

PROCESS AND RELATIONSHIP IN INDIGENOUS ASTRONOMY: CONNECTIVITY OF MOTHER EARTH AND FATHER SKY

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ABSTRACT

Many people around the world still live in accordance with a world view that is remarkably different from the Euro-American world view. This paper discusses some of the striking differences between western academic science and Indigenous ways of knowing. Beginning with the original meaning of the word “science” the paper focuses on the importance of world view and cultural outlook as a framework for understanding the world. Much of the complex Indigenous world view is contained in the original Indigenous languages, which are relational and process oriented, very different from European languages which are noun-centric and non-relational. Many Asian languages, such as Chinese, are constructed in ways similar to Indigenous (in this case Navajo) languages. The work of quantum physicist David Bohm comes closest to Navajo (and Blackfoot) ways of knowing, with his work on the existence of an explicate and an implicate world, existing in ceaseless movement, called holomovement. Indigenous astronomy is positioned in a world view of interconnection and interrelationship of all things. Everything is living and animate in a universe of cosmic movement. This relational way of viewing the universe has major implications for understanding the way a world view impacts and constructs astronomy and cosmology of a people.

Keywords: *Indigenous Astronomy, Navajo Indian cosmology*

Introduction

The word “science” is used by many people, in many societies, in many ways, countless times every day. Yet few words in the English language are used so much with such imprecise definition. At the same time, many people who use the word “science” do so with the conviction that they are being understood, and that their definition is the only definition. To further compound matters, the word “science” has come to stand for a kind of authority in our current western (Euro-American) society, in fact it has become the gold standard, the arbitrator, for what is real and what is not real.

Many people around the world still live in accordance with a world view that is remarkably different from the Euro-American world view. Indigenousⁱ peoples have rich and complex ways of knowing and ways of being and living in this universe. They have observed the natural processes and interrelationships of all things over millennia and can talk about the natural order through languages of process and relationship that allow for a natural expression of holistic systems through complex dimensions and intricate organizations of time and space. These ways of knowing are based on very different world views than that of the Euro-American immigrants who seized and colonized

Indigenous lands around the world. The objectives of this study and paper are to provide an awareness that there are diverse methods of viewing the universe, through unique Indigenous world views, which can be strikingly different from the Euro -American mainstream, academic worldview, and provide an example based on Navajo Indian cosmology, from a participatory research methodology.

Research Method

This paper has been written by an Indigenous knowledge holder. As is often the case, papers written on Indigenous ways of knowing do not fit easily into Eurocentric frameworks of research design and evaluation. The foundation of this type of work can be described as participative research, from within a culture, based on knowledge transmission from renowned Navajo elders and medicine people. The astronomical knowledge discussed here is also based on song and ceremony, from time immemorial, often unchanging for generations. Indigenous wisdom is based on knowledge of the interconnections of all things, which is significantly different from western scientific and academic theories of separatism and individual components. As Shawn Wilson describes in the title of his book, “Research is Ceremony.” He continues, “Indigenous

researchers are knowledge seekers who work to progress Indigenous ways of being, knowing and doing in a modern and constantly evolving context.”

Indigenous scholarship places a strong emphasis on ethics, and, as Indigenous author Robin Kimmerer says, the need for “right relationship” with all the natural world. In this way land and sky become our teachers and a healthy relationship of people and land becomes a spiritual responsibility. The all-important need for western scientific peer review validation, becomes, in the Indigenous world, as Kimmerer notes, changed to a world where the Indigenous Knowledge Holders are the peer reviewers, the community itself provides the validation, and this is continued for generations and generations.

The closest I can come to describing an Indigenous research methodology is a combination of several research designs, a participative framework, based on Phenomenological research. “Participative research “offers a voice to participants (in this case authors and their Indigenous community) “and gives them the ability to form an agenda for reform” (Creswell, 2013). In this paper I have presented an awareness of Indigenous epistemology and transformative inter-relational explanations.

“Phenomenology is an approach to qualitative research that focuses on the commonality of a lived experience within a particular group” (Creswell, 2013). As I discussed with co-author David H. Begay, in an earlier paper published by the International Journal of Applied Science and Sustainable Development, Vol 2, No 1) “We are the group of individuals as well as the academic authors, who, combined, have the first hand knowledge and lived experience among the Navajo community and the world of quantum physics.”

Finding And Discussion

Most people would agree that what we call western science is based on 16th century philosophies, as articulated by noted scientists and philosophers such as Sir Isaac Newton and Rene Descartes. It is common to hear the western science system described as the Cartesian/Newtonian science. It is more common to hear this phrase in among Native Americans and other Indigenous peoples,

however, because they are articulating a keenly felt difference in ways of knowing and are stating that their world view can encompass western science but the Indigenous world view is not defined nor contained by western science.

Western science (and by this I mean classic western science) on the other hand, has tried to contain all other ways of knowing, through a conscious or sub-conscious marginalization, that puts itself at the apex of a reality pyramid, and all other perspectives, world views, ways of knowing, as subordinate, contained and defined by western constructs. This is evident through close examination of world view, language, education practices, and research protocols.

To return to the word “science” as mentioned at the beginning of this paper, it may be helpful to examine the use and root of the word. Today “science” can mean the seal of approval, sometimes arbitrary, sometimes definite, given to a body of knowledge that fits within the parameters of the Euro-American worldview or, to be more definitive and expansive, the Euro-American consciousness. It can also be appropriated by Indigenous peoples to mean a way of observing and being in the world. One of the actual roots of the word “science” is the Latin word *sciencia*, which simply (and of course complexly) meant “to know.” Interestingly, there is no word for “science” per se (in relation to the western definition), in most Indigenous languages. Nor are there words for western constructs such as “art” or “religion” in most Indigenous languages. The actual concepts are deeply and culturally embedded in interconnections of holistic world views.

So, if “science” means “to know” does it not follow that Indigenous or native ways of knowing the cosmos would be science? However, if science is only defined through the lens of Euro-American consciousness, as a rigid Scientific Method process that excludes ways of coming to knowing, such as intuition, spirit, and any such related processes which cannot be seen, proved, or manipulated in replicable experiments, then Indigenous science cannot be called science.

I mention this to bring up the subject of worldview and cultural outlook as determiners of what is science. It becomes of vital importance today since western science has

anointed itself as the standard by which all reality is proclaimed. However, and this is a big “however,” at the end of the 19th century and through the entire 20th century, some scientists, including such notables as Albert Einstein and David Bohm, began to examine the foundations of western science and found them limiting and in some cases, even contradictory. We are now at the beginning of the 21st century and leading western scientists have turned the Cartesian/Newtonian mechanistic worldview upside down, leading to a situation as discussed in such disparate disciplines as quantum physics, systems theory, complexity and chaos theories, where reality itself is in question.

Interestingly, the new, modern or wholeness sciences (as they are often referred to) have strong relationships with Indigenous sciences and in some aspects even with early western civilizations, such as the Greek civilization (pre 5th century B.C., where science and philosophy were holistically united) and with many of the Eastern wisdom traditions. An example is a foundational process of complementarity which is seen through the Yin/Yang of the Chinese and the *Alkee Na'ashi* of the Navajo. The dynamic movement that is intrinsic to the being of these energies emerges and flows continuously through the seemingly oppositional attributes of Yin and Yang, of Male and Female, of Negative and Positive, vibrations. Actually they are not opposites or polarities at all, rather they are related through a multi-dimensional continuum and are vitally necessary to the unending process of cosmic movement, described in Navajo as *nanit'a*.ⁱⁱ

In many native communities the concept of balance is of paramount importance. For the Navajo, a sense of balance, *as'aa naaghai*, pervades all thinking. The Navajo language embeds the concept of balance. Navajo language can be described as a language of paradox, where seemingly contradictory concepts are held together as a unified whole, culminating in a sense of philosophical and cultural balance. Paradox itself is a manifestation of complementary energies.

David Bohm, a colleague of Albert Einstein, and a renowned physicist, wrote of a cosmic universe of complementarities, including his work on implicate and explicate order. Many people have taken the superficial aspects of his work and applied them to other realms, without

really understanding the underpinnings of math and physics. Indigenous physicist and author Phillip Duran discusses Bohm's physics with mathematical understanding and skillfully applies them to Indigenous knowledge. In Duran's article “On the Cosmic Order of Modern Physics and the Conceptual World of the American Indian” he highlights key concepts that link Bohm's cosmology with native thinking:ⁱⁱⁱ

- *The Universe as an unbroken, coherent whole.
- *The existence of a visible (explicate) world, valid in the domain of classical physics.
- *The existence of an invisible (implicate) world, valid in the domain of quantum physics.
- *The explicate enfolding into the implicate, and vice versa, with the two worlds co-existing in ceaseless movement, called the holomovement.
- *The inadequacy of modern languages (including English) to describe quantum processes and the adequacy of Native languages to do the same.

There are many other commonalities between the wholeness sciences and Indigenous ways of knowing. Both have a strong commitment to ideas of constant flux and cosmic cycles. Both are grounded in relational interconnections. Both acknowledge cosmic self-organizing systems in nature and both are based on awareness of processes of regeneration and renewal. There are others.

David Bohm and Leroy Littlebear, a Blackfoot scholar from Alberta, Canada, organized the first science dialogue with native knowledge holders, linguists and quantum physicists, held in Kalamazoo, Michigan in the early 1990s. People who attended that first dialogue, including Bohm, were galvanized by the similarities between quantum physics and Indigenous ways of knowing. During the following 15 years, other meaningful dialogues have taken place, based on a Bohmian dialogue and native talking circle process, as interpreted and developed by Littlebear. Rose Von Thater-Braan has continued holding by-invitation-only science dialogues in the Bohmian-Littlebear tradition, usually moderated by Littlebear. These dialogues are generally small, intimate and often achieve a real epiphany of knowing.

Glenn Aparicio Parry and Dan Moonhawk Alford began a different kind of Bohmian-Littlebear dialogue in 1999, called

Language of Spirit, which is hosted by the SEED Graduate School in Albuquerque, New Mexico, and also moderated by Leroy Littlebear. These dialogues are organized with an Inner Circle of invited participants, including native knowledge holders, Indigenous scientists, quantum physicists, linguists, and others, who dialogue surrounded by an Outer Circle, an audience of paid subscribers. Littlebear rotates some of the Outer Circle participants into the Inner Circle speakers, providing a dynamic and enriching process of contributions, where knowledge is flux, flowing in and out of the circle.

I have had the privilege and honor to attend many of the Von Thater-Braan and SEED dialogues over the past 15 years. I have seen and heard incredibly complex ideas emerge from the process of collaboration, rich collaboration where participants, on the urging of Littlebear, actually and consciously suspend their tacit and cultural infrastructures, and enter into a process of deep listening and real dialogue. In many cases these dialogues come closer to actual transformation of thought, as representatives from two ways of knowing and being are actually engaging in deep listening and subsequent understanding. This has major implications for areas such as conflict resolution and conflict transformation.

The dialogues, positioned as they are, in an area where two cultures often collide, have brought to life commonalities as well as fundamental differences between western Euro-American science and Indigenous ways of knowing. This area where cultural boundaries touch and often collide, can be rough, disturbing, daring, and dynamic. It is an area similar to the border towns surrounding American Indian reservations. A clash of cultures, with sometimes one, sometimes another, dominating. But it is within this rich stew of consciousness that creativity can occur and startling thinking can emerge, pushing the boundaries of science as well as Indigenous traditional knowledge.

I have briefly discussed the process of Bohmian-Littlebear dialogues at some length here, in order to show a dawning of awareness and respectful articulation between two very different ways of knowing. Much of today's western civilization, as we know it, is based on classic science, going back to the Greeks of the

time of Aristotle. These sciences are primarily grounded in what can be sensed and measured, and have been purposefully fragmented into academic disciplines - realms of sciences, religion and philosophy, over the centuries. Most universities today are still constructed along the lines of these ancient disciplines. It is rare to see interconnected disciplines (think departments) in modern universities except in areas of environmental science and Native American studies programs, (ones that are purposefully integrated among many disciplines).

Tribal societies are based on different metaphysics, which we can call Indigenous metaphysics, which in turn are based on millennia of observation of natural order, including use of intuitive senses, experiences, and a concept of the human as an integral part of an animate and non-hierarchical world. For people raised in tribal societies, or with tribal heritage, it is difficult to fragment traditional knowledge into acknowledged academic disciplines. It is also difficult to put aside traditional Indigenous coming-to-knowing attributes, such as the use of intuition, visions, dreams, story, song, and ceremony, through which learning traditionally occurs.

Today, an increasing number of Indigenous scholars are looking at their own traditional knowledge and juxtaposing it with classic western science as well as with the wholeness sciences. Many have earned doctorates in the western sciences and at the same time they have knowledge of their own tribal heritage, knowledge and language. We are living in an era where Indigenous scholars can delve deeply into both worlds and see differences and commonalities. The diversity of thinking opens portals into new ways of knowing.

Many of these modern Indigenous scholars have worked in the areas of western and native science: areas of physics (Duran, Littlebear), environmental science (Roberto Gonzales-Plaza, Ray Pierotti, Dan Wildcat, Mimi Lam, Mansel Nelson, to name but a few), biology (Donna House, James Garrett, Dennis Martinez, Enrique Salmon), astronomy (David Begay, Nancy Maryboy, Paul Coleman, Emil Wolfgramm, Johnson Urama, Alonso Mendez, Pepe Huchim), GIS technology (James Rattling Leaf, Tania Wolfgramm). Others have written

brilliantly in the area of native science such as Vine DeLoria, Jr., Simon Ortiz, Glenn Aikenhead, Greg Cajete, Rose Von Thater-Braan, Linda Hogan) and still others have expressed ideas of native knowing and observation-based science through the field of education (Lloyd Pinkham, Manu Meyer, Verlieann Malina-Wright, Oscar Kawagley, Lilikala Kame'eleihiwa, Amethyst First Rider, Marie Battiste and Sagej Youngblood Henderson). Some have taught Indigenous science concepts through art (Wukuki Kingi) and some through linguistics (Dan Moonhawk Alford). Hawaiians such as Nainoa Thompson and Chad Kalepa Baybayan have traveled thousands of miles across the Pacific in canoes, utilizing traditional knowledge of stars, winds, waves, birds, fish currents and other sources. My point here is that all of these scholars have knowledge from two world views, and they have a native language as well English, in which to communicate their thinking. This was not possible one or two generations ago when most of the Indigenous knowledge holders were grounded in their own language but had less opportunity to master academic and everyday English and thus could not communicate as well among one another, as is possible today. Technology, communication advances, all have enhanced the collaborative process.

Up until now I have been discussing Indigenous science as a unified whole. In reality it is the individual specific tribes that hold observation and place based knowledge. Yet there are enough commonalities among the diverse tribes of North and South America, as well as Polynesia, Africa, Asia (in fact most non-western areas of the world), to be able to speak in generalities about values and concepts held in common. Among tribal peoples of the world, most would agree that what western science calls "science" (knowing) cannot be fragmented but must remain whole and must remain interconnected and interrelated to everything in the universe. This holistic perspective means that any Indigenous science is linked to every other one.

For example, to adequately study Indigenous astronomy mandates some knowledge of many life processes of Mother Earth and Father Sky. When David Begay and I began to write our collaborative Ph.D. dissertation, based on our ancestral Dine

cosmology, we were told that we needed to focus on one particular domain, or area of knowledge. We responded that it was not possible to fragment the holistic native knowledge. When asked how many domains we wished to discuss, we named at least 32! This stunned our advisors and greatly maximized the scope of our work, but it was necessary in terms of native research protocol. Our domains included astronomy (stars, Sun, Moon), biology, botany, zoology, classic science, wholeness sciences such as System Theory and Chaos Theory, geology, ecology, meteorology, history of western civilization, Indigenous history, philosophy, linguistics, art, religion, Eastern wisdom traditions, etc. I mention this to show how holistic and interrelated all astronomy can be. In turn, we were surprised to learn that in modern western space science, as defined by NASA, the academic discipline was divided into planetary, lunar, solar, astrophysics, deep space, etc.

The study of Indigenous astronomy, in our case, of Navajo astronomy, called for different protocols, different research methods, different validations, different uses of researched material, different kinds of knowledge sources (including dreams, intuition, visions, animals, plants, fish, birds, place, time) and different ways of knowledge transmission than are common in academia. One challenge was to position our research within accepted western constructs while at the same time retaining the holistic interdependencies, values of reciprocity, and stewardship of native science. As our research continued over many years, we found that by precisely locating our ancestral knowledge base on *Dine Bikeyah*, Navajoland, using the Navajo language, and stressing the importance of observation-based, place-based research, we avoided some of the more common academic traps which often lead to marginalization of native thinking at the university graduate levels.

This sense of marginalization of Indigenous wisdom is a reality at most universities, increasing as one goes higher in academia. At the doctoral level it is rare indeed for Indigenous students to be able to include their own ways of knowing, of researching, of citing sources. I had a Pueblo friend who taught science at Dine College in the early 1990s and I asked him how he could reconcile his belief in

the scientific method with his participation in traditional dances in his pueblo. He replied that he had to take off his pueblo “hat” when he crossed the cattle guard to the college every morning, and put on his western “hat.” When he left in the evening, it was reversed. He went home wearing his pueblo “hat.” Many Indigenous scientists have been able to compartmentalize the two knowledge systems in their own minds, as part of who they are. But it is with a full realization that the two systems are based on fundamentally different world views and can only be juxtaposed, not blended together into one system. This is similar to the juxtaposition of quantum physics and classical science, where one is based on senses and seen realities and the other on unseen but equally real probabilities.

The study of Indigenous ways of knowing the skies, or if we use the term ‘Indigenous Astronomy’ in the sense of the wider meaning, of knowing about the skies, is an area where both ways of knowing can enrich and inform the other. We all see the same skies over our heads, yet our interpretations of what we see is highly colored by our world views and thus becomes dissimilar. For millennia, humans have observed and venerated the stars, the Sun and the Moon. Ancient peoples were keen observers of the skies and astronomies were developed that included complex interdependencies and holistic ways of knowing.^{iv} People used this knowledge to sustain themselves, to hunt, to plant, and to build. Thousands of years of careful observation led to the creation of knowledge bases, founded on specific, place-based relationships between earth and sky. These ways of knowing were expressed and transmitted through oral (for the most part) and written (think of the Mayan glyphs) means. Whereas western civilization has placed tremendous emphasis on written materials housed in physical libraries and now in cyberspace, Indigenous peoples have put their confidence in oral knowledge transmission, such as story, prayer and songs that may have been unchanging for hundreds, even thousands, of years. The communication that is provided by song, by the vibration that occurs through sounds of the native language, is known to control weather, heal, and provide transformational change. Knowledge holders and ceremonial practitioners are often very strict

about how the songs are sung. In Navajo ceremony, it is said that a mistake can invalidate an entire ceremony. There is protocol that calls for correct words or sounds in a song, in the native language, such as *Dine Bizaad*, in which the very vibrations and energies that come forth can activate other ways of knowing, such as through the crystal or star.

I emphasize this process to make the point that oral knowledge transmission can be every bit as complex (using holistic native languages) and disciplined (certain things cannot be changed at whim) and validated, as the western process of knowledge transmission through the written (or cyber-ed) word. The current western practice of marginalizing Indigenous story and song into myth and fairytale discounts the solid and valid wisdom base on which the story and song are based.

Indigenous astronomy is firmly positioned in a world view of interconnection and interrelationship of all things. All things are living and animate in the universe. All things are living through movement, a cosmic movement, which Dine⁵ call *nanit’a*. There is a sense of reciprocal relationship, of stewardship and caring that permeates native astronomy. When one talks about Indigenous astronomy, one is talking holistically and discussing relationships between energies of earth and sky. The sense of relationship is expressed by terms such as Mother Earth and Father Sky, conferring a familial relationship of responsibilities and obligations, as well as an emotional feeling that one would have when one talks about mother or father. When Navajo people speak of the stars they will often use the phrase *sitsoi yoo*” roughly translated as “my ancient relation from whence I came.” This phrase acknowledges the star as a grandparent, one with knowledge that precedes our times, an entity that becomes a knowledge source to those who can activate the knowledge transmission. Today ceremonial practitioners talk of a consciousness that emanates from the stars, and a belief that we are made of the same components as the stars. One could say we are made of the stardust of the stars. How strikingly similar this is to the western belief that we are made of the same chemical components of the stars and that the light we see coming from the stars is ancient light, from thousands to millions of light years away. What we are actually seeing is the light that occurred in space millions of

years ago. We have no idea what the stars would look like in real time today.

Ancient peoples used their knowledge of stars, Sun and Moon to create architecture that is based on the patterns and cycles of the celestial entities. Western civilization has many of these monuments such as the great stones of Stonehenge in England. Meso-America contains countless Mayan, Aztec and other architectural monuments which are carefully aligned to the cycles of the stars, Sun and Moon. At the same time they are carefully aligned to ways of living in accordance with the patterns and cycles and provide markers for ceremonies and precise times to plant and harvest. The great pyramid of El Castillo at Chichen Itza in the Yucatan, Southern Mexico, is constructed so that the sunlight from the spring equinox illuminates the image of a rattlesnake descending the steps from top to bottom, to emerge in the mouth of the snake. This was a brilliant marker, uniting the deities of the Maya with physical building and celestial pattern. Other ancient Indigenous cities with celestially aligned architecture include the many buildings of Chaco Canyon, New Mexico, Teotihuacan, Mexico, and Palenque, Chiapas, Mexico.

But it is not just ancient peoples who carefully track the stars, sun and moon. Many living Indigenous societies follow their ancient knowledge in ways to live today. In the American Southwest, for example, the Pueblo, Hopi and Navajo still hold extensive, albeit guarded, star, Sun and Moon knowledge and use this knowledge for ceremonial and everyday life. Some tribal groups have lost much of their traditional knowledge and some still hold extensive knowledge. As mentioned earlier, there is a small but growing group of Indigenous astronomers, who are studying their own cultural and physical astronomy, though extensive use of their languages, and are articulating this knowledge in English. This work is being primarily carried out to educate the youth of the tribes, and secondarily to communicate among various tribes, and also, in many cases, to share with a non-Indian world, to the extent that it is permissible by the tribal communities. Vine Deloria, Jr., a respected and revered knowledge holder from the Standing Rock Souix Nation, admonished this generation of native scholars to publish their work. He said we needed to have our work available to other

native scholars, to be cited in other works and dissertations, to provide a knowledge base that will stand equal with western academia. One needs to look no further than the books by Greg Cajete, on Indigenous Science, to see the validity of DeLoria's remarks. Cajete's books^{vi} are widely quoted today and used in dissertation research, providing a much needed Indigenous perspective and articulation of the Indigenous world view.

Native languages are fundamentally different from Indo-European languages such as English, French, and Spanish. Native languages reflect a world view of motion, of process and relationship. They are languages of verbs, not static languages with noun dependencies. How well suited they are to discuss astronomical entities and how to live the cosmic orders. They are holistic. They can hold relational paradox and can be used in complex discussions of quantum theory. In the Navajo language one can talk about waves and particles as different and at the same time, similar, as many and at the same time one wholeness. The Navajo language is a quantum language and Navajo astronomy is a quantum astronomy.

I have worked with Dr. David Begay for many years, and it was his extensive knowledge of everyday and ceremonial Navajo language that enabled us to conduct much of our research. This often involved layers of translation. One example of our research process began with our study of early writings of Franciscan Fathers who came to convert the Navajo, learned the language and studied the culture. Father Berard Haile was one scholar-priest who left clues written in the old orthography, which we were able to use as a knowledge source of Navajo astronomy. I had to read the old Navajo orthography and then pronounce it in accordance with today's Navajo language. Dr. Begay had to translate what he heard from me, into the high ceremonial language that was being used, and from there into today's Navajo and then into a literal English and finally we finished with an English translation that could be understood today. This multi-layered research process led us to rich and little used resources that could only be interpreted with both of our skills and knowledge of languages.

What occurs in the sky is reflected on earth, and vice versa. This is widely known in tribal communities. The connectivity of plants,

animals, humans, stars, Sun and Moon is real and expressed through song, story, building, traveling, hunting, planting, and living. All these expressions are based on cosmic movement and cosmic order. There are acknowledged patterns and cycles that provide flexible structural frameworks for knowledge and knowledge transmission. For example in Navajo cosmology the east is considered as a place of beginning, a dawning of awareness of consciousness. The east is usually imaged as located at the top of a sandpainting, or a page, the location of north in western maps. The direction of the order for Navajo movement is most often sun-wise, beginning with the east. This is a true for the organization of songs, the organization of a traditional Navajo home, a hoghan, and the direction of movement (walking, passing items) within the hoghan.

Navajo cosmology expresses energies and things in pairs, in complementarities, somewhat similar to the Chinese concept of yin and yang. Constellations are spoken of and sung about in pairs, following a prescribed order and set of relationships. These pairs are fluxing and flexible and can transmutate and change in accordance with what is meant to be expressed. This makes perfect sense in Navajo but is confusing to those who speak only English and do not think holistically.

Even the cardinal directions follow the cosmic order and link earthly perceptions with celestial entities. For example the direction of the east is called *Ha'a'aaah*, or “where the Sun comes up” and continuing in a sun-wise pattern, south is called *Shadiaah*, or “as the Sun travels with and for me.” *Ee'e'ahh*, the direction of west is “where the Sun goes down” and *Nahookos*, the direction of the north, refers to the motion of the circumpolar stars as they rotate, while traveling around the North Star, Polaris, in a double motion.

Navajo relationships with the stars, Sun and Moon can be very personal. As we have seen, the relationship can be familial, such as “my grandfather.” It can also be my father, my mother, or some term that acknowledges relationship but is not exactly named. The Navajo constellations provide teaching, of ways to live in accordance with tribal values. The Nahookos constellations, containing the North Star, the Big Dipper, and Casseiopeia, in a

family relationship of mother and father (Nahookos Bika, Nahookos Bi'aad) around a central home fire (Nahookos Biko) teach of the values of family and home. Similarly the constellation Pleiades (Dilyehe) provides temporal guidance of when to plant corn on Navajoland, depending on when the Pleiades disappears from the western horizon in the pre-dawn and when it emerges again in the east. Again a very place-based knowledge that provides useful information to a society that traditionally moved around within a somewhat defined area.

Other more sedentary peoples such as Hopi, Zuni, and various Pueblos, would use the cycles of the Sun and Moon for planting guidance, utilizing age-old horizon markers and tying the Sun and Moon cycles to ceremony and planting. If you are wondering why all the emphasis on planting and hunting, try to visualize a way of life that did not contain convenience stores and mega grocery stores, where one can buy what one needs and can afford, at their convenience.

Navajo people could watch the tip of Scorpius (Altse Etsoh) called Rabbit Tracks (Gah Hahaatei) in Navajo language, to know that when it tipped on its side in early fall, they could begin to hunt deer, because little deer could then survive without their parents. Another constellation, which took us years to define and identify, is the Navajo Thunderbird, Ii'ni, which defies all western constructs and stretches across time and space to provide a clear connection between earth and sky. In the early fall the first feather (a bright star called Denebola, in the western constellation Leo the Lion) becomes visible on the eastern horizon at pre-dawn, a phenomenon known as a heliacal rise. The feather signifies the cosmic spiritual connection to the entire universe. As fall progresses into winter, more stars of the feather become visible, with one appearing each month on the eastern horizon. By mid-February, all six stars of the feather are visible and at that time the nose of a bear constellation (Sagittarius) is also visible on the southeast horizon. Navajos said that when you would see the last feather of Ii'ni and the nose of Shash, that the first sounds of spring thunder would ring out across the sky and lighting would illuminate the earth and sky. This marked the end of winter storytelling and the beginning of spring.

The vibrations of the thunder would reach deep into Mother Earth and wake up the sleeping bears, reptiles and plants. The connectivity of all things is so well illustrated in this observable event, linking animals, plants, humans, stars, weather, in a symphony of regeneration. The entire body of Ii'ni, or Pegasus, takes an additional few months to become fully manifest and stretches across the entire sky. This links time and space in a holistic manner, quite out of the confines of traditional western astronomy.

Other tribes have linked a sense of vibration to the coming of spring and emergence of new life. The Lakota, a Bison People, say that the "buffalo's thundering hooves awaken the plants in the springtime by vibrating the earth alerting the plants' root systems that it is time to begin allocating resources to their above-ground parts."^{vii}

Navajo people say something similar about the hooves of sheep. There is a kind of electricity that is sparked when they run over the ground in the early spring. The vibrations go deep into the earth, waking up the plants. The plants, in turn, communicate through a non-human consciousness to the clouds, and rain follows.^{viii}

In both cases, the hooves of the buffalo and the sheep break through the crust of the soil and enable rain water to refresh the soil, creating optimum conditions for plant growth.

There is a western constellation called Lacerta, which was originally conceived as a weasel by Johannes Hevelius, a Polish astronomer. Later he re-named it a lizard, and that is how it has come down to us through several hundred years. The Chinese used this constellation, Lacerta, as a seasonal marker, depicting the end of winter and coming of spring. They saw Lacerta as a serpent who was awaking at the end of winter, when its stars appeared in the south near midnight.^{ix} This is similar to the Navajo Thunderbird constellation, whose story includes snakes coming out of underground hibernation and heralding the coming of spring, thus unleashing seasonal energies and contributing to regeneration of all life.

As is evident in this story of the Thunderbird, there are complex interconnections of earth and sky in Indigenous astronomy. Knowledge of animal cycles, plant cycles,

meteorology, vibrational and electro-magnetic energies, are all necessary to understand the seasonal marker of the Thunderbird. Human behavior and survival are linked to this kind of knowing. This kind of knowledge is empowering for a community and leads to a sense of renewal and resilience. There is a sense of ethical time and space and a tie to everyday life. This kind of knowledge was lived. The cosmic order was not just an abstraction, it provided real guidance for real living, living the cosmic order.

Conclusion

In native communities, even today, there are protocols in place to enhance knowledge transmission. People are not given knowledge without a corresponding set of responsibilities. Knowledge is precious and valued as such. It is living and nourishing. Knowledge transmission is validated by the community. In our work we are often asked why we wish to acquire certain knowledge, and most often our answer is that we wish to educate our youth, so they will be able to know and to live by these traditional ways.

The Institute of American Indian Art as well as the many tribal colleges in the United States, have a unique situation whereby they could teach science utilizing a truly Indigenous pedagogy. Under the leadership of Steve Wall, a dialogue was held at IAIA in March 2007. All of the participants were energized to participate in this dialogue, which served as a beginning or foundation for the development of curriculum of an Indigenous science program taught in a holistic and inter-relational manner. Today the opportunity exists to deliver a curriculum that is representative of native ways of knowing, based on process and relationship. Questions of articulation would not be the driving force for the curriculum. Individual disciplines would not be the home for this kind of integrated knowing. It is my hope that this curriculum will come into existence at IAIA and other tribal colleges in the US.

Today, in 2020, some things have changed. There is more recognition of the value of Indigenous ways of knowing, in the scientific world of astronomy, and the Indigenous world including schools, in native communities who wish their students to become fluent in both ways of knowing. This bi-cultural world view is

based on acknowledgement of the strengths of both ways of knowing, a collaboration with integrity, as we say in the Indigenous Education Institute. This is most definitely not a blending of the two, it is the strength of each way of knowing standing proud and strong, coming together through interrelationships, use of allies, and valuing the diversity.

References

Throughout this paper I am using the word “Indigenous” to mean the acknowledged first inhabitants of North America. Other accepted designations include American Indian, Native America, People of the First Nations, Native Hawaiian, Alaska Natives. Most tribal people in the US prefer to use their own tribal names (preferably in their own tribal language.

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