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An Introduction to Integral Science

Kurt Koller

This paper argues for an Integral approach to science, which consists of interior, exterior, individual, and collective dimensions, all of which must be included in the various knowledge quests of science. A basic methodology consisting of injunction, apprehension, and communal consensus is elaborated to help create a broad umbrella for distinguishing valid scientific endeavors. Distinctions are drawn between contemporary science and Integral Science, with the conclusion that an Integral approach allows for a greater opportunity for transdisciplinary learning and cohesiveness in the overall scientific endeavor.

What Is Integral Science?

Integral Science is a member of a family of learning disciplines whose collective aim is to be broadly inclusive, comprehensive, and vital—all that the word *Integral* implies. With Integral Science, the particular focus is on the scientific disciplines, ranging in scope from the physical sciences to the social sciences and even into the contemplative sciences (e.g., various meditative endeavors). Integral Science attempts to honor and incorporate the best methodologies and theories of science and integrate them into a generally inclusive framework.

How we actually define science will come to bear on what we decide to include in an Integral Science, and we will return to this point later. But however we define science, the core premise of an Integral Science is that every scientific discipline has some partial yet important truth to tell us, and to exclude the stories that emerge from any given discipline will create unfortunate gaps in our overall understanding.

To that end, one of the key functions of Integral Science is to organize the various scientific disciplines relative to each other in such a way that we can honor their respective, stunning achievements in their areas of inquiry without over-exaggerating their importance. Integral Science also brings attention to areas of scientific inquiry mistakenly considered invalid and makes space for new fields of inquiry as the need arises.

As a means of executing those tasks, Integral Science actively encourages cross-collaboration between the various disciplines of science as a means to better understand and mutually enrich each other. At its best, Integral Science is a well-integrated, transformative practice of the sundry methods of science.

Integral Science and Contemporary Science

Beginning roughly in the last decades of the 19th century and accelerating in the latter half of the 20th century, the fields of science have grown increasingly fragmented and isolated in their respective pursuits of knowledge. Many practices of professional science have been replete with competitive proprietary interests, corporate tribalism, and increasingly jargonized discourse. Elements from an earlier, more broadly "humanistic" approach to science—features of the early scientific literary corpus that incorporated philosophy, literature, and multiple forms of rhetoric—are not strongly in evidence in contemporary scientific literature. Whatever else we might say about it, the practices of science in the past fifty years or so have been characterized by a tendency toward specialization and isolationism. Not having expended great effort to understand their interconnections—and thereby lacking an important reality check—the branches of science have tended to inflate their sense of importance relative to one another. Though some progress has been made in isolated cases, deep fractures remain between the disciplines of science. And this is the general state of science today.

A core aim of Integral Science is to promote dialogue and collaboration between the disciplines. By virtue of that aim, it is transdisciplinary in nature. An Integral Science builds upon the preexisting foundations of science and "houses" the disciplines in such a way that we can make better and more appropriate use of the scientific methods.

While we welcome any scientific endeavor into the house, we might also say that Integral Science has house rules. We avoid assigning absolute primacy to any one method or domain of scientific inquiry and instead attempt to align the various disciplines in such a way that the important differentiations can be maintained (so that research programs can continue to plumb the depths of a particular area of inquiry). At the same time, we construct and identify the many ways in which fruitful dialogue and mutual exchange can occur between disciplines. The combination of depth and breadth rounds out the riches of the broad scientific endeavor.

The Appearance of Integral Science

The glimmerings of Integral Science can be seen wherever multiple disciplines of science have been in collaboration with one another or with other learning disciplines that make use of scientific principles or methods. Though most of these collaborative efforts are appearing in methodological rather than theoretical forms, Integral Science includes both.

For instance, the field of Astrobiology is an excellent example of how an inter-disciplinary approach is crucial to any advancement of the field. Astrobiology is concerned with the study of extra-terrestrial life, ranging from micro-organisms to intelligent beings: the recent Mars missions and the SETI (Search for Extra-Terrestrial Intelligence) project are two endeavors that span the Astrobiological spectrum. As such, the field is informed by methods and theories from several fields of inquiry, such as astronomy, physics, chemistry, biochemistry, biology, ecology, geology, and systems theory. Before getting started in a search for extra-terrestrial life, an Astrobiologist is greatly aided by a preliminary understanding of each of those respective disciplines, without which fluency in communication between Astrobiologists can become quite difficult.

This sort of collaboration is an excellent beginning phase for an Integral Science: it incorporates several different disciplines in order to arrive at more sturdy research endeavors, utilizing multiple methodologies in the quest for knowledge. It applies what we call "vertical" integration: using progressively more inclusive "levels" of science. When the lens is attuned to individual forms, the levels progress from physics to chemistry to biology. When the focus is on communal forms, the scientific levels move from the study of galaxies to planetary systems to ecosystems.

This is just the beginning for Astrobiology, because it also has the potential to integrate "horizontally" as well: that is, uniting interior and exterior aspects. Up to now, Astrobiology has framed its research by focusing on "exterior" dimensions: the material, energetic, and systemic dimensions. All of the disciplines mentioned above (astronomy, physics, chemistry, etc.) are intimately concerned with studying and elucidating the exterior dimensions of their respective subjects. But alongside these exteriors, Integral Science also recognizes "interiors." Every exterior has an interior. The interior dimension is the repository of intentionality or localized consciousness; it is the immediacy of our awareness, or feeling, in a broad sense.

Biological life as we understand it does not exist in isolation but in communal exchange: not simply physical systemic exchanges such as respiration and digestion, but also in some form of exchange of recognition, such as a sharing of perspectives. So, to become an Integral Science, Astrobiology would need to make use of the "interior" sciences (e.g., consciousness studies, psychology, linguistics, cultural studies) as well as the "exterior" sciences.[1] Without that, Astrobiology may well locate the ET's "out there," but they will not know how to communicate with the ET's "in there."

Integral Science Defined

An Integral Science, then, is the broad knowledge-driven endeavor that accounts for both interior and exterior dimensions of individuals and collectives in its methods of inquiry.

Now—to take an extreme example—this definition does not exclude the traditional practice of subatomic physics for failing to examine the interiors of atoms. Quite the contrary: subatomic physics (or any specialized field of science) will still exist and persist in its course of study, but it will not try to monopolize our entire understanding of them by asserting that they have no interiors, which is explanation via denunciation. The interior aspects of the subatomic realm is another field altogether (something like a prehensive physics, perhaps[2]), and an Integral Physics simply emphasizes that both fields together are more complete, more whole, more accurate than either one alone. When we further include the collective dimensions of the subatomic, we have the most accurate view yet.

A more familiar example might be the study of human sexuality. An Integral Science of human sexuality would include (as a minimum) perspectives and methodologies from psychosexual psychology (the interior-individual dimension), reproductive biology (the exterior-individual), cultural anthropology (interior-collective), and social-environmental anthropology (exterior-collective). The exclusion of any one of these dimensions of human sexuality would diminish the overall understanding, and our Science would not be truly Integral.

The Four Quadrants

These four dimensions we have been mentioning—interior, exterior, individual, and collective—can be conveniently arranged into a grid that we call the Four Quadrants (see figure 1).

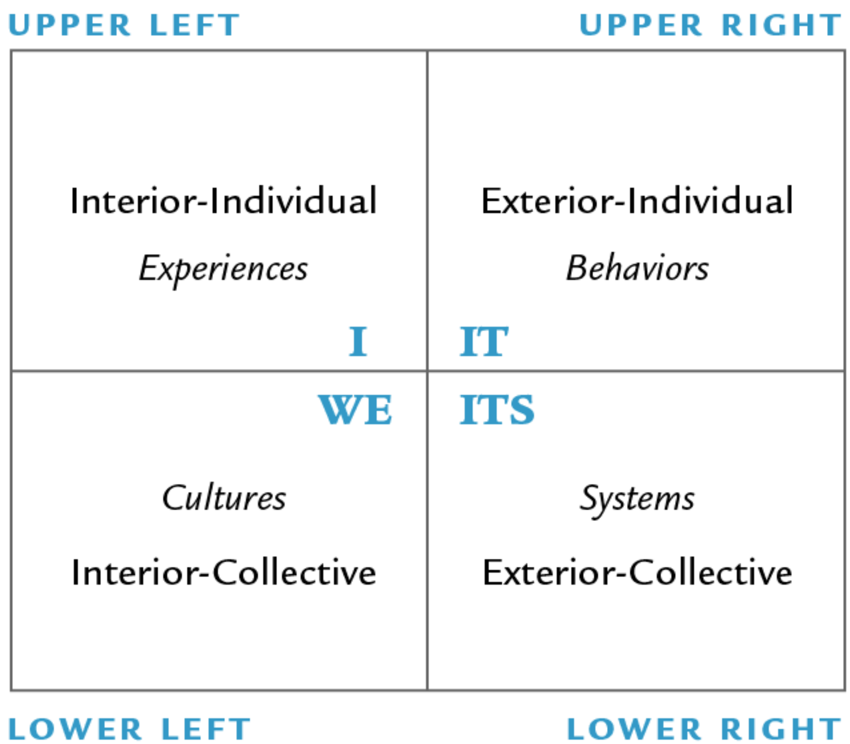

Figure 1. The Four Quadrants

The Four Quadrants are a simplified schematic of the various data domains available. The quadrants can represent both domains of experience (experience here being the equivalent of "data") as well as perspectives employed in the investigation of those domains. Figure 1 lists the domains (Intentional, Behavioral, Cultural, and Social) and the perspectives (combinations of interior, exterior, individual, and collective). Since experiential data occur in all four quadrants, and insofar as science is concerned with experiential data, we will want to touch bases with the data that manifest in all of the quadrants in order to structure an Integral Science.

But before we go any further with our discussion of quadrants, we need to address a very thorny, but extremely important issue, namely….

How Are We Defining Science?

We can define science in a number of ways, and as long as consistency prevails, we will use multiple definitions to flesh out nuances. On the one hand, science is a methodology used to make inquiries and generate reproducible, verifiable knowledge—as with experimental, observational, and survey methods. Science might also be thought of as a data domain or a body of knowledge, as in the various canons of scientific disciplines (Physics, Chemistry, Biology, etc.). Science can also be construed as a modeling technique, as when we attempt to map out the natural world. And science constitutes a form of judgment, as when we attempt to determine the reality of the phenomena we investigate. We will eventually look at all of these variations and their potential relations, but for the moment we will be focusing on three definitions of science: 1) as a mode of judgment, 2) as methodological inquiry, and 3) as a data domain.

Judgment

When we speak of science, and especially of an Integral Science, remember that science is a practice of cognitive judgment.[3] That is, once we have adopted a perspective (individual, collective, interior, exterior), we encounter phenomena. One way we might react to this phenomena is with a "reality check," or a cognitive judgment: we decide if that which is before us is real or unreal.

As a performance of cognitive judgment, science can occur in any of the quadrants and is distinct from aesthetic and normative judgments: differentiations that are generally associated with the dignity of Modernity. Science in this sense allows us to adjudicate the realities of our *interiors* with intentional and cultural sciences, just as we have traditionally adjudicated the realities of our *exteriors* with behavioral and social sciences.

With an Integral Science, we are allowing for cognitive judgments in all quadrants, maintaining the hard-won distinctions between types of judgment and, wherever possible, finding appropriate discourse and embrace between the types of judgment.

Methodology

The second definition of science follows the first, in that once we have encountered a phenomenon and have inquired into its existence, we need a procedural method for determining the reality or truth of the phenomena before us. In this circumstance, science follows the three basic methodological principles of 1) injunction, 2) apprehension, and 3) communal consensus.[4] These are not methodologies per se, but are the three core elements of various methodologies through which we obtain any reproducible, valid knowledge.

Injunction follows the basic form of "do this." It asks for a direct experience first and foremost, such as "shake that apple tree." *Apprehension* is simply the immediate experience or awareness generated by the injunction: "I saw an apple fall on Isaac's head." *Communal consensus* is the sharing of the apprehension with a community who has likewise performed the injunction as a means of judging the validity of the apprehension: "Yes, we also shook the tree and saw an apple fall on Isaac's head." Following these three strands is an illustrative example of good science (even if Isaac's head does not feel the good in it).

Using this general schema, we can find countless representative models of science in fields as diverse as molecular biology, historiography, and mysticism. In this manner, science can be practiced and applied to a vast range of phenomena, including the physical/sensorimotor, the mental, and the contemplative. Using this more generous definition, we also relieve science of the burden of trying to confine itself solely to the physical-empirical domain, and we escape certain materialist orientations that try to restrict the scope of truth to that domain.

So, in our second definition, science, or at least what we are designating "good science," is any data-harvesting endeavor that follows those three strands of valid knowledge (*injunction, apprehension, and consensus*) in its methodological investigations.

Domain

When we adopt a perspective and enact an experience, our practice of Integral Science unfolds from the moment we engage in a cognitive judgment of our experience—judgments which are verified or rejected using a three-strand methodology. And those are our first two senses of science. But science does not stop there. From those judgments we build data domains to house those experiences, data domains which manifest as the disciplines of science that appear in the four quadrants. The broad classes are the four sciences of interiors, exteriors, individuals, and collectives. Within these classes we can continue to apply science as a judgment and methodology, using more sophisticated modeling to create sub-domains or disciplines of science within the quadrants.

When we survey the various disciplines of science, we find that the primary purview of each gravitates toward (though is not necessarily solely confined to) one or another of these quadrants. And this is our third definition of science—science as the various bodies of experiential knowledge brought forth by validated cognitive judgments. Figure 2 provides a brief sampling:

UL	UR
INTENTIONAL Phenomenology Depth Psychology Introspection Meditation Upper-Left Quadrant	**BEHAVIORAL** Physics Chemistry Biology Neurology Cognitive & Behavioral Psychology Upper-Right Quadrant
CULTURAL Cultural Anthropology Cultural Structuralism Linguistics Ethnomethodology Lower-Left Quadrant LL	**SOCIAL (SYSTEMS)** Astronomy Geology Ecology Structural Functionalism Information Services Lower-Right Quadrant LR

Figure 2. Data Domains in the Four Quadrants

In several cases, we will find scientific disciplines appearing in multiple quadrants. Anthropology, for instance, is comprised of physical/forensic, cultural/linguistic, and social/archaeological branches, which are, respectively, UR, LL, and LR. The "Life Sciences" are typically construed as addressing aspects of both the UR and LR quadrants. And Psychology, as a broad study of developmental dynamics, runs through all four quadrants. In these particular disciplines, multiple methodologies are incorporated under one umbrella as each methodology addresses one of these four facets.

We will find some overlap and blending, depending upon which discipline we refer to and how we define a scientific discipline. This is just a preliminary sketch of how we might organize the sciences and we will refine this in later efforts, but bear in mind that when we see this sort of cross-over—this effort to be inclusive of all four quadrants—we are seeing the beginnings of an Integral Science.

Coming Together

We are driven by delight to knowledge. Whether in our first weeks from the womb or the first centuries as a species, we have searched for clues to our being under every rock and within our own skin with equal abandon. We have followed stellar paths with awe and giddy revelation, discovered tidal rhythms on shores within and without, tracked ourselves in the imprints of soil and genes. To know and to be known: it is our birthright, our privilege. And with each new curiosity we confront, it is a birthright reborn and a privilege earned anew.

An Integral Science is an invitation to claim this birthright, an invitation to the vast diaspora of sciences to celebrate and champion each other's being in the world. It looks to honor one another as we have found each other; it is a calling home to convene a family reunion of those questing for truth and knowledge. And it seeks to counsel and comfort where we have thought ourselves lost, unknown, and unknowing.

Integral Science announces our effort to form a common ground for finding ourselves in and through the practices of science, for finding ourselves swathed in every moment in the most magnificent, miraculous manner. By calling attention to the many brilliant ways we have played hide-and-seek, covering and uncovering ourselves again and again, an Integral Science seeks, above all, to deliver ceaselessly the gift of finding one's Self hiding in plain view.

Endnotes

[1] This is not to say that Astrobiology does not make some use of interior sciences. In fact, two major facets of Astrobiological studies are 1) studying and anticipating the ethical aspects of discovering extraterrestrial life and 2) making use of linguistics and hermeneutics to discern what might constitute "meaningful" signals. There was also a strong interior component involved when deciding upon the design of the Voyager Golden Record, an analogue disc of recorded audio-visual material meant to convey the life and culture of earth to any interstellar passers-by. But, by and large, Astrobiology is strongly steeped in the exterior sciences.
[2] "Prehension" is a term coined by the philosopher A. N. Whitehead to refer to the primitive capacity of atoms to experience other atoms.
[3] This section follows distinctions made by Ken Wilber in personal communication, June 14, 2005.
[4] This follows Wilber's three-strand test of valid knowledge as explicated in several works, but most extensively in Wilber, *The collected works of Ken Wilber* (Vol. 3), 1999.

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Architecture of an Integral Science

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This essay proposes a structural model for an Integral Science. The model employed is called an AQAL matrix (an abbreviated term for "all-quadrants, all-levels, all-lines, all-states, and all-types") and it serves to integrate several critical elements of an Integral Science. In order to facilitate such integration, this essay presents several illustrative and suggestive applications of the model in educational, philosophical, personal, and research settings.

Introduction

Suppose we were to build a living laboratory of Integral Science. What might it look like? Where would we build it? What equipment would we include in its construction and perpetuation? What practices would we follow for the experiments conducted therein? And whom might we expect to find there?

As Alfred North Whitehead put it, "it requires a very unusual mind to undertake the analysis of the obvious."[1] I trust that anyone reading this already possesses an unusual mind—naturally drawn to the obvious—and thus is already familiar with the need for a better understanding of both "Integral" and "Science" as we mull over the questions posed above. But no definitions just yet—as we proceed, I will make a few preliminary attempts in that direction, maybe even follow a few good leads, but I will tackle those definitions more thoroughly in other efforts.[2] Rather, as the present and future artisans of an Integral Science, I would like to spend some time reviewing with you the core structural elements of Integral Theory, with special attention to the application of this theory in the sciences.

Design, Practices, Materials

The basic design framework for Integral Science is called the *AQAL matrix*, which is an abbreviated term for *all-quadrants, all-levels, all-lines, all-states, all-types* (I will elucidate these terms as we proceed). Based upon the labor of love of hundreds of researchers, the AQAL (pronounced "ah-qwul") matrix is a theoretical model explicitly designed to apply to any number of real-world endeavors. This model is the blueprint to which I will refer throughout subsequent construction of our lab.

Once I have outlined the AQAL matrix, I will discuss sound building practices: the methodologies of sound science. These practices will both inform our efforts to optimize the form and function of our Integral Science and aid in the training required to become stellar Integral Scientists.

Lastly, the selection and mining of some reliable materials to build the lab will be crucial. The primary building materials for the Integral Science lab are the data of direct experience, generated in accordance with the methods of sound science. I will gather data from a variety of sources, in a variety of ways, and then examine these data collections, considering how they might come together in an Integral Science.

Exploring the AQAL matrix is the topic at hand in this article. In subsequent articles I will consider more closely the methodologies and material of Integral Science. Let's begin with "all-quadrants."

Quadrants

Quadrants are indicative of *four basic perspectives* that we have available to us as Integral Scientists. Perspectives can be both methods of inquiry (ways of experiencing any manifest occasion) and domains of inquiry (those perspectives possessed by a manifest occasion). Using a simple four-square grid, we can represent these basic perspectives as the interior and exterior aspects of beings as they manifest in singular/individual and plural/collective forms (see figure 1).

UPPER LEFT Interior-Individual	**UPPER RIGHT** Exterior-Individual
LOWER LEFT Interior-Collective	**LOWER RIGHT** Exterior-Collective

Figure 1. The Quadrants

As fundamental elements comprising the structure of any given occasion, the quadrants should be understood as aspects or domains of being/inquiry. Whatever/whomever exists, whatever/whomever has "occasion," whatever/whomever we make the object of our inquiries comes ready-made with these four fundamental perspectives.[3] For instance, if you and I converse on cell phones, we might have thoughts (UL phenomena), which register as neural activity in our brains and might be expressed aloud (UR phenomena), which follow patterns of linguistic meaning (LL phenomena), and which are transmitted within a social infrastructure, in this case, via a cellular phone network (LR phenomena).

The quadrants are also a *quadrivium*, or "*four ways*" *that can be employed to make inquiries of any given occasion*. In the example of the cell phone conversation, we might: look at the call from the perspective of our own feelings (UL), focus on the behavioral responses generated by the conversation (UR), ask each other to confirm understanding of what was spoken (LL), or look at the economic impact of our service plans (LR). That is, quadrants can be the *object* of investigation (a set of structures "looked at," an ontology) as well as the *subject* investigating (a set of structures for "looking with," an epistemology).

Another way of putting this is that, on the one hand, the quadrants are the *dimensions* of any occasion (structural elements of being), and on the other, they are the *methodologies* used to make inquiries about any occasion (structural elements of knowing). These two distinctions—dimension/structure and methodology/function—are the two faces of the quadrant coin we will be using for our schematic understanding. For an Integral Science—and specifically for Integral Scientists—this means that we have at least four different methodologies to examine four different dimensions. Thus—going back to our cell phone conversation—we use phenomenology when looking at our thoughts and feelings (UL); empiricism when registering the sound waves of the voices (UR); hermeneutics when interpreting the meanings of the dialogue (LL); and economics to examine the structure of our "minutes" plans (LR).

These four fundamental perspectives are embedded in the basic structure of all major languages as first-person, second-person, and third-person terminology. If we refer back to our quadrant shorthand, the UL quadrant represents a *first-person, singular perspective* (or "I"); the LL quadrant, a *first-person plural/second-person perspective* ("We/You"); the UR quadrant, a *third-person, singular perspective* ("It"); and the Lower Right, a *third-person, plural perspective* ("Its") (see figure 2).

UPPER LEFT Interior-Individual "I"	UPPER RIGHT Exterior-Individual "It"
LOWER LEFT Interior-Collective "We"	LOWER RIGHT Exterior-Collective "Its"

Figure 2. Quadrants as Perspectives

It seems languages are constructed in acknowledgement of these perspectives. We will often use these linguistic terms interchangeably with the names for the quadrants, with the understanding that (1) the first-person domain is the UL quadrant; the second-person domain is the LL quadrant; and the third-person domain is the combination of the UR and LR domains, and (2) the different perspectives-as-methods (i.e., ways of knowing) can be applied to any of the perspectives-as-domains (i.e., aspects of being).

We find then that in adopting one or another of these basic quadrivium and applying those perspectives toward one or another of the quadrants, we generate or illuminate data specific to that particular perspective-domain coupling. Some simplified examples of these couplings and their associated schools of thought are the following:[4]

- A third-person perspective applied to the first-person-singular domain yields structuralism

- A first-person perspective applied to the first-person-singular domain yields phenomenology
- A third-person perspective applied to the first-person-plural domain yields ethnomethodology
- A first-person perspective applied to the first-person-plural domain yields hermeneutics
- A third-person perspective applied to the third-person-singular domain yields empiricism
- A first-person perspective applied to the third-person-singular domain yields cognitive science
- A third-person perspective applied to the third-person-plural domain yields systems theory
- A first-person perspective applied to the third-person-plural domain yields social autopoiesis

Relative to one another, these data sets are irreducible, and they generate various "classes" of science. For example, UL-Intentional Sciences (e.g., structuralism) produce data about the interior dimensions that cannot be found in exterior-oriented UR-Behavioral Sciences (e.g., empiricism); LR-System Sciences (e.g., systems theory) illuminate interobjective data that cannot be seen by intersubjective LL-Cultural Sciences (e.g., ethnomethodology); and so on.

Upper-Left (UL) Quadrant Intentional Sciences Structuralism Phenomenology	Upper-Right (UR) Quadrant Behavioral/ Material-Energetic Empiricism Cognitive Science
Lower-Left (LL) Quadrant Cultural Sciences Ethnomethodology Hermeneutics	Lower-Right (LR) Quadrant System/Social Sciences Systems Theory Social Autopoiesis

Figure 3. Classes of Science and Representative Members

When any given occasion is cognized or "known" using all four fundamental perspectives, an Integral endeavor is in sight. In order to formulate an Integral approach to science, then, each of these four basic perspectives (as a minimum) will need to be included in the overall inquiry of any given phenomenon.

Levels of Science

However, our four fundamental perspectives are not fixed, monolithic entities: perspectives possess growth capacity. Perspectives show changes in their features, contours of development, and evolution of form. Surveying research on development in each of the four quadrants, we find evidence of progressively more complex stages or *levels* of perspectives. These levels are *the indicators or expressions of the various changes in depth within the different perspectives*.

For instance, when a human adopts a first-person singular ("I") perspective and applies it to him/herself, the sense of "I" (his/her sense of self or identity) displays a capacity to evolve over time in accordance with developmental dynamics. The sense of self shows (or has the tendency to show) markedly different features and qualitative distinctions as one ages: the self-sense one possesses at years three, thirteen, and thirty-three tend to be vastly different constructions. Wherever we spot these qualitative distinctions within a perspective, we have a level.

Levels can be earmarked in several different ways. As Wilber says:

> a "level"… is established by several objective criteria: by a qualitative emergence (as explained by Popper); by asymmetry (or "symmetry breaks," as explained by Prigogine and Jantsch); by an inclusionary principle (the higher includes the lower, but not vice versa, as explained by Aristotle); by a developmental logic (the higher negates and preserves a lower, but not vice versa, as explained by Hegel); by a chronological indicator (the higher chronologically comes after the lower, but all that is later is not higher, as explained by Saint Gregory).[5]

One of the tests of whether we are looking at a level is whether it *transcends and includes* its predecessor level. For instance, a molecule transcends and includes its atoms, which transcend and include their sub-atomic particles, etc. This combination of novelty (transcendence) and stability (inclusion) establishes a sequence of levels, embracing depth within any given perspective. As our perspectives become more sophisticated, new ways of knowing and being come into view.[6] What we choose to identify as "I," "We/You," and "It/s" acquires new meaning; on the whole, the data we accept as valid for those perspectives grows.

So long as we are employing evidentiary data in support of our designations, where we decide to demarcate a level, and the total number of levels we choose to identify, is somewhat arbitrary—like a number line that we can subdivide into infinite increments. But what is not arbitrary is the particular sequencing of the levels. Levels emerge in order of increasing complexity, moving along a continuum of *depth and span*. Roughly, the greater the span of any given occasion, the less depth it possesses; and conversely, the greater the depth, the less span. Depth and span are not measures of size, per se: span is a measure of *prevalence* in the Kosmos, depth is a measure of *inclusiveness of* the Kosmos.[7]

For example, if we take a survey of a portion of the UR quadrant and account for the number of hadrons, atoms, and molecules in the known universe, we find that there are more hadrons than atoms, and more atoms than molecules.[8] Hadrons therefore have a greater span than atoms, and atoms a greater span than molecules. But if we also try to account for the relations between these entities, we find that the atoms include hadrons as part of their make-up and that molecules include atoms (and hadrons) as part of their make-up. Thus, molecules have relatively greater depth than atoms (they are comprised of both atoms and hadrons), and the atoms a greater depth than the hadrons. In other words, molecules manifest with the perspectives of hadrons and atoms, and then add a higher-order perspective as "molecule."

Just to help draw out the distinction between size and depth, let's now look at correlative communities of those individuals (hadrons, atoms, molecules) in the LR quadrant, where we still have a depth-span continuum, but it has a slightly different look than in the UR quadrant. So, if our survey now includes hadron communities, galaxies (atomic communities), and planets (molecular communities), we find that sequence moving from greater span to greater depth, just as before, but notice that the relative "unit size" of the entities on a given level *decreases* here—hadron communities are larger than galaxies which are larger than planets—whereas in the UR quadrant, the unit size increases (hadrons to atoms to molecules) with greater depth. We make note of this unit size distinction because confusing increasing size with increasing depth is frequently problematic when we try to establish degrees of depth.

Taxonomies of Depth

Although we can subdivide levels several different ways to elucidate relationships of depth and span, there is some usefulness in grouping those levels that share broadly related features. Just as with any other science, Integral Science will employ various taxonomies as a means of organizing and referencing the data. As an exercise, then, I would like to introduce some basic levels that span the quadrants. For now, I am proposing the use of four levels as they manifest in each of the four quadrants (see figure 4).

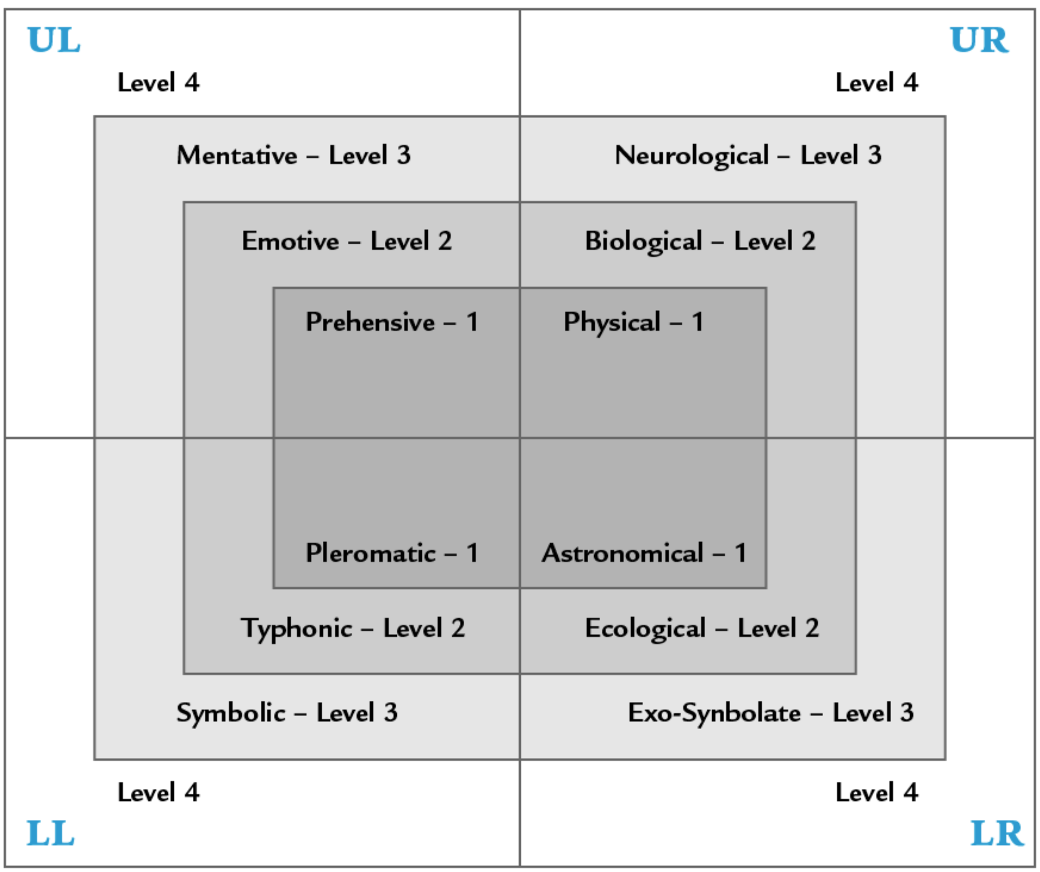

Figure 4. A Four-level Integral Science Taxonomy

I will make efforts elsewhere to help flesh out this taxonomy, but we can make some preliminary observations. Moving from Level 1 to Level 4, we find each level nested within the other, which is indicative of a progressive complexification of the phenomena appearing therein. Development on a case-by-case basis is, of course, never quite that easy, and there occur any number of complications along the way, including regressions, arrests, pathologies, and the like. But on the whole, these four levels are broad demarcations of the emergence of, respectively, a prehensive-data matrix (or, a physiosphere, level 1), a bio-data matrix (a biosphere, level 2), a mental-data matrix (a noosphere, level 3), and a pneumo-data matrix (a pneumosphere, level 4).[9] Using more colloquial designations, this progression moves from the "Hard" or "Material" sciences, to the "Life" sciences, to the "Mind/Social" sciences, to the "Human/Spiritual" sciences.

For example, LR, Level 1 (Astronomical) is a subset of System/Social Sciences (LR, All Levels) and is comprised of elements of Astronomy, Cosmology, and Geology, where the main focus of inquiry is communities of sub-atomic particles, atomic elements, and inorganic chemicals. All of the data examined by these sciences do not include biological features, per se, and so we have drawn a distinction between LR-1 (Astronomical) and LR-2 (Ecological) in our classification scheme. This does not imply that biological (or mental or pneumal) phenomena do not have any bearing on engagements with physio-prehensive phenomenon—they do interact, quite profoundly, in fact—but we are trying to allow for easier digestion at this point.

As far as levels three and four, the primary demarcations are respectively the emergence of symbolic manifestations, and the emergence of trans-symbolic manifestations. As we wish, we can further subdivide these groupings into various sub-disciplines, and even refine the classifications to include several other major levels. But, for the moment, we have a basic shape to play with.[10]

One of the main purposes in fleshing out taxonomies of science is to situate the scientific disciplines with respect to the depth-span continuum. By mapping out the particular level of depth-span a science is adopting within a given perspective, and to which domain it is being applied, we can better understand the area of inquiry and the extent of validity of that science. This mapping not only allows that science to explore more freely within its own purview, against the intrusions of less adequately attuned sciences, but it also frees a discipline from having to extend itself beyond its limits and into making unwarranted knowledge claims in the name of wholeness.

However, because the sciences sufficiently overlap between quadrants and levels, it is best to think of these classification schemes as fluid probability spaces, rather than discrete repositories. And note: if we conclude that physics explores a lesser level of depth than the study of chemistry or biology, we do not mean that physics is therefore less important.

Returning to the notion of the depth-span continuum, we find that physics encompasses a much greater span of the Kosmos than does either chemistry or biology, making it applicable to a greater range of beings in the Kosmos. In the sets of (1) quarks, (2) quartz, and (3) quails, I can employ physics in the inquiry of all three, chemistry only in the last two, and biology only in the last. Some form of the law of diminishing returns will apply, where physics (and its fundamental laws) will become less capable (or incapable) of accounting for the novel emergents with each higher order manifestation (e.g., though it might carry some poetic appeal, strong nuclear force does not very well explain the phenomenon of love). But physics is still at play, however dimly, across the Kosmic expanse. Another way of saying this is that, while the study of depth and span are both important, depth is more *significant*, and span is more *fundamental*. Biology signifies more aspects of the Kosmos than chemistry and physics—it transcends and includes both. But biology simultaneously rests on the foundations of chemistry and physics, which are more fundamental to the Kosmic structure—no life gets going without having secured the blessings of physics and chemistry first.

Before we leave this section, I would quickly like to note something pertinent regarding the Integral Scientist. Among the various levels identified by developmental researchers, we find what has been generally termed an "Integral" level. From his study of evolving worldviews, Jean Gebser called it the "integral-aperspectival" level; in their respective studies of self-development, John Broughton and Jane Loevinger termed it the "integrated self." We will look more closely at what this level entails in other writings, and how we might manifest "Integral" forms. For now, just be aware that this level is a term for a constellation of attributes and properties that are specific to a particular complexification of manifestation called "Integral."

Lines

Whereas the levels of development indicate broad changes in perspective, *lines* of development are *specific forms, capacities, or "intelligences" that move through those levels*. The example given earlier of the changing perspective of one's identity-sense, or "I" sense, is actually one specific line of development (the line of self, or self-identity) that manifests predominantly within the UL quadrant (a first-person perspective of a first-person domain). With strong cross-cultural evidence for twenty or so lines of development, we will want to explore what bearing these lines might have on an Integral Science.

Furthermore, lines of development tend to gravitate toward one or another of the quadrants, though this does not exclude various overlaps between quadrants. Any quadrant/perspective houses several lines/capacities that have the ability to manifest through several levels. See figure 5 for a small sampling.

Upper-Left Quadrant Intentional Sciences Self Cognitive Affective Moral	Upper-Right Quadrant Behavioral/Matter-Energy Sciences Organ Systems Neurologic Proteomic Kinesthetic
Lower-Left Quadrant Cultural Sciences Intersubjective semantics Background cultural contexts Cultural values Worldviews	Lower-Right Quadrant System/Social Sciences Techno-economic Communication networks Modes of Production Linguistics

Figure 5. Lines of Development in the Quadrants

Lines also appear to develop relatively independently of one another. For instance, a person might well be well developed in one line, moderately developed in another line, and poorly developed in yet a third line. A pop-culture example of this sort of uneven development is the "mad scientist:" someone who is quite well developed along cognitive lines, but less well developed interpersonally, and perhaps deficient when it comes to moral reasoning. What we find is that the depth of development along one line does not necessarily guarantee similar depth of development in other lines.

We say that lines develop *relatively* independently because certain lines seem to be "necessary but not sufficient" for the development of other lines. Thus, one of the main conclusions of Lawrence Kohlberg's research was that cognitive development is necessary but not sufficient for moral reasoning development, which is necessary but not sufficient for moral action development. The development of the latter lines was predicated on the development of the previous lines. Because of this generally uneven pattern of growth, we will be looking to assess development along several lines to make sure we have covered as many bases as possible.

For instance: in the field of science education, work on learning experience and curricular design for the past century has been intimately concerned with lines of development.[11] In one of its latest incarnations, the Arts and Sciences Department at Harvard University recently underwent an undergraduate curricular review. Summarizing the conclusions of the review, one interpreter identified the main areas of focus for reform as "[the creation of] more room for broad exploration, a greater familiarity with the world that can only be gained from study abroad, and a deeper, hands-on understanding of science."[12] This idea of "hands-on" understanding is an attempt to integrate an experiential "feel" for science (e.g., affective and kinesthetic lines) with the traditional cognitive "know-how" of science (e.g., cognitive and technological lines). Reflecting this inclusion of other lines of development, the "hands-on" terminology is often expanded into "hands-on, minds-on"[13] and occasionally "hands-on, hearts-on, minds-on"[14] learning. Although the specific meanings will vary in the hands of various interpreters, they are broadly reflective of different lines of development: respectively, sensorimotor, affective, and cognitive lines.

As an amalgamated example, a contemporary science classroom might be consciously constructed to engage these developmental lines. Inquiry-based learning models could employ physical engagement with an experiment (sensorimotor line), journaling exercises to express emotions and broader feelings (affective line), and inquiry processes that are both self-directed (self line) and shared (interpersonal line) to build concept maps (cognitive line) and problem-solving skills (technological line). The desired result is an arena where science education judiciously blends what Dewey called "formation from without" with "development from within."[15]

By incorporating the research in developmental lines, science educators can construct learning strategies and models that mesh well with the present development of the student (and the teacher, we might add). This can potentially act as an expanded form of aptitude testing: by constructing the best possible developmental map, we can better locate where students and teachers "are," so to speak. Then we can tailor appropriate pedagogy, curriculum, and modes of inquiry to ensure more coherent and meaningful learning.

By further expanding these studies of lines to include levels and quadrants, we can track how both individual and collective learning structures unfold in different stages along the various lines of development. So, to give one example, in addition to the individual-interior (cognitive, affective, interpersonal, moral) and individual-exterior (physiological) dimensions already mentioned in pedagogic literature, Integral Science would also look at how lines of exterior-collective (communications, linguistic, productive, techno-economic) and interior-collective (cultural values, intersubjective semantics, background cultural contexts) contribute to science education (see figure 5 for further elements).

Insofar as science curriculum is intimately concerned with the personal growth of scientists, studies of lines of development are applicable to the growth of Integral Scientists. As indicators of resident capacities, the study of lines is crucially important to any scientist seeking a stronger activation of inherent potentials. In their efforts to avoid "mad scientist" tendencies and to integrate a balanced depth and span of growth, Integral Scientists would want to touch base with many lines of development.

States

States are any of several *transient modes, realms or "fields" that manifest in the quadrants*. For instance, there are UR states (material states: solid, liquid, gas, and plasma); LR states (systemic states: dynamic, static, chaotic, and coherent); LL states (collective states: meaningful, inchoate, collaborative, hostile); and UL states (states of consciousness, which fall into three basic classes: natural [waking, dreaming, deep sleep, nondual], altered [meditative, drug-induced, hypnagogic, fevered, religious], and phenomenal [joy, anger, calm, grace]). Unlike stages and lines, states do not develop, per se, and are generally available at any stage or along any line of development. States are something like repositories or playgrounds for perspectives, levels, lines, and types.

Science is famously (or perhaps infamously) associated with the open-eyed, crystal-clear rationality of the waking state. But much of what we deem "scientific" is not confined to the state of waking sobriety. Some famous examples (out of hundreds of accounts in scientific literature) include the experiences of the following scientists:

- Alfred Russell Wallace, who co-discovered with Charles Darwin natural selection in evolutionary theory. According to one of his biographers:

> It was during an actual attack of fever that the idea came to him. His mind was reflecting on Malthus's "Principle of Population," and brought remembrance of this book, which he had read twelve years before, into connexion with the vast stores of knowledge that he had gained of the lives of wild animals in their native haunts in the East Indies... The principle of the survival of the fittest "suddenly flashed" upon him. "Then at once," he wrote, "I seemed to see the whole effect of this," and waited impatiently for his fit of fever to leave him, so that he could write down a sketch of his theory. That same evening he did so, and during the next two evenings he wrote a fuller account to send to Darwin.[16]

- Frederick Kekule, who discovered the chemical structure of benzene, describing his revelation to an assembly of fellow scientists, said:

> I turned my chair toward the fire place and sank into a doze. Again the atoms were flitting before my eyes. Smaller groups now kept modestly in the

background. My mind's eye sharpened by repeated visions of a similar sort, now distinguished larger structures of varying forms. Long rows frequently rose together, all in movement, winding and turning like serpents; and see! what was that? One of the serpents seized its own tail and the form whirled mockingly before my eyes. I came awake like a flash of lightning. This time also I spent the remainder of the night working out the consequences of the hypothesis.[17]

- George Boole, inventor of Boolean algebra:

…made his breakthrough while trying to develop a mathematics of thought. He was a strange character, deeply engrossed in mysticism and occult. This inclination made him subscribe to the view that man receives information not only through his senses, but "also from some source, invisible and undefinable." His aim was, "to unfold the secret laws and relations of those high faculties of thought by which all beyond the merely perceptive knowledge of the world and ourselves is attained or matured."

It was while musing on such metaphysical problems, that one day, while crossing a field, the "Mystic Law"—"x + (not x) = 1"—flashed in his mind. And that was the beginning of the Boolean Algebra…[18]

Add to these examples Poincare's use of caffeine-induced states in developing his Fuchsian functions, Carl Sagan's use of marijuana for securing insights seminal to his work, and the list goes on. If we also include the contemplative scientists (mystics past and present), we have a veritable cornucopia of states with which an Integral Science will want to concern itself.

Types

Types concern *any of several different orientations that one might assume or possess at any point within the AQAL matrix*. Personality types (such as Enneagram, Jungian, Myers-Briggs), and gender types (masculine and feminine) are representative of this aspect of the AQAL matrix in the UL. There are also types associated with the other quadrants. For example, cultural types (American, Brazilian, Irish, Japanese) in the LL, physical body types (ectomorph, endomorph, mesomorph) and blood types (A, B, A/B, O) in the UR, and economic types (capitalist, communist, socialist) and ecological types (alpine, desert, temperate forest, tropical) in the LR. These are just a few examples of the kinds of types associated with each quadrant. For the purposes of this paper I will focus on UL types.

Gender types, for instance, seem to influence cognitive development, orienting individuals toward different modes of learning, emphasizing different strengths of methodology and preferences for different domains of inquiry. Masculine orientations tend to evolve through lines with an emphasis on *agency*, or *relatively autonomous individualistic pursuits*, whereas feminine orientations evolve with an emphasis on *communion,* or *relatively relational or communal pursuits*.

The cause of the relative paucity of females enrolled in higher education science tracks and employed as professional scientists has been a debate in both professional and educational circles for many years now. One component of this debate will no doubt need to involve the numerous studies on gender identity: how does one's gender affect one's self-sense, one's moral attitudes, or one's cognitive structure? Myers-Briggs scales (also called the Jung-Myers-Briggs scale following Carl Jung's work on personality types) are other examples of possible orientations available at any given level of development. For instance, the Myers-Briggs instrument employs the following four scales of personality preferences, named by their opposite poles: (1) extraversion/introversion, (2) sensate/intuitive, (3) thinking/feeling, and (4) judging/perceiving.

Matching different combinations of characteristics in this system, there are sixteen personality types, usually denoted by four-letter abbreviations (e.g., an introversion-intuitive-thinking-judging profile is denoted as INTJ). Each personality type has a certain profile, such as the following description of an INTJ (also known as "the Scientist"):

- insightful, conceptual, and creative
- rational, detached, and objectively critical
- likely to have a clear vision of future possibilities
- apt to enjoy complex challenges
- likely to value knowledge and competence
- apt to apply high standards to themselves and others
- independent, trusting their own judgments and perceptions more than those of others
- seen by others as reserved and hard to know.[19]

An Integral Science Unbound

All quadrants, all levels, all lines, all states, all types. These are the prerequisite design components of an Integral Science. As we proceed in our efforts to build our laboratory, these will be the gossamer outlines of our future science and future selves. Because, at the heart of an Integral Science is… Us. It is a constant return back to ourselves, where our sense of Self grows with every sojourn. Every science is an exchange, a gifting of ourselves to each other in inquiry.

We wander ceaselessly, compulsively, madly into this love affair we have with knowledge, a primal craving to understand, replete with ecstatic delights and exquisite torments. This most serious game we play with each other, this fondness for the wound of wisdom, drives this endeavor on until... what? What is the endgame of an Integral Science? What is the love of knowledge requited?

The laboratory of Integral Science is dedicated to this search. Its design is meant to elicit and perpetuate this love affair, until, by virtue of the very quest, we are unbound by this craving. Drawn close by Nature's whispers, pressing ever closer to hear what secrets are sung, we find that we are that Nature, whose voice is our own, whose secrets are not secrets at all but the most obvious movements of our own being.

Glossary

agency	A drive toward autonomy; seeking individualistic pursuits; associated with masculine types; opposite tendency of communion.
AQAL	Shorthand abbreviation of "all-quadrants, all-levels, all-lines, all-states, all-types;" a model of Integral Theory developed by Ken Wilber.
AQAL matrix	The basic design plan of Integral Theory; incorporates the five major features of quadrants, levels, lines, states, and types.
communion	A drive toward community; seeking relational dimensions; associated with feminine types; opposite tendency of agency.
depth	Measurement of inclusion of the Kosmos; frequently contrasted with span.
fundamental	Relative designation of span; something is more fundamental with greater span, less fundamental with lesser span; often contrasted with significant.
Kosmos	Pythagorean term for the wholeness of existence; in terms of Integral Theory, it is indicative of the interior and exterior dimensions of individual and communal entities.
levels	Indicators or expressions of the various changes in depth within the different perspectives; indicative of developmental gradations.
lines	Specific forms or capacities or "intelligences" that move through the levels of development.
quadrants	Four basic dimension-perspectives that encompass interior and exterior dimensions of individual and communal entities; often designated as Upper Left (UL) for individual interiors, Upper Right (UR) for individual exteriors, Lower Left (LL) for collective interiors, and Lower Right (LR) for collective exteriors.
quadrivium	literally "four ways;" an aspect of quadrants that emphasizes the use of the quadrants as perspectives with which to view any manifest occasion.
span	Measurement of prevalence in the Kosmos; frequently contrasted with depth.

significant	Relative designation of depth; something is more significant with greater depth, less significant with lesser span; often contrasted with fundamental.
states	Temporary or transient modes, realms, or fields of manifestation; in human experience (UL) they are often differentiated into natural states and phenomenal states.
types	Any of several different orientations that one might assume or possess at any point within the AQAL matrix.

Endnotes

[1] Whitehead, *Adventures of ideas,* 1967, p. 4; Whitehead, *Science and the modern world*, 1967
[2] For some beginning thoughts on these matters, consult Koller, "An introduction to Integral science," 2006
[3] Technically, any occasion can be looked at via the four quadrants, but only "whomevers," or sentient beings, possess perspectives or "have" the quadrants. The reason I've left things a little loose here is to give room for those circumstances where occur transformations of "whatevers" into "whomevers", or when "things" that arise in consciousness are later experienced as "beings." This is sometimes explained as a shift in perspective from third-person to second-person (an "it" becomes a "you"), and even into first-person perspectives (an "it" or a "you" becomes a "me" or "mine").
[4] There are several other perspectives, but I am confining this sampling to first- and third-person perspectives in accord with the usual understanding of the scientific perspective. These are roughly equivalent to what Wilber calls "primordial perspectives," though he has created an Integral "calculus" to elaborate further complexity regarding the actual dance steps involved in the play of perspectives. There are other perspectives or perspective-domain couplings—these are simply some of the "base pairs." Consult Wilber, "Excerpt C: The ways we are in this together; Intersubjectivity and interobjectivity," 2003.
[5] Wilber, *The collected works of Ken Wilber* (Vol. 6), 2000, p. 62-63
[6] In some cases it might be an extended repertoire of perspectives (as with compounded perspectives such as cognitive or value structures, which build upon and incorporate predecessor perspectives). In other cases it is a more encompassing but relatively exclusive perspective (as with transitional structures such as morals, which seem to present singularly—one is not simultaneously selfish and caring at the same time).
[7] "Kosmos" is a Pythagorean term for the totality or wholeness of existence, a step up of sorts from the comparatively diluted contemporary homonym, "cosmos."
[8] A hadron is an elementary particle composed of quarks and/or gluons. Protons and neutrons are both examples of hadrons. Also note that hadrons, atoms, and molecules are not, strictly speaking "in" the UR quadrant—they manifest with all four quadrants, but for simplicity's sake, I am using a shortcut. The same heuristic device will apply to subsequent placements of phenomenon in one or another quadrant.
[9] I presume at this point that I will be forever identified as heralding the dawn of the "Pneum-Age," and since I am not entirely sure I want that as a legacy, I invite you to insert your own pet term for the complexity of humanity as you wish.
[10] Any statements we make about Level 4 grow complex very quickly because it essentially demarcates the emergence of distinctly human phenomenon. I have conflated some major levels within each of the four levels (and especially the fourth level, hence my reluctance to attempt any descriptive term for those classes), and we will eventually want to differentiate them. In future papers I will add some provisos to the possibility of having anything resembling a science of those uppermost regions of Level 4—a science that is not intimately bound to theoretical/provisional knowledge—but that is getting a little ahead of things for the moment. So please hold these particular designations lightly for now, and I will explore these areas later.
[11] Though educational reformers such as Herbert Spencer and John Dewey would not have identified "lines" as such, they were effectively arguing different experiential curricula based on developmental lines, be they moral, cognitive, affective, or techno-economic. For an excellent overview of curricular trends in science education in the United States, consult Montgomery, *Minds for the making: The role of science in American education, 1750-1990*, 1994.
[12] Rimer, "Committee urges Harvard to expand the reach of its undergraduate curriculum," 2004
[13] Consult the National Research Council, *National science education standards,* 1996, p. 2
[14] Russell, "Hands-on, minds-on, HEARTS-on," 1997
[15] Dewey, *Experience and education,* 1997, p. 17
[16] Shukla, "The creative muse: Stories of creativity and innovation," 2004
[17] Shukla, "The creative muse: Stories of creativity and innovation," 2004
[18] Shukla, "The creative muse: Stories of creativity and innovation," 2004. Consult also the work of Robert Root-Bernstein who has contributed extensively to this literature.
[19] Carroll, "Myers-Briggs Type Indicator," n.d. Although this website is not necessarily friendly in its interpretation of the Myers-Briggs or Enneagram instruments, it gives a nice overview of the basics.

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