Revolution in the Understanding of Space-Time: A Project

Introduction

Issue

In the beginning, there was time. We know this because for anything to have a beginning, time must be operating. In fact, the time-based operation of human cognition is so integral to our experience and conceptualization of existence itself, that the greatest minds of our species have been unable to create a consistent definition that does not refer to a sense of time in order to explain it. The problems inherent in simply describing our sense of time date back as far as recorded history. The enigmatic and intriguing linkage of space and time within relativity establishes a single constant governing these two radically different human perceptions, suggesting they are aspects of one unified reality that, for the past 100 years, has eluded the best minds and most sophisticated instrumentation ever conceived.

Selected Focus

Speculating directly on “The Nature of Time” can be engaging and inspirational, but amounts to a Hail Mary pass in the face of obstinate difficulties. Achieving reliable progress requires persistence, patience, care, optimism, and reining in our natural tendency toward easy solutions. Group brainstorming such as this essay contest and discussions may see 100 papers submitted by intelligent, creative authors. It is most likely that all submissions of substantial size will contain ideas of great value going unrecognized, whereas other ideas will appear valuable, but ultimately prove otherwise. If each paper contains a single new brilliant idea, the sum of submissions from this one contest represents a surprising potential resource on which to draw, if we can identify the high-value ideas. A main obstacle to choosing well appears to be the lack of a selection system based on what is known about the problems in cosmology relating to time, and what is known about how similar problems were solved in the past. This essay analyzes how to manage these obstacles based on what is known about delivering successful solutions within time or cost constraints.

Content

In this essay, we focus on the history of humanity’s concept of time relative to current, profound mysteries in physics. We will explore the revolutionary paradigm shift widely expected to resolve these mysteries, and explain why what we know about that revolution suggests that virtually all the questions physicists are asking today are the wrong questions.

Core Science

To plan a journey into the future of science, we shall orient ourselves to “the big picture” by identifying core features of science that remain constant across transformative changes. If we were to receive a cosmology textbook from 300 years in the future, we would be familiar with its goal of investigating nature, and its approach of describing the order of nature with maximum precision and universality. We would also be comfortable with the manner in which this is done: presenting theories as internally consistent and closely matched to available observation as possible.[1] We would share a recognition with the authors of that work, that logic and experience exert huge influence determining whether an idea is considered to have attained the status of “knowledge”.

Assumptions and Approach

An assumption in this description of science is that nature exists and its rules can be known. However, when faced with apparently intractable problems, a tendency to change the rules emerges, based on the perception that relevant data is inherently unverifiable, too remote, or impossible to define clearly. In this paper, we adhere to a conservative approach, both to the traditional boundaries of rationalist science as the most reliable, productive system of inquiry in history and, to restrict our analysis to concepts which meet well-established requirements for scientific theories. These traditional boundaries eschew or exclude approaches based on solipsist and Anthropic principles.

Scope of Scientific Theory

For a theory to qualify as “Scientific”, it must:

- Exhibit Systematic Structure and Logical Self-Consistency;
- Express All Previous Observations Within Its Domain;
- Describe a Framework Addressing Natural or Social Phenomena;
- Make Predictions;
- Be Testable and Tentative in Principle;
- Be Subject to Inclusion in a Larger Theory and Revision

Definition of each of these requirements is beyond the scope of this essay; however, these guidelines enable us to screen results of time theory and model development.

Tools and Analysis

A Thinking Crown[2]

Like any complex task, predicting how time will change in the future paradigm requires specific tools. Our best guide to this future is a map based on successful revolutions in the past. If we apply “synthesis”, (historical reasoning to obtain the best explanation) [3], to well-known, uncontroversial examples of successful, transformative revolutions, we can extract what planners call “key performance indicators”, enabling us to devote sufficient resources to areas that distinguish revolutionary science of the kind needed.

Other tools we need for planning: a working familiarity with scientific paradigms, how they operate and change, and project management, the discipline concerned with successfully creating change.

Copernican Revolution

The Copernican Revolution is perhaps the best known archetype for a revolution in science. Five centuries ago, the generally-accepted model in Europe was a Ptolemaic system which held that the Earth is at the center of the universe, does not move, and that objects in the sky rotate around the Earth. This model explained and was confirmed by the lack of detectable motion of the Earth and the apparent rotations in the sky. In addition, Ptolemy was official Church doctrine. The sun-centered cosmology of Copernicus removed the human observer from a central observational position in the solar system and redefined Earth as one of the ‘wandering stars’. “Planets” is πλανήτης (*planētēs*) in Greek, and means "wanderer"[4]...literally: an Earth-shaking idea.

Darwinian Revolution

When the Darwinian Revolution began, the prevailing model of biological change was that animal and plant varieties were the result of changes acquired by ancestors during their lifetimes. A giraffe that stretched its neck to eat would pass on an acquired, inherited trait of a longer neck to its offspring – and major differences of species were the result of the original pairs made by God during creation in Genesis. The view based on this model of change was called Lamarckism, which adhered to the old paradigm that humanity was a special creation, central and separate from other creatures. Lamarckism explained biological diversity, the observed uniqueness of humans, and how countless different varieties of species came about. Darwin’s evolutionary theory proposed natural selection as a mechanism that could account for all known forms of life. While it provided incredible explanatory power, it also repositioned the human observer from a central place of importance. As Copernicus had changed the understanding of humanity’s physical position, Darwin changed the understanding of our biological position. Where Copernicus joined Earth with all of the cosmos, Darwin joined humanity with all other life forms, relating us as one kind of organic species among countless others.

Cognitive Frameworks

Understanding any situation requires a mental structure to tell us what the rules are, and make it intelligible. A structure helps us decide what is important and dictates what questions are sensible. In turn, this defines what type of instruments and activities we use to answer those questions. If our cognitive framework contains a rule that "telltale numb spots convey information about demonic enslavement", we are likely to have investigators develop pricking instruments to detect this spot in the specialized activity of witch hunting. If our cognitive framework contains a rule that "sounds from inside the body convey information about health", then we are likely to build an instrument like a stethoscope to detect those sounds for the specialized activity of medical diagnosis. The structures that govern what instruments and procedures we develop are called cognitive frameworks, paradigms, worldviews, or in physics: models. These are more specific ways of viewing reality than the general scientific method,[5] defining what the world is relative to our discipline. Our current beliefs about what time is or represents are no exception. The overthrow and replacement of our current cosmological paradigms is widely regarded as inevitable because of scientific "anomalies." When our paradigms are old history, those studying our instruments and methods will be able to see where the boundaries for our cognitive frameworks were. If now, we compare current models carefully for similarities with Copernican and Darwinian revolutions, we can deduce something about how our views will be different in the future from those of today.

Revolutionary Change

Whether or not a scientific change is revolutionary is a matter of some debate. Some specialists regard discovering the existence of stellar clusters to be revolutionary, as it gave rise to several astronomical disciplines, whereas others consider this merely a new bit of information about stars. Some definitions of transformative paradigm changes include development of "widely applicable technology", while other descriptions provide examples of unconventional, successful researchers and approaches. We avoid disputes over details by using criteria developed from the class of change unambiguously considered both revolutionary, and uniquely valuable. We will judge normal, incremental advances in science to have occurred when "no previously classified [types] have been reclassified."[6] Because the discovery of stellar clusters provides a means of investigating the history of the Milky Way and created a new astronomical subfield, the discovery is important, but does not reach revolutionary status by this standard.

Type Recategorization: A Litmus Test?

While debates over specifics of the Copernican and Darwinian Revolutions continue, there is no significant disagreement that if you want to list the most important revolutions in science, these top the list. An obvious question is: "If Copernicus and Darwin changes were revolutionary, then what types were reclassified by the new paradigms?" In the Copernican Revolution, 'celestial motion' was a type of cosmological phenomenon reclassified; becoming the result of human observers moving in a sun-centered system. The Darwinian Revolution recategorized separate, divinely created types of animals into related species sharing a common ancestor on a single biological tree.

Because recategorization of paradigms' defining 'types' is a key characteristic of revolutions, time - the measurement of periodic repetitions we view now as evidence of time's operation – will be reclassified. As a defining example of time's operation within both quantum and cosmological paradigms, both paradigms will be affected by any change in our model of time. What a clock measures will still be regarded as "time" in the same sense that we regard the sun "coming up" each day. The recategorization is not due to improved observation and measurement; it is due to structural changes in the cognitive framework underlying our conceptualization of time.

Assumption Correction

Assumptions are defined as factors that are considered to be "true, real, or certain without proof or demonstration."[7] They affect all aspects of cognition, knowledge, planning, and in the research enterprise with which we are concerned: assumptions introduce risk. In the large scale history of cosmology, the most pronounced cost associated with that risk is the waste of careers and progress over centuries, sometimes lives are lost. The time, money, and lives devoted to making the Ptolemaic paradigm conform to observations were tragic, as were the infamous efforts to enforce a geocentric worldview. The natural assumption of a stable earth with humans at the center was rejected in the Copernican revolution whereas under Darwin, the assumption of a hierarchy of separately-created, stable species – with humans in a reassuringly important position – was rejected. The Einsteinian revolution rejected, among other things, the assumption that time is a characteristic of reality separate from space. Each of these fundamental theories obliterates assumptions involving special status for humans.

The successful revolutionary time paradigm will not regard time and space as fundamental dimensions of the universe which humans are uniquely able to perceive and clocks are able to measure, despite the very natural, common sense assumption that this is the case.

Observational Component

One astoundingly similar characteristic of archetypal, revolutionary ideas alluded to above, is a specific type of assumption these new paradigms refute. They directly address a natural assumption made by previous investigators, rejecting it by demonstrating that well-accepted measurements and observations actually depend on conditions unique to the human investigators. The demotion of Earth from the center of the universe to a relatively insignificant planet moving through an unimaginably large cosmos demonstrates this perfectly. Darwin's revolution moved Homo sapiens from God's central concern, to a small, just-sprouted twig on a great tree of life, with no gardener in sight.

The type of observer-centered bias that we should expect from a revolutionary theory of time will propose that a basic assumption in current models is incorrect. For example: "time is a fundamental quantity" appears likely to be replaced in a manner similar to the Ptolemaic assumption that "Earth is a fundamental center". A successful, revolutionary paradigm for time will propose a new categorization for time as the observational consequence of a process we cannot directly observe due to perceptual limitations. However, the new cognitive framework will explain why making that assumption is understandable, if not inevitable.

Progressive Elaboration

Revolutionary models demonstrate vague descriptions of concepts in their early stages, acquiring greater detail as more research is performed and a better, more complete understanding is gained. The heliocentric model of Copernicus appears primeval compared to modern conceptualizations. The Big Bang, production of atoms, heavy elements, gravity, space-time, black holes, and the origins of life, all derive in some part from the simple idea of putting the sun at the center. The inadequacy of Darwin's theory by today's standards likewise illustrates the initial lack of elaboration shared by all new concepts. Such vagueness makes the value of the new model difficult to perceive, especially if we have invested much in developing or preserving the old model. New, revolutionary ideas are often clamoring for attention and funding among others, they appear to have fatal flaws and to be unreasonable, yet we know that these appearances are misleading. This characteristic suggests that development of efficient screening processes to distinguish flawed and/or unreasonable models from consideration will be helpful in managing these misleading appearances.

A Missing Mechanism

Although Copernicus' model rejected the orientation of the crystal sphere "firmament" given in the Bible as surrounding the Earth, it kept these invisible spheres as the mechanism for celestial movement. The Copernican revolution is often regarded as completed when Newtonian gravity was advanced as an orbital mechanism. In turn, these revolutionary ideas of gravity by Newton similarly lacked a mechanism by which the attractive force of gravity might operate. In fact, problems of "action at a distance" have remained since the theory was proposed; today the details, (or even the broad principles), for the mechanism by which gravity operates remain a mystery. With Darwin's theory, no hereditary explanation existed which could account for gradual variability or mutation, despite evidence indicating the existence of such a mechanism.

The revolution in our concept of time will, like past revolutions, lack a mechanism explaining how the model operates.

Process Orientation

Despite their initial lack of elaboration and one or more mechanisms, successful revolutions prominently focus on processes. These processes describe phenomena and core invariants. They share common explanatory features such as: a generative characteristic, an iterative dynamic, and interactivity.

Generative Characteristic

Heliocentrism explains what generates our celestial observations, explaining *why* heavenly bodies appear to move the way they do. Natural selection explains what generates organism speciation, and answers the question of why there are so many varieties of each species. The new time paradigm will likewise explain what generates our observations of time in terms that answer *why* questions of a similar nature. While we recognize the importance of a proper "why" question, our current lack of a reliable framework with which to formulate a question makes any hypothesis unreliable. Proposals and guesses in such circumstances also can be dangerously prejudicial. Nevertheless, a possible candidate question might be: "Why do we observe distance and time the way we do?"

Iterative Dynamic

The generative characteristic of processes in these paradigms is supported by an iterative dynamic – a repeating cycle of activity giving rise to whatever is being generated. In Copernican cosmology, these are the repeating rotations of the Earth and the planets' revolutions around the sun. For Darwin's biology, the iterative dynamic is a repeating cycle of change from one generation of organism to the next. Our new conceptualization of time will include an iterative component or characteristic that explains our perception of time as flowing.

Interactivity

Interactivity in a paradigm process can refer to feedback within the processes described in the new conceptualization. In the Copernican system, we might consider the way that an output of this model, (i.e.: sun, moon, and planetary positions), can be used to accurately predict observed positions for the previous day or for the following year, and these positions can provide an input for the next iteration. In evolution, a more robust form of interactivity appears: as effects of evolution significantly determine which incremental changes in offspring are advantageous. Evolutionary changes are cumulative due to the replicative nature of life. Over time, the results of this cumulative interactivity include the full, rich diversity of living forms. In the case of revolutionizing our understanding of time, the degree, nature, and importance of the interactivity characteristic appears uncertain.

Mathematically Expressed

The process orientation of revolutionary paradigms is expressed using the *lingua franca* of science: mathematics. While logical rules describe qualitative attributes of observations and relationships, mathematics describes quantitative aspects. Planetary orbits and the rotation of the Earth have specific, measurable velocities associated with them, and math formulas describe ellipses of stable orbits and "fly-by" hyperboles through our solar system. In evolution, formulas and quantitative measurements describe critical observations of population size, reproduction, mutation rates, and our current understanding of DNA-based genetics. In the future, new mathematics for time will describe quantifiable aspects such as the rate of its perceived flow in a more complete way than clocks or the lightspeed c relationship does now. A key problem in understanding time sufficiently to predict what kind of quantities these future equations will describe is shared with our problematic understanding of other "fundamental" metrics like space, matter, energy, and force. This problem exists for all metrics lacking a meaningful, non-circular definition, and which are not yet qualitatively linked within a cognitive framework consistent with observations.

Domain Expansion

Revolutionary paradigms expand established areas of study into new domains. Heliocentrism extended natural philosophy into the heavens, revolutionizing and creating new branches of science. Natural selection did the same in biology, synthesizing animal husbandry, biogeography, geology, morphology, and embryology.[8] When complete, the time revolution will almost certainly synthesize relativity, quantum mechanics, and gravity – but the manner in which it will do so will be surprising.

Practical Anomalies

One surprise will be the way in which the revolution in time modeling will resolve the anomalies currently baffling the physics community. Isaac Asimov wrote: *"The most exciting phrase to hear in science, the one that heralds new discoveries, is not 'Eureka!' - but 'That's funny...'"* With Copernicus, unworkable and conflicting calculations of the date motivated a new method for calculating dates and reforming calendars. In biology, crisis was brewing with the explosion of new species being discovered during the Victorian 1800's. The inability of existing classification systems to handle these discoveries and resolve conflicts led to the search for a way to explain how variety and speciation occurred, which would enable a rational naming system. When Darwin proposed natural selection with common ancestry as a method of solving the naming problem, he changed the world. In both cases, theoretical anomalies were incurring real-world costs. The effort to eliminate those costs by solving the theoretical problems triggered the revolution. Pursuit of a goal, (such as faster than light travel), could be proactively sought before an asteroid or other threat made revolutionizing space-time models a survival imperative.

Disciplines Created, Crossed, and Unified

Expanding the domain of established disciplines is not the only relationship change that revolutionary new frameworks have on science. Transformational concepts create new fields, link previously disparate knowledge areas, and integrate cognitive skills, tools, and evidence from those knowledge areas. Providing explanatory efficiency, greater clarity, and depth of understanding, the new paradigm for time will cross and draw upon fields like mathematical algorithms, group theory, relativity, dimensional analysis, and cosmology.

Context Sensitivity

Revolutionary new paradigms assimilate the old and provide an explanatory context for historical precedents and observations. This enables us to judge why past paradigms might be the best to use in a particular situation. For example, a relativistic view is the best perspective if we want to understand how GPS signals work, but the Newtonian view was best for figuring out how to land on the moon. If we want to call from Cairo to Shanghai, thinking of Earth as a sphere with differing time zones is more useful, but in working with maps, a flat-earth conception is typically more efficient. If we intend to climb up or ski down a mountain, local inclinations are far more relevant than a flat representation. Time as "what clocks measure" will undoubtedly remain most useful for most everyday activities, but we will recognize when the revolutionary approach is best for accomplishing our goals.

Definition of the Goal

Creating a successful, revolutionary theory of time is our goal. It will be accomplished through planned work, performed and controlled by people, constrained by limited resources, and have identifiable start and end points. The goal will be difficult or impossible to attain within normal scientific operations. Minimum components of a successful effort will include: requirement identification, clear and achievable objectives, balancing competing demands for quality, scope, time and cost. Adaptation of specifications, terminology, plans, and approaches will be necessary to coordinate different kinds of stakeholders.

The successfully transformative theory of time will:

- Qualify as a scientific theory;
- Structurally alter current cognitive frames;
- Recategorize types;
- Correct previous assumptions;
- Address observational consequences;
- Exhibit progressive elaboration;
- Initially omit important components;
- Have a process orientation including
    - Generation;
    - Iterative dynamic;

  - Interactivity;
- Be expressed mathematically;
- Expand a discipline of science
- Resolve anomalies;
- Create new scientific disciplines;
- Cross traditional disciplines;
- Unify previously separate disciplines;
- Possess sensitivity to application context;

Project Relevance

If the effort to fundamentally transform our conceptualization of space-time is successful, the scope of human knowledge will be irrevocably changed, bringing the dawn of a new era for our species. Modern society now stands at a crossroad between societal collapse based on scarcity of resources and revolutionary renaissance based on creative ingenuity. The intended expansion of our genius and capabilities will bring with it unintended impacts for our society, the economy, environment, and technology. Some of these impacts will be dangerous, even deadly, and like our understanding of the structure of the atom, it will sometimes seem that we might have been better off without that knowledge.

Despite the risks, we must struggle to understand great unknowns because of who we are as a species, how we evolved, and that our survival is based on learning and cooperative tempering of our selfish, grasping instincts. We are driven to discover what is over the next hill. With diligence and wisdom, those who have the unique privilege of contributing to scientific knowledge can fulfill an adventurous destiny in the audacious, divine future of exploration and discovery.

Endnotes

[1] (Hoyningen-Huene, 1993) p.32, "observation" is substituted for "nature" to preserve the Kantian distinction between phenomena and noumena: In other words: we want to avoid referring to (and thereby assuming to know), "real nature" when developing new models.
[2] Knob on a mechanical clock used to adjust or set the time.
[3] (Wikimedia Foundation, Inc., 2008)
[4] (Wikipedia, p. Wandering_star)
[5] (Wikimedia Foundation, Inc, 2008, p. Paradigm)
[6] (Anderson, Barker, & Chen, 2006) p.82
[7] (PMBOK® Guide 2004 Update Team, 2004, p. 352)
[8] (Wikipedia, p. History of Evolutionary Thought) http://en.wikipedia.org/wiki/History_of_evolutionary_thought

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