely from scratch, or whether we leave behind something of interest in the fossil record that might be a good launching pad for Humans-II. The evolution of life and planet Earth will be following exactly the same rules as

have applied in the past. However, the countless variables that play a part in determining the future will mean that the history of life on planet Earth may not necessarily be a good indicator of what lies ahead.