Scott Bonham

Order from Chaos

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Behold, I am making all things new (Revelation 21:5).

Emergent transitions provide a conceptual framework to relate cosmic history, Genesis accounts, and redemption. In this framework, each new level of emergence is initially in a state of non-order (chaos) and undergoes a transition into a more ordered state; disorder results if there are competing, incommensurate domains. Cosmic history, from quarks to galaxies and from simple cellular life to complex societies, is easily described in this framework. A similar model of God's creative activity, involving states of order, non-order, and disorder, has been elaborated by John Walton based on his analysis of the Genesis accounts in their original cultural setting. With similar models emerging from different perspectives, scripture and science seem to point toward the same underlying truth about God's creative activity. Furthermore, redemptive history from Adam to Christ to the end times can also fit into this conceptual framework, suggesting that this framework reflects important aspects of the way God interacts with the world.

On Passover Friday nearly two thousand years ago, a man died on a cross amidst the chaos and disorder of soldiers, mockers, spectators, and others. In the midst of that chaos and disorder, many believe, a new order came into being. Certainly the religious movement that came out of Jesus's death has had a significant, enduring impact on human history. The central claims of Christian faith go much further, asserting that the life, death, and resurrection of Christ brought into being a new order, a new reality that changes the relationship of God with people, between different groups of people, between the physical and the spiritual, between life and death.

How does this relate to the other great work of God, that of creation? In the prologue of his gospel, John affirms that they are closely related through the person of Jesus Christ.[1] However, creation and redemption are sometimes described as being very different types of events. Wolters, for example, divides redemptive history into three different stages: Creation, Fall, and Redemption.[2] This type of thinking has deep roots; Augustine asserts that the first parents lived in Paradise "where neither death nor ill-health was feared, and where nothing was wanting which a good will could desire, and nothing present which could interrupt man's mental or bodily enjoyment,"[3] but that perfect state was lost due to humans' sin.

While frameworks that describe creation and redemption as distinct stages have their strengths, for example, emphasizing the seriousness of sin, a concern is that they can lead to viewing Christ's life, death, and resurrection as something entirely distinct from God's creative activity, and perhaps even seeing Christ's sacrifice as a "plan B" that would not have been necessary if the first man and woman had not sinned. The idea that God might have had to resort to a "plan B," creates, of course, tension with the classical understanding of God having perfect

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wisdom, foresight, and power to bring about his will. The view that God's interaction with the world can be divided into distinct stages also creates tension with the scientific view of cosmic and Earth history in which there are no sharp discontinuities but rather a continuity of different processes—many of which are still present today—shaping the development of the cosmos, Earth, and life. In this article, I present a conceptual framework for understanding both God's creative and redemptive activity that helps to resolve those tensions, rooted in both scientific and scriptural understanding: nucleation and growth of order in an emergent transition.

Throughout scripture, God is portrayed as establishing good order and instructing his people to do the same. Genesis 1 describes God creating in an orderly fashion and calling it "good." God instructed the Israelites through the Law to live orderly lives. The Corinthians were instructed to maintain order in their devotional meetings.[4] The association of order and goodness is a central theme of this article, but I first need to clarify how those words will be used. In the rest of this article, the meaning of "goodness" will follow that of the Old Testament scholar John Walton who argues that "good" in the creation account refers to "functioning properly," and not to a moral or ethical statement.[5] Thus, "goodness" depends on the context in which it is evaluated, and what is good in one context can be not good in another. For example, at the single-cell organism level, a streptococcal bacterium living in my throat can be perfectly "good," that is, it functions well, takes in nutrients, expels waste, and multiplies. However, at the multicellular organism level (myself), it is not good, as the strep throat infection it causes severely interferes with my proper functioning.

Walton also argues that the main focus of the description of God's creative work in Genesis 1 is best understood as bringing into existence functional order rather than material objects.[6] Related to this, the idea of "order" that I will develop has to do with the proper arrangement of component parts into a system in which new properties and functionalities emerge, expanding a concept coming from phase transitions in materials. The central thesis is that cosmic and redemptive history can be understood as a long series of God bringing into existence additional levels of order to existing reality. First, I would like to illustrate and develop more fully this framework in the context of transitions in the order of materials.

Order and Disorder in Materials

Diamond and graphite are composed of exactly the same thing—carbon atoms—yet have vastly different properties. One is a hard, clear, highly refractive, large-bandgap semiconductor, while the other is a soft, opaque, strongly absorptive, electric conductor. The difference is not in what they are made of, nor in the particulars of their histories, but in how the atoms are arranged in each solid. Likewise, the different properties of ice, water, and steam arise from the differences in how the atoms are organized. A basic principle in the study of materials is that the electrical, magnetic, thermal, optical, and mechanical properties of materials depend significantly on the order—or lack of order—of the atoms that make them up. Thus, these properties are emergent—they are not properties of individual atoms, but rather arise from how the atoms are ordered. However, that order does affect the individual components: the electronic bonds of a carbon atom in graphite are oriented differently from those in diamond because of the different contexts—graphite order or diamond order—in which the carbon atom finds itself.

The different ways things are or are not ordered correspond to different phases of the material. Ice, water, and steam are different phases of H_2O; graphite and diamond are different phases of carbon. The concept of phases and their associated order is far more general than atomic arrangements, though. At low temperatures, iron is ferromagnetic while at high temperatures it loses that magnetic property. The liquid crystals that are the heart of LCD displays have different phases, and the application of an electric field changes the ordering of the molecules. Other examples of phases include plasmas (such as in the sun where electrons are stripped out of atoms), superconductivity (where electrons move without resistance), and superfluidity in ultra-cold helium (where the atoms flow without resistance, even uphill). Naturally, the transition of a material from one phase to another—a phase transition—is a significant phenomenon, and has been an area of much study for many years.[7]

A striking fact about phase transitions is that despite different underlying physics, they have surprisingly similar behaviors. Ferromagnetism in iron comes from the alignment of the intrinsic magnetic moments of the atoms. Superconductivity arises from electrons being paired up due to lattice vibrations. Superfluidity in helium comes from the atoms fall-

ing into the same quantum mechanical state. Water freezes at the surface of ice by the electrically polarized molecules attracting each other. Plasmas become normal gas by electrons combining with nuclei to form neutral atoms. Yet all of these are continuous phase transitions; the measure of the amount of order in the system follows a power-law mathematical relationship independent of the specific physical mechanism of the phase transition.[8] This power-law behavior cannot be explained through a reductionist analysis of the components themselves or the specifics of their interactions, but rather requires a more holistic description of their cooperative behaviors. Phase transitions are examples of the emergence of general patterns, structures, and behaviors in quite different contexts.

In a phase transition, one can identify three different possible conditions that will be referred to as non-order, order, and disorder for the purposes of this article. At temperatures above the transition point, the magnetic moments in iron fluctuate randomly in all directions with no relationship to each other; this is a state of non-order. As the material cools below a critical temperature, groups of atoms start aligning their magnetic moments with those around them, and this grows as more atoms join in. Now, there is not necessarily any intrinsic reason that one particular direction is selected for the moments to align, but once order is established, that one direction becomes the preferred direction (referred to as symmetry breaking, because all directions are no longer equivalent), and the rest align with it.

A fully magnetized piece of iron is an example of an ordered state. However, most pieces of iron one encounters do not behave like magnets, though the reason is different from the high temperature stage. At the microscopic scale, all the atoms in a region are ordered with their moments aligned. However, there are different regions or domains in the material with different magnetic orientation directions, which when all added together, cancel each other out. Here *disorder* refers not to a complete lack of order, but rather the condition of multiple domains with some degree of local order but in conflict with each other so that no large-scale order is present.

To summarize, there are three conditions that can exist. *Non-order* refers to the complete lack of any of the particular order, for example, a lack of either local or larger-scale magnetic ordering. *Order* refers to the material sharing a single ordering orientation, and *disorder* refers to a state in which there are domains of local order that are in conflict with others to negate any long-range order. Note that the terms are being used here differently from how they are often used in the study of phase transitions, in which what I define as "non-order" is more commonly referred to as "disorder," and what I refer to as "order" and "disorder" represent the two ends of a continuum, which might instead be described by the size of the ordered domains. I adopt this terminology for two reasons. First, ambiguity exists in the scientific use of the term "disorder." In the study of phase transitions, "disorder" refers to the unordered phase above the transition temperature. In other areas of condensed matter physics, the term can refer to a lack of long-range order existing below the transition temperature. Second, this usage is parallel to the terminology that Walton adopts, facilitating making connections between science and scripture.

While in some practical applications disorder may not matter or even be desirable, in others it can create significant problems. Disorder exists in both the crystalline atomic structure and magnetic domains of a cast iron skillet; the former has no impact on its ability to cook eggs and the latter keeps it from sticking magnetically to other objects in the kitchen. However, in other applications problems arise from the existence of multiple domains, in particular, the boundaries between them where atoms are caught between two incompatible orientations. This condition generally arises when there are multiple places in the material where order begins, each place independent of the other, called *nucleation sites*. Silicon chip manufacturers use specially prepared silicon wafers cut from a single crystal chunk, grown from a small single crystal that serves as the nucleation site in the manufacturing process. They do this because the boundaries between different domains of crystalline order would introduce electronic defects that would significantly degrade the performance of the microelectronics. Metal parts in a high performance engine can develop fatigue where microscopic cracks appear and grow until the part fails; these cracks usually start at the boundaries between domains arising from multiple nucleation sites, since the boundaries are weaker than the ordered areas within the domains. It is possible (though quite expensive) to eliminate this by casting pieces as single crystals. The secret is to establish order in a single location or nucleation site that is allowed to grow out to the rest

of the piece while preventing other nucleation sites from beginning.

The concepts of phase transitions and symmetry breaking are not limited to materials. In particle physics, similarities between the different families of quarks and leptons have long been observed, though they have quite different masses. This led to the formulation of a theory of symmetry breaking between them due to some acquiring excessive mass; in addition, this theory predicted the existence of the Higgs boson, evidence for which is accumulating.[9] Other important phase transitions involving fundamental physics include the separation of the four fundamental forces and the formation of hadrons (e.g., protons and neutrons) from quarks, which are believed to have occurred in the early stages of the universe's existence.[10]

Structure and History of the Cosmos

The concepts of phase transitions and emergence arising in different fields of physics and related disciplines can be generalized into a conceptual framework describing transitions with emergent properties. This section shows how such a framework of emergent transitions can be used to describe the structure and history of the cosmos, suggesting that such emergent transitions may be a fundamental element of God's creative activity. It also offers an alternative to a reductionist approach to understanding nature that seems to leave no place for divine activity. This follows emergence theory that has been developed elsewhere[11] and uses the language of transitions to describe it. First a synchronic and then a diachronic description will be offered.

We observe synchronic emergence when, at any given point in time, the properties of an entity may be dependent on, but qualitatively different from, its components. Subatomic particles such as neutrons, protons, and electrons combine in different ways to form different atoms that have properties different from their parts and different from each other. Atoms, in turn, assemble to form molecules, which can be small and behave as gases, be large and flexible, or form ridged arrays in crystals. Certain molecules such as amino acids can further be strung together to form long chains to make more complex molecules that can serve many different functions. These might function as digestive enzymes, molecular pumps to maintain the right level of ions in a cell, or structures that build other proteins from DNA strands. While these molecules have interesting properties in their own right, when assembled in just the right way relative to each other, they form living cells that are able to take in nourishment, repair themselves, and reproduce—alive in a way that the constituent parts are not. Each macroscopic living organism is composed of vast numbers of these cells that function together as a tree, a butterfly, or a dog. At the next level, different living organisms form complex, interrelated ecosystems. As we move up from the parts of atoms to vast ecosystems, we see multiple layers of order and new properties emerging out of the structures below them, dependent on, but qualitatively different from, their constituent parts.

The emergence of order from non-order is a feature not only of the different scales of natural phenomena, but also of natural history in a diachronic description. Current theories of the big bang posit that the earliest stage of the universe was "quark soup" in which the tremendous heat and density meant that even subatomic particles such as protons and neutrons did not exist. As the universe expanded and cooled down, a phase transition took place in which quarks organized themselves into stable protons and neutrons. This drastically changed the nature of the material universe into one dominated by electromagnetic forces rather than by strong nuclear reactions between its components.

After further cooling, another important phase transition took place as neutral atoms were able to form. This led to the matter in the universe becoming "invisible" to photons in the universe at that time; these photons which no longer constantly interact with matter persist today as the cosmic microwave background. This phase transition again drastically changed the properties of the matter in the universe, which at that time was fairly evenly spread throughout it, to a condition in which the interactions were dominated by gravity. Gravitational interactions eventually caused slightly denser spots of gas to condense into clouds of gas, which in turn strengthened the gravitational attraction until they condensed into stars and galaxies, adding another level of order to the universe.

The formation of stars can be thought of in terms of another critical phase transition with the emergence

of completely new properties. Not only did fusion of atomic nuclei begin inside stars that caused them to radiate electromagnetic energy, but the resulting radiation pressure pushed away the gas not yet incorporated into the star out of its vicinity, leading to dense, relatively well-defined bodies surrounded by nearly empty space. These stars also became factories for heavier atomic nuclei; the larger of them would eventually blow much of this material into surrounding space, where it could be incorporated into second-generation stellar systems like the one we live in. Gravitational attraction caused large quantities of the dust incorporating heavier elements such as carbon, silicon, and iron to condense into solid chunks and eventually into rocky planets like ours, which remained in place even after the solar radiation had cleared much of the gas out of the inner solar system.

The initial non-order of our planet formed by rocks and dust colliding and mixing up began to be ordered. Much iron and nickel, along with many heavy radioactive materials, sank down to form the earth's magnetic core (which in turn protects us from solar bombardment), silicon, and other elements that form much of the rock in the earth's crust, and gases and water vapor above it. Earth's once-molten surface cooled to form a solid surface, and eventually cooled enough that liquid water could form on it, allowing the emergence of important properties of our planet that are crucial for life. In this liquid water, different atoms somehow became ordered into complex molecules which began to cooperate with each other as the first primitive life emerged. This transition eventually led to "reshaping" the earth, including an oxygen-rich atmosphere and the organizing of multicellular creatures.

Once again, this transition produced a layer of order with qualitatively new properties and forms, which spread out from the shallow seas to inhabit almost every part of the earth's surface. One line developed increasingly complex nervous systems, and one of those species developed the ability to use tools, make long-term plans, and work in complex organizations—yet another emergent, ordering transition with new properties. From quarks to protons to atoms, from gas to galaxies and stars, from a molten ball to core and mantle to current geological structures, from complex molecules to single cell life, from multicellular organisms to human beings in complex societies, history is full of new levels of order emerging. Each order emerges out of preexisting ones, dependent upon them but possessing properties and structures distinct from those which exist in the lower level.

Another important aspect of this framework of emergent transitions is that it can provide a counterbalance to the tendency for reductionist scientific approaches to understanding the cosmos, in which there seems to be no place for God's creative activity. In the reductionist approach, phenomena are understood in terms of their underlying components and material processes that brought them into existence. Clearly, the components of material entities will themselves be material entities, and material processes will involve material entities. Thus, about the only way that reductionist science could point to God would be through its failure to explain something—the "God of the gaps" approach—which is fraught with difficulties. However, an organizational or systems approach to understanding the world around us does not intrinsically exclude nonmaterial entities such as God. It could describe organizational structures that include both material and nonmaterial entities, as well as organizational structures with properties that do not come directly from the components, such as the phase transitions described earlier. This idea of emergent transitions illustrates such an organizational structure.

Further, an emergent as opposed to reductionist conceptual framework provides a different way of thinking about the seeming improbability of a world in which intelligent life can exist. Despite the great number of emergent transitions around us—present and past—the entities in the underlying layer must possess certain characteristics and/or histories for the next level of order to emerge. The incredible fine tuning of the universe, in which slight deviations in the initial speed of the expansion of the universe, the relative masses of the fundamental particles, the relative strengths of the different forces, and many more aspects, has been explored by both non-Christian and Christian authors.[12] Many characteristics of our earth, such as its distance from the sun, its size, magnetic field, amount of water, a single large moon, et cetera, have been critical to its supporting of life. Exactly how complex molecules formed and began to cooperate in the first living cells is still an open scientific question. While genetic mutation and natural selection do provide a plausible explanation for the variety of life forms, it has been argued that

it is quite improbable that all the diversity we see has arisen strictly from unguided, random genetic variation.[13] When viewed through a reductionist, materialist framework, it is hard to provide an explanation for what appears to be improbability piled upon improbability, and some are inclined to reintroduce God as an efficient or scientific cause.[14] However, in the more holistic, functional framework of emergent transitions, there is a general pattern in the structure and history of the cosmos of new layers of order emerging on top of older ones, from quarks to galaxies and from big bang to human civilization, suggesting that this pattern reflects something intrinsic about the functional design of the universe.

Non-order, Order, and Disorder in Genesis

In the ancient Near East, a common motif in creation accounts described the gods as bringing order and functionality to preexisting, non-ordered and nonfunctional material. They do not create perfect order out of nothing. Following a tradition that stretches back to some of the early church fathers[15] and gained strength with the discovery of ancient Middle Eastern creation texts,[16] John Walton argues that the creation accounts in Genesis should be understood in that context, that its focus is on the functional rather than the material origins of the world. This would be consistent with the idea that what Genesis and the rest of scripture describe are the establishment of yet another layer of order on top of the physical and biological orders as now studied by science—some sort of spiritual or human-divine structure.

It should be noted that Walton seeks not to reinterpret Genesis through modern cultural understandings, neither to accommodate modern scientific accounts,[17] nor to employ the hermeneutic of skepticism.[18] Neither is he modifying or defending "traditional" readings of Genesis, such as six twenty-four hour days, which have their intellectual roots in nineteenth-century American cultural understanding, drawing from Scottish common-sense philosophy and Baconian understanding of science.[19] Instead, drawing upon scholarship in archeology, anthropology, communication theory, and other related fields, Walton is trying to reconstruct, as much as possible, the original meaning of the text in its initial cultural context as would have been given to and understood by the Hebrew community that produced it. In the rest of this section, I will present a summary of the model based on relevant sections of his works, *The Lost World of Genesis One*, *The Lost World of Adam and Eve*, and (with co-author Brent Sandy) *The Lost World of Scripture*. I will not attempt to lay out the arguments for his conclusions, which can be found in those works, but simply summarize Walton's positions.

The accounts in Genesis were produced in a very different cultural context than modern western thought. It was an oral culture in which communities transmitted and preserved knowledge that may have originated from an authority such as Moses; the knowledge was recorded in writing at some later time. In an oral tradition, the core message is defended from change while allowing some flexibility in the details. The text is interwoven with the community's identity and purpose and is not critically assessed in the same manner as is common in written cultures.[20] Scientific, theological, and historical analysis as we now know them had not yet been developed.[21] These cultures made no distinction between "natural" and "supernatural" phenomena, and symbolism was quite important. The cultures of the ancient Near East also were not very interested in the material origins of the cosmos (where did all the stuff come from?), but rather, in the functional origins (from where did the order and functionality of the world, civilization, etc. come from?).[22]

The accounts in Genesis focus on God's bringing functional, productive order to nonfunctional, unproductive chaos, and not on the material process of the cosmos coming into being that our culture tends to emphasize. This does not contradict the doctrine that God brought material things into existence out of nothing; rather, the focus of the text is the creation of functional order and not the creation of matter.[23] The darkness and deep waters in Genesis 1 and the arid land in Genesis 2 were common motifs in ancient creation stories representing nonfunctional chaos, and would have been understood to exist before God began the creative work described in the passages. Note that the darkness and the seas are not called "good" in Genesis 1, and they no longer exist in the new creation described in Revelation 20. Days one and four in Genesis 1 do not actually refer to the creation of light, the sun, moon, and stars as material entities, but rather the ordering of time into days, months, seasons, and years. The rest of God on day seven, which Walton argues is the climax of the passage, does not represent that God had

fully completed his creative work, but rather that he was taking up residence in his temple (the world) and commencing ordinary rule from it.[24]

God's rest on day seven in which he commences ordinary rule immediately follows the creation of human beings, who bear his image and are charged to rule over the earth. Bearing God's image involves both having some of God's characteristics—for example, the ability to bring order to non-order—and being his representatives. Thus, human beings were created to join God and be his agents in continuing to bring order from non-order to the world. Human beings also were given a priestly role in representing the world to God and God to the world. In addition to the temple motifs Walton sees in Genesis 1, he associates the garden in Genesis 2 with gardens that were often part of ancient temple complexes and suggests that the man and woman may not have lived there continuously, but rather entered into that sacred space to meet with God.[25]

While Walton believes the man and woman described in Genesis 2–3 were actual historical figures, he argues their significance is as archetypes representing humanity. They are not necessarily the biological ancestors of the entire human race, but were given a particular priestly role. To use terminology introduced above, they were selected to be the nucleation site of a new human-divine order, which presumably was to have been spread to the rest of the human race through them. The trees named in the garden represented that which is God's to give—wisdom and life. The man and woman did not possess intrinsic immortality, but had the opportunity to live forever by partaking of God's provision through the tree of life. True wisdom is achieved in obedience to God, not seeking it on one's own terms. The disobedience of the man and woman in seeking to achieve wisdom outside of God's will introduced disorder into the world. Disorder results when humans seek to set up an order organized around themselves and their desires, rather than an order centered on God and his plan. The first consequence of disobedience was a broken relationship with God and his special provision. The man and woman did not become mortal as a consequence of disobedience, but lost access to the remedy for their mortality. Similarly for the earth and the rest of creation—the disobedience of Adam and Eve did not introduce chaos or evil into creation, but interfered with God's plan to bring good order to it through human activity.[26]

Discussion

The convergence of Walton's interpretation of the Genesis passages and the framework of emergent transitions helps address multiple sources of tension between scripture and the understanding of the natural-scientific history of the cosmos and life on Earth. First, if the focus of the Genesis text is the creation of functional order rather than of material entities, then its description of God's creative work operates at a different and complementary level than that coming out of natural science. This is similar to the statement that a particular shoe is made by Nike; it is true at the functional level—the Nike company planned, designed, and marketed it—but not true at the material level. Since Nike contracts out all its manufacturing, the people who assembled the shoe are actually employed by some other company.

One example of how this functional perspective can resolve tensions is shown in the resolution of the conundrum of how one can have light on day one before the sun comes into being in day four. First, if God's activity on days one and four is not the physical creation of day, night, sun, moon, and stars, but is meant to establish their function for humans reckoning the passage of time and cycles of life, then there is no contradiction with our knowledge that one cannot have light without a source. Second, and closely related, if the texts in Genesis are about the establishment of functional order for image-bearing humans, then much of cosmic history understood through natural science—for example, the big bang, formation of the earth, emergence of many different forms of life—takes place well before the account in Genesis 1 picks up in verse 3. Stars and galaxies, oceans and mountains, animals and fish already existed by Genesis 1:2; the rest of the passage is about God establishing their functional roles for human existence. Third, if "good" is understood to refer to being functional and productive within a system, then as in the previous example of a streptococcal bacterium, something can be good at one level and not good at another. Thus, we can describe biological death of organisms as "good," necessary for proper functioning at an ecosystem level, but not being good in the new creation previewed at the end of Revelation and other scriptures. Order at one level does not automatically translate into order at a subsequent level; it can translate into non-order that then needs to undergo a transition to establish order.

A particular application of this insight opens up possibilities for how to understand the Fall in relationship to scientific understandings of cosmic history, for which multiple approaches have been proposed.[27] One set of approaches maintains that human sin is the cause of evil and chaos, though with a variety of different ideas about exactly what was the direct consequence of human sin, ranging from drastic changes in the fundamental laws of physics, to physical death of humans, to merely altering human psychological and spiritual state. Another set of approaches reconsiders whether human sin is the temporal cause of natural evil, instead suggesting there might be retroactive causation, nontemporal causation, or a gradual development in human understanding of sin and its consequences over time. All of these proposed explanations have both their strengths and their weaknesses. While there are major differences between them, these different approaches are largely operating out of a two-category paradigm, in which different entities and aspects of creation are considered as belonging either to the category of that which is good, ordered, and within the divine will, or to the category of that which is evil, chaotic, disordered, sinful, and in opposition to God. They differ primarily in what is assigned to each category and how the latter category comes about.

The three-category paradigm proposed by Walton allows there to be things, for example, biological death, that are not good but also are not a result of human sin that tries to set up self-centered order in opposition to God.[28] Thus we could accept Arthur Peacocke's argument that suffering and death are intrinsic to the process through which self-aware beings possessing free will came to be,[29] but, at the same time, we can agree with Paul that death is the enemy.[30] Rather than being the cause of suffering, death, and natural evils, human sin interfered with God's plan to fully bring forth the order hinted at in the Garden of Eden and described at the end of Revelation. If, as argued above, humans were created to be the primary agents for establishing God's good order on the earth, then human rebellion has consequences for the rest of creation in what we have failed to do:

> For the creation waits with eager longing for the revealing of the sons of God. For the creation was subjected to futility, not willingly, but because of him who subjected it, in hope that the creation itself will be set free from its bondage to corruption and obtain the freedom of the glory of the children of God. For we know that the whole creation has been groaning together in the pains of childbirth until now. And not only the creation, but we ourselves, who have the first fruits of the Spirit, groan inwardly as we wait eagerly for adoption as sons, the redemption of our bodies.[31]

God commanded humans bearing his image to fill and subdue the earth,[32] and made Adam and Eve to work and care for the garden.[33] These are both consistent with an idea that humans were not to do their own thing or to lie around the garden in ease, but rather to work in expanding the garden until the sacred order nucleated in Eden filled the earth, resulting in something like what is pictured at the end of Revelation where God is intimately present with humans, who also have access to the tree of life. Thus humans have a pivotal role as created sub- or cocreators in helping to shape the final outcome,[34] but operating firmly underneath the authority of God. Along with death, things such as sickness and natural disasters could be understood to be in the category of things that are not-good but are also not the result of sin, things which are part of a lower order and still need to be addressed in the establishment of the higher one. The same meteorological system that produces summer rainstorms to water prairies and crops in the Midwest also gives rise to tornados.

The framework of an emergent transition could also be extended to characterize key points in the history of God's interaction with humans. God's choosing and forming a covenant with Adam and Eve, with Noah, with Abraham, with the nation of Israel through Moses, with David, and with others throughout Old Testament history can be thought of in terms of God's seeking to nucleate an emergent transition into a new human-divine order. Furthermore, a number of tensions between scripture and history/science disappear if we understand their significance to be that of nucleation sites for divine order rather than biological ancestry. Eve becomes the mother of all the living, and sin and death entered into the world through Adam, not necessarily as our biological ancestors but as flawed nucleation sites. In the same sense, we are the children of Noah, even if the flood was a local one in Mesopotamia, and Abraham really is the father of all who believe. We are heirs of the Mosaic covenant and, through conforming to God's order, we have been grafted onto it.

Of course, the most important of these nucleation sites for God's emergent order is the life, death, and

resurrection of Christ. Metaphors such as a kingdom, a body, and a building all reflect an ordered system in which the whole is more than a collection of parts. Statements that Jesus's disciples would be known by their love one for another reinforce that it is out of the collective relationships that new phenomena emerge. Jesus's parables of mustard seed and the yeast, and the growth of the church from a small band of disciples to a worldwide movement, parallel the nucleation and growth of an ordered phase in materials. Exhortations to leave an old way of life, to be conformed to the likeness of Christ, reflect changes in the orientation of the constituent parts as they become part of the new order. The understanding of sin and opposition to God overlaps comfortably with the idea that humans introduce disorder when they seek to build order centered on their own selves rather than on God. Discussions about eternal life and a new creation, as well as the mysterious features of the resurrected Christ (for example, entering into locked rooms) point toward entirely new phenomena emerging in the new order, of which we currently have glimpses only. Note that Jesus explicitly stated that he was not overthrowing the Mosaic order, but rather he was fulfilling and adding to it. Just as helium-3 undergoes multiple transitions from a gas to a liquid to a superfluid, biblical history can be thought of as passing through multiple transitions from the beginning to God's final kingdom.

This general framework of emergent transitions is useful as a framework to understand the sweep of both cosmic and divine history. It suggests something about metaphysical reality, something about God's general approach to his interactions with our world. This leads to six additional congruences with doctrines about God, the world, and applications to our lives.

1. The general pattern of emergent transitions across the sweep of history is consistent with an unchanging divine nature.
2. The pattern emphasizes that scriptural history is a progression from a starting point in a garden to an end point in a city, and is not trying to return to an original perfect state. Thus Christ's life, death, and resurrection were not simply about counteracting the effects of the first sin, but fully and finally ushering in a new order that was not originally present.
3. As emergent phenomena come not from individual parts but their collective interactions, the pattern emphasizes the relational elements of God's plan. The God of scripture is a covenant-making God. The Law is fulfilled by loving God and one's neighbor. Christians are described as members of a body and of a building.
4. The pattern is compatible with several major models of the salvific efficacy of Christ's life, death, and resurrection. Christ, as the model human whom we should imitate, resonates with the image of atoms rearranging themselves to conform to a new order. Christ, as the sacrificial lamb who turns away God's wrath, incorporates the concepts of the Mosaic order, yet builds on them to make something new. Christ's triumph over sin and death reflects an emergence of an entirely new phenomenon.
5. The pattern reinforces the central role of Christ and our need to be in relationship with him and conformed to his pattern. At the same time, it also affirms that much of the present reality—for example, physical, social, economic—will not disappear but will be incorporated into the emergent reality; the glory and honor of the nations will be brought into the kingdom.[34]
6. The pattern has obvious applications to evangelism and missiology. People generally come into relationship with Christ through other people instead of through direct divine action; and effective mission strategies often focus on establishing a nucleus of believers in the target group and enabling the gospel to spread out from it.

As with any framework we use to describe the reality in which we find ourselves, it makes simplifications which, if taken to the extreme and not balanced with other information and models, can introduce distortions. For one, the focus on emergent order could tend to minimize sin, evil, human responsibility, and judgment, which are major themes in scripture. Two, this framework tends to minimize significant differences found in frameworks that draw distinct stages in scriptural history. Three, it is a broad analogy to compare atoms arranging themselves in a material to establishment of an order in which God himself plays a significant role.

The framework of emergent transitions has some limitations and does not replace other theological frameworks. However, it is a productive framework that can be used to describe a wide range of phenomena, from early stages of the universe to emergence

of life to God's work in Genesis to his establishment of covenants with his people. The way that it can productively describe multiple levels of God's interactions with the world suggests that the framework captures key aspects of the reality of God's relationship with the world and thus is a valuable tool for understanding it. ⁂

Notes

[1]John 1:1–18.
[2]Albert M. Wolters, *Creation Regained: Biblical Basics for a Reformational Worldview,* 2nd ed. (Grand Rapids, MI: Eerdmans, 2005).
[3]Augustine, *The City of God,* trans. Marcus Dods (New York: Random House, 1950), 14.10.
[4]1 Corinthians 14:33, 40.
[5]John H. Walton, *The Lost World of Genesis One: Ancient Cosmology and the Origins Debate* (Downers Grove, IL: InterVarsity Press, 2009), 50.
[6]Ibid., 24.
[7]For example, see H. Eugene Stanley, *Introduction to Phase Transitions and Critical Phenomena* (New York: Oxford University Press, 1971); Nigel Goldenfeld, *Lectures on Phase Transitions and the Renormalization Group* (Upper Saddle River, NJ: Addison-Wesley, 1992); *Phase Transitions: A Multinational Journal* (Abingdon, UK: Taylor & Francis, 1979–).
[8]"Continuous transitions" are also referred to as "second-order" transitions. In the case of ice, this is true only of the transition at the surface; bulk ice is a first-order or discontinuous transition. Second-order transitions are described by an order parameter Ψ which obeys the relationship $\Psi(T) = (1 - T/T_c)^{\beta}$ for temperatures T below the critical temperature T_c. The critical exponent β is characteristic of the system.
[9]ATLAS Collaboration, "Observation of a New Particle in the Search for the Standard Model Higgs Boson with the ATLAS Detector at the LHC," *Physics Letters B* 716 (2012): 1–12.
[10]"Phase Transitions," in Andrew Liddle and Jon Loveday, *The Oxford Companion to Cosmology* (New York: Oxford University Press, 2008), http://www.oxfordreference.com/view/10.1093/acref/9780198608585.001.0001/acref-9780198608585-e-288.
[11]For example, see Harry Cook, "Emergence: A Biologist's Look at Complexity in Nature," *Perspectives on Science and Christian Faith* 65, no. 4 (2013): 233–41, http://www.asa3.org/ASA/PSCF/2013/PSCF12-13Cook.pdf; Arthur Peacocke, *Theology for a Scientific Age: Being and Becoming – Natural, Divine, and Human* (Oxford, UK: Oxford University Press, 1990).
[12]For example, see Paul Davies, *The Accidental Universe* (Cambridge, UK: Cambridge University Press, 1982); Martin Rees, *Just Six Numbers: The Deep Forces That Shape the Universe* (New York: Basic Books, 2000); Alister E. McGrath, *A Fine-Tuned Universe: The Quest for God in Science and Theology* (Louisville, KY: Westminster John Knox Press, 2009); William Lane Craig, *Reasonable Faith: Christian Truth and Apologetics,* 3rd ed. (Wheaton, IL: Crossway Books, 2008).
[13]Michael J. Behe, *The Edge of Evolution: The Search for the Limits of Darwinism* (New York: Free Press, 2007).
[14]See for example, ibid.
[15]Sjoerd L. Bonting, "Chaos Theology: A New Approach to the Science-Theology Dialogue," *Zygon* 34, no. 2 (1999): 323–32.
[16]Hermann Gunkel, *Creation and Chaos in the Primeval Era and the Eschaton: A Religio-Historical Study of Genesis 1 and Revelation 12* (Grand Rapids, MI: Eerdmans, 2006).
[17]John Walton, *The Lost World of Adam and Eve: Genesis 2–3 and the Human Origins Debate* (Downers Grove, IL: InterVarsity Press, 2015), 105.
[18]John Walton and Brent Sandy, *The Lost World of Scripture: Ancient Literary Culture and Biblical Authority* (Downers Grove, IL: InterVarsity Press, 2013).
[19]George Marsden, *Fundamentalism and American Culture,* 2nd ed. (New York: Oxford University Press, 2006).
[20]Walton and Sandy, *Lost World of Scripture,* 280.
[21]David C. Lindberg, *The Beginnings of Western Science: The European Scientific Tradition in Philosophical, Religious, and Institutional Context, Prehistory to A.D. 1450,* 2nd ed. (Chicago, IL: The University of Chicago Press, 2007).
[22]Walton, *Lost World of Genesis One,* 21–34.
[23]See also Bonting, "Chaos Theology."
[24]Walton, *Lost World of Adam and Eve,* 116–18.
[25]Ibid.
[26]Ibid., 144.
[27]Randy Isaac, "Chronology of the Fall," *Perspectives on Science and Christian Faith* 48, no. 1 (1996): 34, http://www.asa3.org/ASA/PSCF/1996/PSCF3-96Isaac.html.
[28]See also Gunkel, *Creation and Chaos in the Primeval Era and the Eschaton.*
[29]Peacocke, *Theology for a Scientific Age,* 79–80.
[30]1 Corinthians 15:26.
[31]Romans 8:19–23, English Standard Version (Wheaton, IL: Crossway Bibles, 2011).
[32]Genesis 1:26–28.
[33]Genesis 2:15.
[34]Gregory R. Peterson, "The Created Co-creator: What It Is and Is Not," *Zygon* 39, no. 4 (2004): 827–40.
[35]Revelation 21:26.

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