HOW ACTS OF DISCOVERY TRANSFORM OUR TACIT KNOWING POWERS IN BOTH SCIENTIFIC AND RELIGIOUS INQUIRY

by Aaron Milavec

Abstract. In this essay I take Michael Polanyi's analysis of scientific discovery and extend it to encompass fresh encounters with the living God. Given the embodied character of all human knowing, Polanyi challenged objectivism and positivism as untenable. In its place, Polanyi noted that the tacit skills established when a physicist learns to detect radio waves has its counterpart in a Christian's being trained to find God. Once trained, stubborn organismic habits constrain both physicist and believer within a socially approved heuristic circle that can be broken only by the act of discovery. The puzzlement that erupts at the onset of an inquiry ultimately finds relief only in an expanded encounter with the realities that one has been trained to serve. Thus, the act of discovery not only serves to disrupt the tradition as it has been received but also reveals that the realities being served make themselves known in novel ways. The lifelong pursuit of God and the lifelong pursuit of novel manifestations of radio waves thus share a common epistemological and phenomenological underpinning.

Keywords: Augustine; Copernicus; development of dogma; discovery; embodied knowing; empiricism; epistemology; history of science; ontology; philosophy of science; Michael Polanyi; revelation; science and religion; tacit knowing; tacit knowledge; theory; verification.

Admittedly, religious conversion commits our whole person and changes our whole being in a way that an expansion of natural knowledge does not do. But once the dynamics of knowing are recognized as the dominant principle of knowledge, the difference appears only as one of degree. —Michael Polanyi (1958, 244)

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Michael Polanyi (d. 1976) challenged the claim of strict objectivism in science as misleading. After dismantling various prevailing accounts of the scientific method, Polanyi concluded that "a scientist can accept . . . the most inadequate and misleading formulation of his own scientific principles . . . because he automatically supplements it by his tacit knowledge of what science really is" (Polanyi 1958, 169). In the end, therefore, Polanyi arrived at the position that science itself is "a system of beliefs to which we are committed" (1958, 171) and that faith, authority, and tradition form the indispensable foundations for the conduct of every intellectual tradition, science included.

From this starting point, it becomes possible to envision the pursuit of religion and science as relying upon the selfsame human processes. The purpose of this essay is to explore how tacit powers of knowing, apprenticeships under the direction of trusted mentors, and pioneering feats of discovery might serve to define joint epistemological foundations for both the scientific and religious enterprise.

British Empiricism and Polanyi's Legitimating of Embodied Knowing

The empirical school of British philosophers took great delight in undermining the reliability of the senses. They did this under the mistaken conviction that physics and chemistry disclosed the absolute nature of reality. According to this norm, our bodily senses routinely deceived us by projecting human sensations onto the objects themselves. The vinegar is not "sour"; taste buds on the surface of the tongue simply register the presence of acidic materials with a sour sensation. The bottom of the well is not "black"; the absence of reflected light makes any object appear black.

Polanyi allows that all bodily perceptions are projections of interior states, but at the same time insists that such projections are spontaneous, necessary, and reliable. Already in *Personal Knowledge* (1958) Polanyi had devised the rule that all knowing relies upon the organismic integration of particulars into self-satisfying wholes. When preparing *The Tacit Dimension* (1966b), Polanyi went much farther toward explicating the repercussions of bodily indwelling. For our purposes here, the "semantic aspect" is most important:

> To see more clearly the separation of a meaning [as the integration of bodily clues] from that which has this meaning, we may take the example of the use of a probe to explore a cavern, or the way a blind man feels his way by tapping with a stick. . . . Anyone using a probe for the first time will feel its impact against his fingers and palm. But as we learn to use a probe, or to use a stick for feeling our way, our awareness of its impact upon our hand is transformed into a sense of its point touching the objects we are exploring. This is how an interpretative effort transposes meaningless feelings into meaningful ones, and places them at some distance from the original feeling. . . . (1966b, 12f.)

Polanyi selected the term "semantic aspect" because anyone hearing a message left on an answering machine appropriately projects the linguistic meaning arrived at (due to a bodily integration of the audio clues) onto the person whose voice is heard.

Because no two persons have identical tacit skills (Polanyi 1958, 95–102; Kuhn [1962] 1970, 191), no two persons ever hear precisely the same thing. The voice (and maybe the language as well) on my answering machine is unrecognized by a plumber who happens to overhear the recorded message. Alternately, I am amazed when my auto mechanic listens to my car's "sick" engine and immediately declares, "You have loss of compression in one of your cylinders." I also witnessed Seiji Ozawa rehearsing the San Francisco orchestra and suddenly stopping the piece in order to direct attention to an oboe player who came in late and played a B-natural instead of a B-flat. I had heard nothing of these things.

Messages left on an answering machine are usually clear enough. When it comes to the spontaneous meanings that emerge upon listening to a mythical story or a love poem, however, vast differences can show up, revealing how our assimilated cultural values, personal life experiences, and linguistic training tacitly shape each person's understanding.

Persons born blind who, following surgery, receive their sight for the first time do not see the world as we do (Polanyi 1958, 99). This was dramatically portrayed in the 1999 film *At First Sight*. Virgil, removing the bandages after his experimental operation, sees patches of moving colors that are confusing and fatiguing. He recognizes nothing, not even the one he loves! He has to touch things and people he already recognizes in order to painstakingly train his eyes to recognize them visually. A similar thing happens every time a newborn opens its eyes after birth, and this helps explain why infants require so much sleep: They suffer sheer fatigue at the sensory overload that as yet has so few integrated meanings.

Polanyi provides the means to overcome the mind-body impasse that has plagued philosophy ever since the time of Descartes. He does this by restoring faith in our bodies. Sensory and intellectual perceptions routinely rely upon the bodily enhancement of clues, the bodily integration of these clues, and the projecting of the consequent meaning-for-us into the locus where the clues originated. As long as we continue to be embodied spirits, we cannot know things *as they are for themselves*. We know all things *as they are for us*—that is, as conditioned by our historically and anthropomorphically conditioned skills that operate tacitly in every act of knowing.

Building upon this, Polanyi examines how scientific observations are theoretically informed. In so doing, he offers a solution to the impasse within the philosophy of science when it comes to deciding to what degree theories have a bearing upon the reality that exists independently of ourselves.

To approach the heuristic role of theories, Polanyi explores the familiar case of using maps. A scientist using a theory resembles a motorist using a

map. Road maps, like theories, can be properly understood only when they are in use. A skilled map reader consulting an appropriate map in order to navigate his car to a given address in an unfamiliar part of town is akin to a trained scientist making use of specialized theories for the adjustment of an electronic circuit or the design of an experimental apparatus. Both maps and theories are oriented toward human action; as a result, the correspondence between theoretical anticipations and practical consequences serves to accredit both the map and the map user at the same time. This helps explain why only trained scientists can properly use and test theories designed by other scientists.

Maps, like theories, have a limited scope of application. Each serves to integrate a preselected range of clues while overlooking other clues entirely. Thus, a truck driver hauling an extra-wide or an extra-high load needs a specialized map designed for his specialized need. Theories of chemical valence are very helpful in predetermining what substances might combine and in what proportions; yet, such theories are blind to melting points or to rates of reaction or to color changes. As a result, a scientist has to cultivate the skill of rightly selecting the "map" that fits the phenomenon under investigation.

The mental indwelling operative in the use of maps/theories is akin to the bodily indwelling that was explored earlier. My auto mechanic, hearing loss of compression in one of my car's cylinders while relying upon his tacit powers of hearing, then relies upon his trained theoretical understanding of how my car works to begin fixing it. My doctor relies upon his trained theoretical understanding of how my body works when he sets about to diagnose and fix it. The same can be said of a nuclear physicist designing an experiment to bombard gold foils with fast neutrons. At no point can any of his or her senses ever detect fast neutrons. In this regard, Albert Einstein was quite correct when he said to Werner Heisenberg: "Whether you can observe a thing or not depends on the theory which you use. It is the theory which decides what can be observed." Hence, from beginning to end the physicist relies upon his or her theoretically informed choice and use of appropriate instruments to extend the power of his or her senses. From beginning to end, the design, the adjustment, the execution, and the interpretation of the experiment are theoretically informed.

Tacit Powers of Knowing and the Experience of "God"

Unlike many other scientists, Polanyi regarded Christianity as having intellectual foundations and inherent worth. For someone without any religious formation, "God" often remains "an idea," "a projection," or even "a superstition" that others have but that has no relevance or importance "for me in my life."[1] After an adequate apprenticeship, however, the tacit powers of knowing and of judging are so transformed that "God" inevitably

and stubbornly shows up in expected and unexpected ways during the whole course of one's life. This is what persuades average Christians that "God is alive and well" and that their God meets them and addresses them in their joys and sorrows, their struggles and successes.

As a child, I did not find either "God" or "radio waves" in the corner of my playpen. One cannot lick or see or twist "radio waves" or "God." But then, in a surprising moment, my father turned my attention toward radio waves. When? As best as I can recall, we were driving across a bridge when all of a sudden the radio program I had been listening to went dead. Once off the bridge the program continued.

"What happened, Dad?"

My father explained how the steel bridge we had just passed over blocked the radio waves from being received by the antenna of our car. I was mystified by this new discovery. From that time forward, I knew that radio waves were to have an importance for me if I paid attention to them. And I did. Ten years later I would build an amateur radio station in the abandoned coal bin of my family home, erect an antenna, and send out radio waves that would allow me, in the wee hours of the morning, to communicate with amateurs around the world.

In my parents' home, hardly anything was ever said about God. On Sundays, however, when I turned five, my parents began to take me to church. As a child I had not the least sense of who God was or how s/he was to be found. I did notice, however, that my parents became mysteriously quiet as they entered the church. Others did the same. People spoke in hushed whispers. In this quiet space, something like the following exchange took place:

Aaron: "Hey, Papa, why is everyone so quiet?"

Dad: "Shhhhhh! People come here not to talk but to listen to God!"

Aaron: "But I don't hear anything."

Dad: "Look at that gold box [tabernacle] on the table [altar] at the front of the church."

Aaron: "Oh, it's shiny! I see it."

Dad: "God lives in that little box. The people come here to silently talk to God who lives there. And God silently talks to them."

This was my first introduction to "God." I realized that my parents sensed the presence of something or someone that I had hitherto overlooked. I was both puzzled and impressed. When I saw the earnest listening written on the faces of my parents as they faced the altar, I tried to join in. I strained to hear God so that I could participate in the act of worship that they enjoyed. After a few years, I developed the practice of silently speaking to "God," and I "heard" God wordlessly speaking back to me. The tacit skills exemplified by my parents and by my teachers had become my own. In fact, God became much more fascinating for me than God had been for my parents. It had been the same way with radio waves.

Yet, what if my parents had given birth to me in India and, during the confusion of an earthquake, their baby son had been separated from them and found and sheltered by Hindu parents who raised me as their own? In this case I would have witnessed my new parents placing fruit before the image of Lord Krishna each morning and reciting their pujas. Do you think that I would have admonished them for their idolatry and turned their faces toward Jesus Christ? Hardly. Given the bond between parents and their children, Hindu parents devoted to Lord Krishna would have discovered that their son would have assimilated for himself their devotion.

Once established, the tacit powers of knowing shaped by one's acritical childhood upbringing and by one's freely embraced apprenticeships shows up not only in the early formative years but also in the liminal experiences in the twilight years of one's life. Elisabeth Kübler-Ross and others have documented how, in the case of near-death experiences, Christians frequently meet someone "on the other side" whom they often identify as a lost loved one or even as "Jesus." When medical doctors chronicle such near-death experiences in India, they discover that their patients speak of meeting "Yamraj" (the Hindu god of the dead) or someone else standing in for him—with never a single instance of Jesus showing up (Pasricha and Stevenson 1986). This demonstrates that even in the extremities of life, when the brain is beginning to shut down due to lack of blood/oxygen, our tacit powers of recognition cultivated and cherished during life still are very much in control. This tends to confirm what Thomas Aquinas meant when he concluded that grace does not supplant or bypass nature; rather, as he was fond of saying, "Grace builds upon nature" (*Summa Theologiae*, I, 1, 8 ad 2).

Mastering a Tradition Requires Submission to a Master

As long as someone has only a superficial acquaintance with any given tradition, such a person cannot expect to plumb its depths or to be absorbed by its practice. In order to gain a mastery of a tradition one must begin by yielding to that spontaneous admiration and trust of someone who exemplifies the tradition one intends to master. The disciples of Jesus are spoken of in the Gospels as leaving behind family and occupation: they "followed him" (Mark 1:18, 20). This Jewish metaphor means more than going to a local pub for a drink. It means admiring him, staying close to him, watching him, listening to him—all with the prospect of entering wholeheartedly into his way of being and doing and valuing life with his God. This is what Polanyi would describe as an apprenticeship.

Every apprentice who would master an artistic or scientific tradition is required to contemplate reverentially and to reproduce painstakingly the classics for him- or herself. Thus, future violinists are apprenticed to per-

form the concertos of Mozart such that they might progressively assimilate for themselves the standards of performance and the aesthetic sensibilities that are shared by the living masters who take their stand within the charism offered by Mozart. Likewise, future physicists painstakingly reproduce the Millikan oil drop experiment such that they might develop the stubborn perception that the electrical charge is not continuous but increases or decreases in discrete jumps. At the end of an apprenticeship, the novice knows that he or she has arrived by the fact that the classics evoke the same habits of judgment and the same powers of performance that are exemplified by the masters of the tradition.

Within the Christian tradition, the sacred scriptures function much in the same way as do the classics in art, music, and science—they serve to evoke and to impose normative modes of feeling and of perception upon a widely dispersed (in place and in time) body of adherents (Dodd [1929] 1962, 21–29, 32; Milavec 1982, 249–52; Newman [1845] 1974, 75–79; Tracy 1981, 115f.). The Gospel narratives, in either oral or written form, have been used by masters as the preferred vehicle for transmitting the particular (denominationally specific) faith, hope, and strategy for living that follows upon their submission to Jesus of Nazareth. Novices are led by their masters to contemplate reverentially and to immerse themselves imaginatively into these narratives allowing themselves to produce the same habits of judgment and the same powers of performance exemplified by their living mentors.

Sometimes parents tell me that they do not want to burden their children by training them in a particular religion. They say, "When they are old enough to decide for themselves, they will choose." Other parents give their children a Bible and imagine that they will read it with profit and the Holy Spirit will guide them without any need of having a mentor. Polanyi would have agreed with St. Augustine in noting that these attitudes are shortsighted.[2] Augustine remarks that "every kind of scholastic discipline . . . demands a teacher or a master if it is to be acquired" (*De util. cred.* 17.35). With all the greater force, therefore, the "divine oracles" within the scriptures demand a master if they are "to refresh and to restore souls" (*De util. cred.* 6.13).

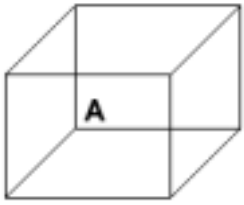
Scholars such as C. H. Dodd ([1929] 1962, 20f.) and Peter Stuhlmacher (1977, 60, 87–91) have noted that the Protestant refusal to shackle the intent and power of scripture within papal or dogmatic confines never meant that the text could properly function outside of the history of its effects and interpretation within a congregational tradition. Left to oneself, the uninitiated is as incapable of discovering the proper function of the sacred scriptures as would an inexperienced violinist left alone with the scores of Mozart. Under the guidance of a religious mentor, however, one can rightly come to "taste and see that the Lord is good [and how] happy are those who take refuge in him" (Psalm 34:8 NRSV).

For Polanyi, a master gradually transforms the knowing powers and habits of judgment of his or her understudies so that they can contemplate and interact with those transcendent realities that they must both serve. In this enterprise, there can be no coercion. Rather, the spontaneous admiration that began the apprenticeship must be sustained during the whole time of the training. Anyone who has a falling out with his or her mentor will stop learning and begin resisting the mentor's influence. Thus, Polanyi says with St. Augustine, "Unless you have faith, you cannot arrive at understanding" (Polanyi 1958, 267).

In Pentecostal and charismatic circles, new initiates are customarily offered an intense period of initiation directed toward enabling them to receive the gift of the Holy Spirit as manifested in the speaking in tongues (glossolalia). Once glossolalia has commenced and baptism by the Spirit is confirmed, it can be resumed with greater ease each successive occasion and finally give way to spontaneous and evocative prayers in plain language as well. Careful studies have shown, however, that those having a falling out with their mentor or pastor lose their ability to pray in tongues and, unless the breach is repaired, they leave their congregation with a sense of shame and disappointment (Kildahl 1972, 50, 79; Milavec 1982, 31–37). Faith in God, consequently, cannot be securely cultivated in the absence of faith, at least initially, in those persons who might lead one to God (Milavec 1982, 193–98).

How Present Intellectual Satisfaction Inhibits Pioneering Explorations

Once a given recognition is developed, it positively impedes an alternative. Polanyi called upon Gestalt experiments to illustrate this. For example, when the corners of two partially overlapping squares are joined with straight lines, bodily enhancement interprets the resulting design as that of a transparent cube. The letter *A* appears either on the forward or the rear surface or floating somewhere in between. Once one's habitual tacit skills fix the *A* in one position, it is very difficult to dislodge that perception; one must look away for a while or blink one's eyes in the hope of dislodging the first integration and arriving at an alternative.



While at a picnic, most people will continue to eat their food should they discover and remove an ant or a fly on their plate. Should they discover a cockroach, however, most Westerners would be unable to continue eating, for they would perceive the food as unclean the moment that a cockroach touched it. Usually no amount of rational persuasion would make a person change his judgment in this matter unless he or

she is half-starved and must satisfy his or her hunger. Here again, once a given pattern of recognition is established, it positively impedes every alternative.

The same holds in every field of science. Once the Ptolemaic Sun-centered system of the universe was established for more than a thousand years, for example, scientists habitually relied upon this theory-informed way of viewing the movements of the stars and planets to guide their observations. Within the system, it made perfect sense that the stars were made of ethereal matter and executed perfect circles around the earth, while rocks and baseballs, being made out of earthly matter, executed straight-line movements toward the center of the universe. At any given moment, someone in Ohio and someone in Beijing could discover where the center of the universe was by releasing a rock. In terms of local references, however, someone in Ohio would claim that the rock "fell down" while, at the same time, an observer in Beijing (who could see through the world) would claim that the rock "rose up." In terms of the Ptolemaic system, nonetheless, local references were deceiving; every rock released anywhere moved toward its "natural place," that is, toward the center of the earth that remained immovable at the center of the universe.

When Nicholaus Copernicus first claimed that the Sun was immovable at the center of the universe and that Earth moved in a circular orbit around it, one can understand why his hypothesis was immediately judged as experimentally absurd. Anyone releasing a rock knew full well that it did not go off in the direction of the Sun save in those instances when someone at the equator dropped a rock at midnight. The astronomers in the sixteenth century knew that the Ptolemaic system had held up for over a thousand years. They did not need the Bible to tell them that the earth stood still at the center of the universe. They needed only to release a stone at any time and any place to discover in what direction the stone moved as it followed a straight line toward the center of the universe. The hypothesis of Copernicus thus appeared to be patently absurd.[3]

Even in science it is important to recognize that once long-standing, theory-informed recognitions are accepted they become akin to scientific "dogmas" that function within the scientific community to positively impede the reception of every incompatible alternative.

Now that Copernicus has routinely been taught in science classrooms for more than two hundred years, it is commonplace to view those who resisted Copernicus as dogmatically closed to innovations and as unwilling to examine evidence for a system that seemed absurd. In truth, however, every working scientist trusts the tradition as it has been handed down as a buffer against idle imaginings and gross superstitions. No scientist, no matter how brilliant and how dedicated, could possibly expect to investigate firsthand even a thousandth part of what he or she routinely accepts and relies upon as the approved theory-ridden mode for understanding

the nature of heat, the nature of light, the nature of gases, and so forth. For every working scientist, the presumption is in favor of the tradition as it stands, because the history of the progress of science tacitly supposes that errors of judgment and contradictions with experience have been sought out and explored by hundreds of independent investigators dedicated to disproving false theories and improving true theories.

This is precisely where the community of astronomers found itself in 1543 when the massive volume of Copernicus was released from the press. Not only did Copernicus put forward a theory that contradicted common sense, it also contradicted many of the prevailing notions of celestial motions that had been derived from the theoretical and practical observations of Aristotle and routinely confirmed ever since. At the time of its publication and for more than three hundred years thereafter, not a single experiment could be put forward that demonstrated that the earth moved. For those who imagine that progress in science always follows upon new experimental evidence, the reception of the Copernican theory demonstrates that new theories in science often are accepted in advance of and independent of any new experiments.[4] In the case of Copernicus, only those astronomers who already had firmly accepted the truth of his system were even disposed to try to design a novel experiment that would demonstrate the superiority of his system. The design of critical experiments, it must be remembered, is the task of those anxious to change the minds of their colleagues. Those who stand for the status quo routinely rely upon the wealth of experimental evidence already collected by way of sustaining their commitment to the tradition as it has been handed down to them.

In the end, every apprenticeship is historically conditioned. Without human contact, a human would live out his or her entire life only marginally different from brute animals (Polanyi 1958, 69–71). Once one participates in a human community and is trained in its established ways of judging and of doing, however, tacit powers of recognition and theory-informed patterns of judgment take over and persistently sanction the tradition as it has been handed down. From this vantage point, every culture, every religion, and every science can appear as a system of both enlightenment and indoctrination. Prior to one's scientific training, one sees hardly anything of the scientific worldview; following one's training, one sees only what one has been indoctrinated to see. The same frequently has been said relative to religious training. For Polanyi, the very process for transmitting a tradition, whether it be scientific or religious, ensures that enlightenment and indoctrination go hand in hand. The more we are trained to perceive, enjoy, and act in traditional ways, the more we are blocked from their alternatives. This is what Polanyi refers to as the heuristic circularity of every enterprise—"our believing is conditioned at its source by our belonging" (1958, 322).

One may be tempted at this point to dismiss all intellectual endeavors as efforts to reinforce the particular groupthink to which one happens to belong. To counter the mental stupor that results when one is caught red-handed defending what one has been trained to uphold against its alternatives, Polanyi draws attention to the "sense of calling" that results when those committed to a tradition undertake pioneering efforts to make fresh contacts with the realities that they have been trained to serve (1958, 322f.). He thus establishes "the knowledge of an approaching discovery" as the paradigmatic phenomenon that enables the seeker to affirm his or her belief system as more than just an empty ideology or circular indoctrination:

> The pursuit of discovery is conducted from the start in these terms; all the time we are guided by sensing the presence of a hidden reality toward which our clues are pointing; and the discovery which terminates and satisfies this pursuit is still sustained by the same vision. It claims to have made contact with reality: a reality which, being real, may yet reveal itself to future eyes in an indefinite range of unexpected manifestations. (Polanyi 1966b, 24)

Polanyi arrives at the position that science itself is "a system of beliefs to which we are committed" (1958, 171). Being committed, however, does not mean that we are locked hopelessly within our self-chosen system of indoctrination, for our commitment itself is the necessary condition for pushing back the blinders on our eyes. "Commitment is in this sense the only path for approaching the universally valid" (1958, 303).

In brief, Polanyi surfaces the two dialogically interwoven aspects of human knowing: "dwelling in" and "breaking out." We arrive at dwelling within a system by submitting ourselves to an apprenticeship under the direction of its practitioners such that we may replicate in ourselves their powers of knowing, admiring, and doing. We arrive at breaking out by submitting to the demands and the adventure of discovery that guide us toward making fresh contacts with the realities that we have been trained to admire and to serve.

At this juncture, everything Polanyi says about the necessity of faith for all learning and about the resistance to change that follows an apprenticeship can be applied to Christianity just as it does to physics. When properly understood, the joy and the satisfaction of knowing the Lord can be assimilated only by submitting oneself to parents, mentors, and pastors capable of transmitting their skills to their understudies. Once trained, however, the life of a believer is anything but a dogged repetition of what went before; it is the lifelong adventure of following the Lord wherever he might lead. Polanyi was fond of finding within the religious system the dual movements of dwelling within and breaking out (1958, 281–85). Because of his impoverished religious training, however, he failed to note that religious inquiry alters what it is that God would have us be and do.[5] Thus, what Polanyi said regarding "the knowledge of an approaching discovery" can be put forward as the paradigmatic phenomenon enabling the

religious seeker to affirm his or her conviction that s/he has encountered the living God and not some mummified abstraction of historical theology. The paradigmatic importance of an approaching scientific discovery could thus be reformulated in religious terms to disclose the key importance that Polanyi failed to assign to religious discovery:

> The pursuit of religious discovery is conducted from the start in these terms—"Seek the Lord while he may be found, call upon him while he is near" (Isa 55:6). Thus, all the time we are guided by sensing his hidden presence toward which our whole lives are pointing; and the eruption of God which terminates and satisfies this pursuit is still sustained by the same vision —"Today, if you hear his voice, do not harden your hearts" (Heb 3:8). It claims to have made contact with him: a reality which, being real, may yet reveal itself to future eyes in an indefinite range of unexpected manifestations. (Polanyi 1966b, 24 revised)

Thus, in tandem to what has already been said about science, we can now assert that the propositions of religion cannot be either properly understood or verified independent of commitment within the system itself. By making fresh contacts with the Lord, however, a Christian's training is freed from being an empty indoctrination, for it anticipates a lifelong series of fresh discoveries that function to purify and to enlarge those very commitments that originally set one on the course of discovering the Lord.

How Intellectual Passions Function when Making a Fresh Discovery

By examining the dynamics undergirding revolutions in the history of science, Polanyi finds that he can correct misleading notions of science. The so-called facts of science are not naked and self-evident observations but rather theory-laden events that are conditioned by our acquired habits of thinking, judging, and doing. The rules for conducting scientific research can never be exhaustively formulated or adequately understood by someone who has not assimilated them through an intensive apprenticeship and a prolonged immersion within a problematic situation.

At the time of Copernicus, for example, everyone acknowledged that something was wrong with the Julian calendar, because the leafing of trees in the spring and the associated spring planting occurred at a later date than ten, thirty, or fifty years ago. No one could decide, however, whether the Julian calendar was five or twenty-five days out of sync with the Sun cycle. Nor could anyone decide the exact length of the solar year such that a calendar could be designed that would not have to be corrected in a hundred or a hundred thousand years. When this problem was laid at the feet of the experts, the astronomers, they admitted that the Ptolemaic system failed to provide an accurate assessment of the solar year such that the Julian calendar of 365-1/4 days could be corrected. What was to be done?

Copernicus spent years trying to adjust the size of the orbits and the epicycles of the Ptolemaic system so as to get a better fit with the astro-

nomical data at hand. This produced some marginal results, but not enough to recalculate the length of the solar year. Then, taking note that Venus and Mercury never strayed beyond certain well-defined limits from the Sun, Copernicus recalculated the orbits of these planets when their axis of rotation was transposed to the Sun. A minor yet decisive improvement was achieved. At this point, let it be noted, Earth was still at the immovable center of the solar system where Aristotle and the Bible said it should be; Copernicus had as yet done nothing to disturb the evidence of our senses respecting rocks moving toward the center of the universe. But then, in the hope of furthering his perfecting of the Ptolemaic system, Copernicus decided to try placing Earth and the three outer planets rotating around the Sun along with Mercury and Venus. Eureka!

By fudging with epicycles,[6] Copernicus was able to modestly reduce the margin of error all around. More important, by using a solar axis, Copernicus was the first to discover that the planets exhibited a distinct ordering principle, namely, that the time required for a planet to make a complete orbit around the Sun depended upon the planet's distance from the Sun. To achieve this gain, Copernicus was painfully aware that he had to dislodge Earth from the center of the universe and treat it as though it were one of the planets orbiting around the Sun. This, he well knew, would be laughed at by even the common people, because they all were persuaded that the stillness of the air on a lazy summer morning was entirely incompatible with the idea that Earth was hurtling around the Sun at nearly 4,000 miles per hour in order to make its annual circuit.[7] In 1543, despite the fact that Copernicus still had no compelling way of explaining why rocks moved toward the center of the earth even though it was no longer at the center of the universe, he permitted Andreas Osiander to publish his work with an apologetic preface calculated to placate philosophers and theologians. Legend has it that Copernicus held his newly published volume as he lay dying in his bed.

Whereas Polanyi focuses on the series of progressive discoveries that enabled Copernicus to rework the Ptolemaic system he had inherited, Thomas Kuhn ([1962] 1970) focuses on the importance of social dissatisfaction with the reigning paradigm as the necessary impulse that enabled the scientific community to look for and to entertain alternatives. In Kuhn's view, dissatisfaction with the Ptolemaic system must reach "crisis" proportions before allegiance to the reigning paradigm could be shaken. Even a community in crisis, however, could not harmoniously embrace the alternative system of Copernicus, because the new system offered a masterful computation of the solar year at the expense of abandoning the long-standing conviction that the earth stood immobile at the center of the universe. As a consequence, there was a split between those who stubbornly continued to believe that an adequate solution would yet be forthcoming *within* the old system and those who committed themselves to improving and

demonstrating the merits of the new system proposed by Copernicus. The two sides embraced incompatible commitments, so there was no neutral ground, no appeal to common sense, and no experimental evidence that could persuade those who perceived the reality of things from the other side.

Kuhn correctly notes that the choice between incompatible theories cannot be determined merely by appeals to evaluative procedures since every set of evaluative procedures depends in part upon a particular paradigm, and the validity of that paradigm was at the heart of the issue. When paradigms enter, as they must, into a debate about paradigm choice, their role is necessarily circular. Each group uses its own paradigm to argue in that paradigm's defense (Kuhn [1962] 1970, 94).

When it comes to competing paradigms, Kuhn suggests that each astronomer makes his choice on grounds that are "ultimately personal and subjective; some sort of mystical experience is responsible for the decision actually reached" (p. 199). Kuhn's use of "subjective" and his appeal to "mystical experience" in this context tends to obfuscate the discovery process. Furthermore, given Kuhn's conviction that "there is no neutral algorithm for theory-choice" (p. 200), Kuhn ends up by insisting that one must wait for the verdict of history to reveal which side of the debate wins out over its contender.

Kuhn is most unsatisfactory at this point. Polanyi, for his part, was keenly aware that even in science ideological concerns and powerful personalities can misdirect the verdict of history. Hence, Polanyi explored what Kuhn pejoratively described as "some sort of mystical experience"—namely, the process whereby an explorer entrusts him/herself to intuitions that guide him or her from beginning to end. Just as faith in one's admired mentors formerly led the novice to discover the depths of the tradition to which he or she is committed, now it is faith in "the gradient of deepening coherence" (Polanyi 1966a, 88) that must be yielded to if the pioneer is to find his or her way progressively toward making fresh contacts with those hidden realities that stimulated the investigation in the first place.

I do not give a detailed description of the discovery process here—only a brief outline. Polanyi notes that intellectual passions function spontaneously and necessarily at various critical points in the discovery process:

1. Initially, pioneering scientists yield to the lure of a particular problem that attracts them, deliberately allowing the problem to consume them over an extended period of time. Such straining for a solution has a kinship with trying to remember a forgotten name.

2. The pursuit of discovery entails selecting investigative procedures and designing thought experiments. These choices are based on practical intuitions that necessarily guide the investigation at every step. In the absence of guiding intuitions, an investigator would be reduced to blindly trying everything and would exhaust his or her energies in trivialities and dead ends.

3. Approaching a solution is registered by sensing a growing coherence. The intellectual satisfaction that erupts at the recognition of the final solution relieves the strains that have been deliberately maintained during the quest and ushers in the "Eureka!" experience. At this point, the investigator cannot enter into the problem without feeling the satisfaction that his solution provides.

4. Following the publication of a solution, pioneering scientists inherently trust that their colleagues will come to discover the same satisfaction that they have found. For a time, however, it may divide the community. Meanwhile, the intellectual satisfaction attached to the new system enables those who have accepted it to resist criticism and to passionately promote their new understanding (Polanyi 1958, 150–74).

5. Because a pioneering discovery claims to have made contact with an aspect of reality that exists independent of our knowing powers, the expectation is that it will "manifest its truth inexhaustibly and often surprisingly in the future" (Polanyi 1966b, 69). As a result, it can be upheld with universal intent and relied upon to make further discoveries.

Thus, setting aside the ideal of detached objectivity, Polanyi maintains that the intellectual passions that undergird every act of discovery are personal without being subjective and are reliable without being infallible (Polanyi 1958, 171–73). Just as Polanyi overcomes the philosophical mind-body impasse when it comes to the reliability of bodily knowing, so too he exposes the mistaken ideals of detachment and of logical positivism that disguise from ourselves the reliability of our personal intellectual passions guiding us in the quest for truth.

Polanyi appealed to the intellectual passions by way of acknowledging how a pioneering investigator could progressively leave behind an old system and become passionately attached to a new one. Polanyi knew that pioneering scientists did not merely cultivate a detached attitude and doggedly follow a predefined set of research rules to arrive at a new discovery. Furthermore, he used the history of science to illustrate that an old system never gets dropped the moment it encounters experimental data that seem to refute it.[8] Rather, for Polanyi, the conversion experience that results from having made a fresh contact with reality stays with the pioneering discoverer and his or her allies and persuades them that they eventually will find compelling arguments and/or experiments to persuade those who currently resist them.

The History of Physics and the Development of Doctrine

When one examines the history of physics, one discovers that (1) in the course of history the community has changed its judgment many times, and, (2) with each change in judgment, earlier theoretical notions were either abandoned or revised.[9] Major shifts do not happen too often. The

fact that they do happen testifies to the dedication of its members to the pursuit of truth that goes beyond mere conformity to the current groupthink or to the banal preservation of the tradition as it has been handed down.

In contrast to modern science, Christianity often has been characterized as committed to the mere repetition and preservation of a onetime discovery about God revealed through Jesus. When one examines the history of Christianity, however, one discovers how beliefs and judgments upheld by orthodox communities have shifted over time. All deeply committed Christians can relate their own personal history of periodic encounters with the living God that have reshaped their image of God and given new direction to their lives. Yet, the curious fact that fresh encounters frequently emerge from the depths of contemplation of the sacred scriptures gives the impression that, since the classical sources remain the same, nothing has changed. Because the sacred scriptures themselves point to how God's revelation changes in accordance with different times and places, it would be self-contradictory to imagine that God's self-revelation is always and everywhere the same. So, too, the doctrine of the immutability of God or of the closure of revelation with the death of the last apostle sometimes has served to enforce the notion that the content of faith never changes and that God always appears the same. Yet, one has only to examine the opening chapters of John Henry Newman's classical work *An Essay on the Development of Christian Doctrine* ([1845] 1974) or read Karen Armstrong's *A History of God* (1993) to discover how persons and communities oriented toward God have been shaped and reshaped by fresh encounters with the living God.

The changing of the Christian tradition finds ample testimony already within New Testament books. In every chapter of Acts, for example, one finds evidence of this. Sometimes the changes are small, as in the case of drawing straws to replace Judas. More significant is the practice of the early community meeting daily in the courtyards of the Temple. Then, Stephen emerges saying that "the Most High does not dwell in houses made with human hands" (Acts 7:48 NRSV). By the tenth chapter of Acts, bold new revelations are being put forward. Near the opening of that chapter, Peter is praying before lunch and is carried away into imagining a sheet with a mixture of living animals and the command "Kill and eat." Peter refuses three times saying, "By no means, Lord; for I have never eaten anything that is profane or unclean" (Acts 10:14). Then, by mid-chapter, he says to Cornelius, "You yourselves know that it is unlawful for a Jew to associate with or to visit a Gentile; but God has shown me that I should not call anyone profane or unclean" (10:29). Two hours later, Peter asks his companions, "Can anyone withhold the water for baptizing these people who have received the Holy Spirit just as we have?" (10:48) Once the first Gentiles are baptized, Peter returns home, and one might expect that he would get a hero's welcome. But no—he gets rebuked: "Why did you go

to uncircumcised men and eat with them?" (11:3) In effect, these Christians are just where Peter found himself when his noonday prayer was interrupted. Being true to their faith, they confront Peter to his face. Peter, of course, could pull rank and say "I teach you; you don't teach me." If he did, however, he would slip into authoritarianism. Being a wise pastor aware that his faith has shifted, Peter narrates to them in detail his whole history: "Then Peter began to explain it to them, step by step" (11:4). The expectation, of course, is that by evoking the details of his own conversion Peter will draw others to follow him saying, "If this had happened to me, I would have done the same."

Luke does not tell us how successful Peter was. Needless to say, if he had not been partially successful, he would immediately have been ostracized as someone who had betrayed the Lord. On the other hand, we know that he was not entirely successful, for he has to retell his conversion experience in Acts 15. All in all, Polanyi allows us to notice how fresh encounters with the living God often divide communities and that open persuasion frequently fails to heal this divide because different intellectual passions are being affirmed with universal intent on both sides.

The course of Christian history is shot through with similar encounters. Take the case of Martin Luther. As a young monk, Luther was plagued with a sense of his utter sinfulness and overwhelmed by the certainty of the righteous judgment of God. "I can praise God," he would say, "but can he not smell my fear?" After a prolonged period of anguish, Luther finally abandoned all his fasting, all his confessions of sins, all his studious efforts to save his soul, and let go. In letting go, he finally fell into the hands of the living God. Following what has come to be known as his tower experience, Luther went on to write and preach based on the intellectual passions that flooded from his fresh understanding of what it means to live by faith. This divided the church of Luther's day—and continues to divide the churches today.

In my own life, I have known parallel experiences. It happens about every ten years. Everything is going smoothly when, suddenly, I am thrown off my horse. I doubt the worth of nearly everything I have come to be and to do in the name of God, and I surrender to God who knows me better than I know myself. The years following are spent integrating under God's guiding hand what I have freshly discovered. With Newman I can say "To live is to change, and to be perfect is to have changed often" ([1845] 1974, 100). Every mature Christian will understand what I am saying and be able to identify their own string of encounters with the living God.

The discovery process itself stands as a sober witness that a rigorous and prolonged initiation into physics or Christianity does not function as an impervious indoctrination that renders one's knowing powers immune from discovering anything new. On the contrary, the fact that physicists and Christians do change their minds and do accept what they themselves did

not discover shows that their communities have developed the practical art of tempering the enforcement of conformity with the inducement to dissent. Polanyi says:

> The discoveries of science have been achieved by the passionately sustained efforts of succeeding generations of great men who overwhelmed the whole of modern humanity by the power of their convictions. Thus has our scientific outlook been molded. . . . Science will appear then as a vast system of beliefs, deeply rooted in our history and cultivated today by a specially organized part of our society. . . . Such a system cannot be accounted for either from experience as seen within a different system or by reason without any [concomitant] experience. Yet this does not signify that we are free to take it or leave it, but simply reflects the fact that it is a system of beliefs to which we are committed and which therefore cannot be represented in non-committed terms. (Polanyi 1958, 171)

This, of course, could be paraphrased to apply to the Christian enterprise: Fresh encounters with God have been achieved by the passionately sustained efforts of succeeding generations of holy men [and women] who overwhelmed the whole of modern believers by the power of their convictions (Hebrews 1:1–2). Thus has our religious outlook been molded. Christianity will appear then as a vast system of beliefs, deeply rooted in our history and cultivated today by a specially organized part of our society. Such a religious orientation cannot be accounted for either from experience as seen within a different system or by reason without any concomitant experience. Yet this does not signify that we are free to take it or leave it, but simply reflects the fact that it is the system of beliefs to which we are committed and can only be affirmed as did Peter: "We must obey God rather than any human authority" (Acts 5:29) and as did Martin Luther: "Here I stand. I cannot do otherwise."

The Verification of Novel Discoveries in Science and in Religion

Faced with the distrust of both the bodily powers of knowing and of settled authority as a guide to knowing, the Enlightenment endeavored to set up an ideal of knowing that bypassed bodily processes and appeals to authority. Objectivism in science takes many forms. So does Fundamentalism in religion. Objectivism in science purports to show that science has a sure foundation because scientists accept a new theory only to the degree that it has been confirmed by experimental testing. Fundamentalism in religion generally takes the form of securing the foundations of Christianity by demonstrating that the rites and beliefs of a given community conform to what has been divinely approved in the New Testament. Both of these expressions are misleading precisely because they endeavor "to relieve us from all responsibility for the holding of our beliefs" (Polanyi 1958, 323).

Allies of Copernicus committed themselves to his theory for more than two hundred years despite (a) the absence of any new experimental verifi-

cation and (b) the commonsense experience that the earth was motionless. Quakers came to the realization that slavery was an abomination in the late eighteenth century despite (a) the absence of any such declaration in the scriptures and (b) the many scriptural texts that seem to sanction slavery. Sometimes a new scientific discovery can prompt the acceptance of a new theory, just as the experience of Quakers prompted them to oppose slavery in the name of God. Even in these instances, however, what constitutes a suitable theory or acceptable evidence always relies upon the paradigm being used. "Verification and falsification are both *formally indeterminate* procedures" (Polanyi 1966a, 85). Polanyi, accordingly, vigorously objects to objectivism and positivism in all its forms because it removes bodily knowing, human responsibility, and the phenomenology of discovery from the process whereby truth is known in the first place and, once known, how it may be revised or disproved.

> I shall go on, therefore, to repeat my fundamental belief that, in spite of the hazards involved, I am called upon to search for the truth and state my findings. To accept commitment as the framework within which we may believe something to be true, is to circumscribe the hazards of belief. It is to establish the conception of competence that authorizes a fiduciary choice made and timed, to the best of the acting person's ability, as a deliberate and a necessary choice. The paradox of self-set standards is eliminated, for in a competent mental act the agent does not do as he pleases, but compels himself forcibly to act as he believes he must. He can do no more, and he would evade his calling to do less. (Polanyi 1958, 315)

For Polanyi, the sense of personal calling that grips the soul of a research scientist is not just an empty metaphor, for the pursuit of discovery always begins when a seeker yields to an unaccountable sense that something is not quite right, that something needs looking into, and that he or she is positively drawn to surrender a large portion of his or her life energies to go where no one has gone before. Without surrendering to and intensifying such intellectual intuitions, nothing can ever be discovered.

Conclusion

Admittedly, the pursuit of what God would have us be and do does not take place within the context of controlled laboratory experiments. Nonetheless, in this essay I have endeavored to extend Polanyi's analysis of key aspects of the scientific enterprise that find fitting counterparts in the religious enterprise. In both domains, one can give deliberate attention to (a) how tacit powers undergird every act of knowing, (b) how apprenticeships inform such tacit powers of knowing under the direction of trusted mentors, and (c) how the phenomenology of discovery enables adherents of a tradition to transform their tradition while being entirely committed to it. If the progress of science can be said to depend on reason, one must also say that it likewise depends on a cultivated faith that leads to revelatory

discoveries. If the progress of religion can be said to depend on grace, one must also say that it likewise depends on tacit human powers of knowing that are shaped within the historic fabric of ongoing discipleships and sustained prophetic inquiries.

In many circles, scientific affirmations are still considered to be strictly impersonal and therefore deemed reliable, whereas religious affirmations are automatically denigrated as being personal in the sense of being inherently unreliable. One can even suppose that misleading notions of objectivism in science were quite influential in reinforcing defective notions of religion. In effect, therefore, by pioneering a more accurate notion of how science progresses, Polanyi inadvertently has paved the way for arriving at a corrected notion of how religion progresses. The physicist and the Christian, consequently, need no longer be complete epistemological strangers seeking different truths by distinctively different methods. Rather, they seek different things using remarkably similar human methods. As such, a new level of dialogue is ready to begin.

NOTES

Portions of this essay are drawn from public lectures presented at Claremont Graduate School (12 January 2004) and Azusa Pacific University (14 January 2004). See *www.didache.info*.

1. Polanyi examines, for example, how intelligent members of the Azande tribe of Africa have been quite capable of refuting the persistent attempts by Europeans to discredit the oracular powers associated with their witchcraft (1958, 287–92). The Azande have the cultural background that enables them to take notice of witchcraft. The Europeans, meanwhile, lack the requisite theory-informed experiences and are forced to conclude that Azande witchcraft is merely superstitious mumbo-jumbo.

2. Polanyi reinforces the imprint of early learning (primary socialization) by reminding us what happens to human children who get lost or are abandoned in the wild and after many years are found. Two girls raised by wolves in a remote part of Japan, for example, were found when they were five and seven years old. During the nine years that these girls subsequently lived in a home, they were never able to acclimate themselves to eating with chopsticks or to understand or speak Japanese. Until their deaths they took food directly with their teeth and howled at three regular intervals every night just as the wolves who raised them did. Japanese culture surrounded them, but they were unable to enter in.

3. Using the Aristotelian physics popular in the day, the Copernican system would have implied that a rock released on Earth would have gone flying off toward the Sun (which was now understood to be at the center of the universe) the moment that it was released. Because this did not happen, Copernicus was forced to admit that all astronomers had been misled by Aristotle. Copernicus instead theorized that "gravity is nothing else than a certain natural appetition given to the parts of the earth by divine providence . . . in order that they may be restored to their unity and to their integrity by reuniting in the shape of a sphere" (*De revolutionibus* 1.9). In so doing, Copernicus imagined that rocks fell to the earth in order to conform to a spherical shape in the same way that dew drops naturally reconstitute their spherical shape when disturbed. He was later proved wrong in this surmise; however, this only shows that Copernicus felt the intellectual need to present some alternative to Aristotle's doctrine of "natural place" if his new doctrine was to be given any hearing at all.

4. Electricity, for example, was first thought to be static and to have two distinct varieties. Then, with the discovery of the battery, it was necessary to think of an "electrical fluid" that "flows" in metal conductors. Benjamin Franklin persuasively argued that instead of two kinds of electricity there was, in effect, only one kind and that it flowed in wires from the positive pole (which had a surplus of electrical fluid) to the negative pole (which had a deficiency). Later, thanks to the efforts of Robert Millikan and others, the electron was isolated, giving rise

to the conclusion that electricity came in discrete bundles of negative charges that moved within conductors from the negative to the positive pole of batteries. With subsequent explorations, the bundles of negative charges were associated with a discrete particle that had a mass, a spin, and an angular momentum. In each of these steps, the nature of electricity revealed itself in new and unique ways to researchers dedicated to progressively revealing the mysterious aspects of electrical events that were open to them.

5. I am not the first person to note that Polanyi himself was hampered by his own ill-informed and marginal participation in both Judaism (the nominal religion of his parents) and Christianity (the religion of his hero, Dostoevsky, and the nominal religion of his later years) (*Convivium* 22:4–14). Consequently, I believe that the current efforts to dissect Polanyi 's writings in order to find confirmation for this or that epistemological position respecting religious knowing are bound to be haphazard and unsatisfying. It is futile to expect that Polanyi would provide us with a masterful synthesis in a domain in which he was not a master. In this essay, accordingly, I use, interpret, and supplement Polanyi in ways suggested to me by virtue of my twin apprenticeships in science and theology.

Beginning as far back as the 1979 annual meeting of the Polanyi Society, a vigorous debate erupted among those who knew and worked with Polanyi as to how to understand his epistemology of religion. This debate continues vigorously to this day. Richard Gelwick and Harry Prosch, two men who enjoyed extended exchanges with Polanyi, offer significantly divergent impressions of how Polanyi regarded the ontological status of religious realities. R. T. Allen summarizes their views as follows: "What Gelwick gives us is a 'maximalist' interpretation of Polanyi's writings which has him definitely affirming the reality of God, whereas Prosch gives us a 'minimalist' account in which the reality of God is not affirmed, outside of purely imaginative integrations" (*Convivium* 17:28). More recent issues of *Tradition & Discovery* have been nearly entirely devoted to this single issue (see *TAD* 26/3 and 27/2).

6. Neither Ptolemy nor Copernicus had the vaguest idea that the planets followed a slightly elliptical path. Kepler, working some two generations later, was the first to discover and plot elliptical orbits. In the case of Ptolemy and Copernicus, epicycles had to be used on the rims of the large planetary cycles in order to devise a system for how circular movement at a constant rate (as Aristotelian physics required) could be used to situate the planets where the star charts showed them to be.

7. The velocity of the earth around the Sun is here given using the computations that Copernicus would have made. Copernicus (d. 1543) accepted Ptolemy's calculation that the earth was eight million kilometers from the Sun. No one had any reason to quibble with this figure until the time of Halley (d. 1742), when the transit of Venus was used to determine that the distance of the earth from the Sun was something like twenty times what Copernicus and Ptolemy had surmised. In any case, traveling at 40 miles per hour would have been enough to create winds; 4,000 mph would have been expected to create gale-force winds.

8. The notable philosopher of science Ian G. Barbour wrongly claims that "by the [early] seventeenth century Copernican astronomy was widely accepted [because] the scientific evidence was by then indisputable" (2000, 45). The so-called "indisputable" scientific evidence only came in the mid-eighteenth century with the first measurement of stellar parallax by Friedrich Bessel in 1838 and the first experimental detection of the earth's rotation by Leon Foucault in 1851. These experimental confirmations of Copernicus's theory came precisely because, for three hundred years, many astronomers had spent years seeking such experimental evidence in order to confirm the commitments that they had already made on other than experimental grounds.

Polanyi allows that experimental verification plays a role in science; yet, he is a sharp critic of those who continue to imagine that nothing is accepted by scientists unless it has a prior experimental verification. According to Polanyi, "Objectivism seeks to relieve us from all responsibility for the holding of our beliefs. That is why it can be logically expanded to systems of thought in which the responsibility of the human person is eliminated from the life and society of man" (Polanyi 1958, 323).

9. Copernicus's theory was accepted, for example, even though astronomers were unable to detect stellar parallax. Given the fact that Copernicus fixed the earth as 4,000 miles from the Sun, every six months the field of equatorial stars viewed from the spaceship Earth would be either 8,000 miles closer or farther away. The absence of stellar parallax tended to confirm the position of the earth as immovable at the center of the field of stars. Those who accepted

Copernicus's theory, however, wanted to believe that stellar parallax was too small to be measured with then-current methods. It was not until 1838, nearly three hundred years after Copernicus's theory was published, that Bessel first measured stellar parallax.

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