Transcript of "Religion and the Copernican Revolution", talk given by Todd Timberlake at Berry College on March 25, 2009.

I am not an astronomer, a theologian, nor a historian, so I need to start by explaining why I am up here talking about astronomy and religion in the 16th and 17th centuries. A year ago I began teaching a course on the Copernican Revolution (the transformation from a system of astronomy with the earth at the center to one in which the earth is just another planet orbiting the central sun). This course was actually developed by Paul Wallace, who spoke here a few weeks ago on "Positive Science and Negative Theology" and I want to briefly digress to something Paul mentioned in his talk. He discussed four possible relationships between science and religion, categories that were originally proposed by Ian Barbour in his Gifford Lectures. The categories are:

- conflict: science and religion are naturally opposed to each other,
- independence: science and religion deal with completely separate worlds and are irrelevant to each other,
- dialogue: science and religion deal with the same reality, but in very different ways, so perhaps they can inform each other,
- integration: science and religion deal with the same reality in largely the same way and must match up perfectly.

Now I had always heard of the Copernican revolution as an example of the inherent conflict between science and religion. But my studies revealed a different story. Because many of my students are religious (mostly Christian) I felt it was especially important for me to present a fair evaluation of the interaction of science and religion in the Copernican Revolution. So for the past year or so I have been studying the historical scholarship on this topic. I want to make it clear that this talk is not an original work of historical scholarship

(I am not a historian). All I have done is to try to synthesize the work of others for the purpose of teaching.

Before we get to Copernicus himself we have to lay a little groundwork. Prior to Copernicus astronomy was dominated by the ideas of two men: Aristotle and Claudius Ptolemy. Aristotle laid out a cosmology in which everything had its proper place. The entire universe was a great big sphere with the earth at the center and the stars at (or near) the outer edge. Between these boundaries each planet (which for the ancients included the moon and sun) had its own earth-centered sphere. Outside the outermost sphere was NOTHING (I mean nothing). Below the sphere of the moon things were made of four elements: earth, air, fire, and water. From the moon out everything was made of a fifth element that was perfect and unchangeable. Each region had its own natural motion: below the moon natural motion was in a straight line toward the center (for heavy things) or away (for light things), in the heavens things moved in circles around the center. Aristotle's cosmology was partially adopted by Medieval Christians, but some changes were made. For example, the region outside the outermost sphere became the abode of God (and the angels, saints, etc.). The devil was placed at the center of the earth (this system is sometimes called geocentric, but might be more properly called diabolocentric). This was the general picture of the universe that was accepted in Copernicus' day. [shown here in a diagram from Apian's *Cosmographica*]

Aristotle's cosmology was great, but it couldn't be used to predict the motions of the planets relative to the stars. For that a separate (and to some extent incompatible) system was developed. This system reached its highest form in the *Almagest* of Claudius Ptolemy. The most pertinent features of Ptolemy's system are shown in this animation. Ptolemy placed the earth at the center of the universe. Each planet moved along a small circle called an epicycle. The center of this circle moved along a larger circle called a deferent which was centered near earth. Ptolemy's system did a reasonably good job of matching the observed motion of the planets and it stayed in use for over 1400 years. In 1543 Nicholas Copernicus

published *De Revolutionibus orbium coelestium*, in which he laid out a very different system. In Copernicus' system the earth was now one of the planets. It and the other planets orbited the sun. This system proved as capable as Ptolemy's (though not more capable) but it had some serious obstacles to overcome.

For one thing Copernicus' idea caused lots of conflict with the natural philosophy (or what we would now call physics) of his day. The rotational and orbital motion of earth didn't fit into Aristotle's picture of natural motions in the sublunary sphere. The whole idea of the sublunary sphere was disrupted by the motion of the earth (and with it the moon) around the sun. In Aristotle's physics any motion required a force to produce it - but what force could push the heavy earth around? And why didn't we all fall over as the earth moved out from under our feet? There were astronomical problems as well. If the earth moves around the sun we should see the stars shift relative to each other, but no such shift was seen. This either meant the earth didn't move, or that the stars were VASTLY farther away than was previously thought. But how could there be so much empty space when, as Aristotle told us, "nature abhors a vacuum"?

Now what about theology? We encounter problems there as well. The Bible seems to favor a stationary earth. Consider the following passages:

I Chronicles 16:30: yea, the world stands firm, never to be moved.

Ecclesiastes 1:5: The sun rises and the sun goes down, and hastens to the place where it rises.

Joshua 10:12: Then spoke Joshua to the Lord in the day when the Lord gave the Amorites over to the men of Israel; and he said in the sight of Israel,

> Sun, stand thou still at Gibeon, and thou Moon in the valley of Ai'jalon.
>
> And the sun stood still, and the moon stayed, until the nation took vengeance on their enemies. Is this not written in the Book of Jashar? The sun stayed in the midst of

> heaven, and did not hasten to go down for about a whole day.

Add to these the fact that you've put the devil on the move, and closer to God, and it stacks up to major problems for Copernicus.

But this wasn't the first time a scientific idea was found to be in apparent conflict with the Bible. St. Augustine dealt with a similar situation back in 415 AD. In his *De Genesi ad literam* he attempted to reconcile several passages in the Bible which refer to the heavens as being like a "tent" or "curtain" with the accepted idea that the heavens were spherical. He made use of three important strategies. The first was to emphasize that the Bible is not about natural philosophy, but about faith and morals. So we should be careful about tying the Bible to any position on natural philosophy:

> In points that are obscure, or far from clear, if we should read anything in the Bible that may allow of several constructions consistently with the faith to be taught, let us not commit ourselves to any one of these with such precipitous obstinacy that when, perhaps, the truth is more diligently searched into, this may fall to the ground, and we with it. Then we would indeed be seen to have contended not for the sense of divine Scripture, but for our own ideas by wanting something of ours to be the sense of Scripture when we should rather want the meaning of Scripture to be ours.

His second strategy was to stick with the most obvious interpretation of the Bible whenever there was some doubt about the issue, but if a scientific truth is clearly demonstrated then the science must be taken into account when interpreting the Bible. His final strategy gives us a means to account for apparent contradictions between demonstrated truths and the words of the Bible: we must consider the perspective of the observer. This argument is known as accommodation, and it basically says that the Bible speaks in everyday terms not in terms of natural philosophy. So in natural philosophy we find the the heavens to be spherical, but they might still look like a tent or curtain to an individual observer.

Now we are ready to tackle the religious response to the Copernican system. Since Copernicus published his *De Revolutionibus* in 1543, right in the middle of the Reformation, we must separately consider the Catholic and Protestant reception of his ideas. The two stories turn out quite differently, as we will see. Since Copernicus was himself a Catholic canon (a kind of administrator) at the cathedral at Frombork, Poland we will start with the Catholics. Initially the Catholic reception was quite favorable. The basic outline of Copernicus' system was explained to Pope Clement VII in 1533 (10 years before the *De Revolutionibus*) and was received favorably. Copernicus was encouraged to publish his work by two high-ranking Catholics: Nicholas Shoenberg (Cardinal of Capua) and Tiedemann Giese (Bishop of Culm), as well as by the Lutheran astronomer Georg Joachim Rheticus. Giese, at least, believed the truth of the Copernican system and wanted to publish a treatise by Rheticus reconciling the system with Scripture. Copernicus' book was even dedicated to Pope Paul III. I want to make it absolutely clear that Copernicus was never persecuted by the Church. He delayed publishing his work because he feared the response of Aristotelian natural philosophers. The first printed copy of his book was delivered to him on his deathbed.

So far, so good, with the Catholics. But things were about to change. The Council of Trent was convened to formulate a response to the Protestant uprising, and in its fourth session (1546) it laid down the following rule for interpreting Scripture:

> ... no one by relying on his own wisdom should distort Sacred Scripture into his own meanings and dare to interpret Sacred Scripture contrary to the sense which the holy Mother Church has held and holds in matters of faith and morals which pertain to the edification of Christian doctrine. ... Nor is it even permitted to hold interpretations contrary to the unanimous agreement of the Fathers. ...

This proclamation would cause trouble down the road, but not immediately. In fact, the only written theological response to Copernicus that dates from the 16th century is a treatise on Job by the Augustinian monk Diego de Zuñiga in 1584. In this treatise de Zuñiga uses

Job 9:6 ("Who shakes the earth out of its place, and its pillars tremble") to claim that the Copernican system agrees with Scripture better than the Ptolemaic.

At the end of the 16th century things did go badly for one outspoken Copernican. In 1600 the Italian philosopher Giordano Bruno was burned at the stake. But he was convicted of a wide range of heresies, and the verdict against Bruno made no comment about the Copernican system. But another outspoken Copernican was about to burst onto the scene.

Galileo Galilei became instantly famous in 1610 when he published observations made with his newly developed telescope. These discoveries, which included mountains on the Moon and moons orbiting Jupiter, poked some major holes in Aristotle's cosmology. The Church had no negative reaction to Galileo's work, and in fact the Jesuits backed up his claims with observations of their own. But Galileo had Aristotelian academic enemies who persuaded a Dominican friar to preach against the Copernican system. In response, Galileo made a theological defense of the Copernican system which was most fully developed in a letter he wrote to the Grand Duchess of Tuscany in 1615. In his letter Galileo closely follows St. Augustine. He begins by arguing for a separation of science (including both natural philosophy and astronomy) from theology. He even cites the proclamation of the Council of Tent, pointing out that it only prohibits new interpretations in "matters of faith and morals." He presents the standard accommodation argument:

> Hence in expounding the Bible if one were always to confine oneself to the unadorned grammatical meaning, one might fall into error. Not only contradictions and propositions far from true might thus be made to appear in the Bible, but even grave heresies and follies. Thus it would be necessary to assign to God feet, hands, and eyes, as well as corporeal and human affections, such as anger, repentance, hatred, and sometimes even the forgetting of things past and ignorance of those to come. These propositions uttered by the Holy Ghost were set down in that manner by the sacred scribes in order to accommodate them to the

> capacities of the common people, who are rude and unlearned.

He then argues that one must make use of clearly demonstrated scientific propositions to properly interpret the Bible:

> Having arrived at any certainties in physics, we ought to utilize these as the most appropriate aids in the true exposition of the Bible and in the investigation of those meanings which are necessarily contained therein, for these must be concordant with demonstrated truths.

He concludes his letter by providing a new interpretation of Joshua 10 in which it is the *rotation* of the sun which is halted. Following the work of Johannes Kepler (who we'll discuss soon) Galileo believed that it was the rotation of the Sun that was the source of all other celestial movements. So halting the sun's rotation ("Sun, stand thou still.") would also stop the rotation of the earth and the orbit of the moon, etc.

Galileo's argument did not go over well with the Church. It particularly conflicted with the views of the influential Jesuit Cardinal Roberto Bellarmine. Bellarmine, like most other theologians of the era, was willing to concede that scientific theories could be so clearly demonstrated that we must accept them as true and reinterpret any biblical passages that seem to contradict them.

> if there were a true demonstration [of the Copernican system] then one would have to proceed with great care in explaining the Scriptures that would appear contrary, and say rather that we do not understand them than that what is demonstrated is false. But I will not believe that there is such a demonstration, until it is shown to me.

He also didn't believe Galileo's argument that the statements about a stationary earth in the Bible are not "matters of faith and morals." He thought of the Bible as being directly dictated by the Holy Spirit, and therefore believing in a statement that contradicted ANYTHING in

the Bible was equivalent to believing that the Holy Spirit had lied. Bellarmine's attitude, combined with the machinations of Galileo's acadeic enemies led to the official condemnation of the Copernican system in 1616. The Copernican system was deemed:

> foolish and absurd in philosophy, and formally heretical since it explicitly contradicts in many places the sense of Holy Scripture, according to the literal meaning of the words and according to the common interpretation and understanding of the Holy Fathers and the doctors of theology.

At that time, 73 years after its publication, Copernicus' *De Revolutionibus* was "prohibited until corrected", which meant passages proclaiming the truth of the Copernican system were to be deleted. Galileo's name was never mentioned in the verdict, nor was he even consulted.

Galileo laid low for a while after the 1616 ruling, but before long he made himself the enemy of the Jesuits by engaging in bitter scientific disputes with two members of that order. Even so, the election of his old friend Maffeo Barberini as Pope Urban VIII gave him the courage to publish, in 1632, his *Dialogue on the Two Chief World Systems*: a defense of the Copernican system thinly veiled as an argument that ends in favor of Ptolemy. The Church easily saw through Galileo's ruse and in 1633 Galileo was convicted of suspicion of heresy for violating both the 1616 ruling and a personal warning given to him by Bellarmine. He was forced to "abjure, curse, and detest" his erroneous views and he was placed under house arrest for the remainder of this life. During his house arrest Galileo wrote his *Discourses and Demonstrations Concerning Two New Sciences*, which would ultimately provide the key to Newton's new physics and the eventual triumph of the Copernican system. But after Galileo it became very hard for a Catholic to defend Copernicus, and the further development of Copernican astronomy would mostly take place in Protestant lands.

It is to those Protestant lands we now turn. We begin with the views of one of the great Reformers. Martin Luther was quoted as dismissing the Copernican system during a dinner conversation, but Luther makes no mention of Copernicus anywhere in his voluminous

writings. And from these writings we do know that Luther was willing to take science into account in interpreting the Bible. One example is a comment he made on Genesis 1:16. The passage states that "God made the two great lights, the greater light to rule the day, and the lesser light to rule the night". This was a problem because it seems to be saying that the Moon is larger in size than, for example, Jupiter. But already in the 16th century astronomers believed that Jupiter was much larger than the moon. In his discussion Luther is quoted as saying:

> From the theory of eclipses, which is supported by accurate demonstrations, we are convinced that astronomical theories ought not to be rejected. I believe, therefore, that Moses spoke according to our power of comprehension, describing the moon as it seems to us.

In general Luther wanted to interpret the Bible in the most obvious, most literal way. It was important for Luther that the Bible be easy to interpret because he denied the need for the Catholic priests to serve as specialized interpreters of Scripture. But in this case we see that Luther was willing to use the accommodation argument when it was deemed necessary.

Philipp Melanchthon, perhaps the most prominent Lutheran after Luther himself, wrote in opposition to Copernicus. Although he did quote scripture against Copernicus, he was particularly concerned about contradictions with natural philosophy. Melanchthon felt that astronomy should be subordinate to both theology and philosophy, a view that was common at the time. But he strongly encouraged the study of astronomy, in part for theological reasons:

> To recognize God the Creator from the order of the heavenly motions and of His entire work, that is true and useful divination, for which reason God wanted us to behold His works. ... In the sky, God has represented the likeness of certain things in the Church. Just as the moon receives the light from the sun, so light and fire are transfered to the Church by the Son of God.

Melanchthon even promoted the study of Copernican astronomy, provided it was understood only as a means of predicting the motions of the planets and not as a true description of the universe. This attitude became the standard approach to Copernicus in Lutheran Germany.

But gradually the desire to know the truth about the planetary motions grew. The great Danish astronomer Tycho Brahe spent his life seeking the "true astronomy." Tycho was dissatisfied with the Ptolemaic system, but could not accept the Copernican system because it failed to fit physics and Scripture. Instead he devised his own system, one in which the sun orbits a stationary earth while the other planets orbit the sun. He was convinced until his dying day that he had discovered the only system that could meet the demands of astronomy, natural philosophy, and theology. He hoped that his assistant, Johannes Kepler, would prove him right.

Kepler had other ideas. Kepler was both a committed Copernican and a devoutly religious man. He responded to the standard theological objections to Copernicus with the usual accommodation argument:

> Joshua meant that the sun should be held back in its place in the middle of the sky for an entire day with respect to the sense of his eyes, since for others during the same interval of time it would remain beneath the earth.

But Kepler didn't just think that the Copernican system could be reconciled with theology. He saw great theological significance in the Copernican system. He believed that the general structure of the Copernican system mirrored the Holy Trinity, referring to

> That beautiful commensurability of static objects: the sun, the fixed stars, and the intervening medium with God the Father, the Son, and the Holy Spirit...

Kepler viewed his task as interpreting God's creation, just as the task of theologians was to interpret God's revealed word. Kepler believed that God had created the universe for the benefit of man, and this principle played a role in his astronomy. In his first book he tells us that

> [from the] love of God for man a great many of the causes of the features in the universe can be deduced.

It was this faith in a loving God who took special interest in mankind that gave Kepler his supreme confidence in the Copernican system. The mathematical harmonies of the Copernican system were clues to God's plan for the universe that God had intentionally made accessible to the human mind.

The debate over Copernicus, which had been silenced in Catholic countries by the condemnation of 1616 and the trial of Galileo, would rage on in Protestant countries after Kepler because the Protestant countries lacked any central authority (like the Inquisition in Rome) that could end the argument. And as long as the argument was allowed to continue it was only a matter of time until the triumph of Copernicus, Galileo, and Kepler. Kepler developed a new version of the Copernican system that was vastly superior to anything that had come before, and Galileo laid the groundwork for a new physics that would answer the philosophical objections to the earth's motion. Once the astronomical and physical objections were answered, theological objections were no longer a major stumbling block. Theology had always proved itself capable of supporting either side of the debate. In predominantly Protestant countries like the Netherlands and England, which didn't have to contend with an official ruling from the Inquisition, the new astronomy flourished.

We've come to the end of our story. Now I would ask you to reflect. Has this story been one of an inherent conflict between science and religion? We have seen that theological arguments were made on both sides of the debate. In fact, the only thing that was consistently used to argue *against* the Copernican system was another branch of science (Aristotelian physics). Given the scientific knowledge of the day, there were strong *scientific* reasons to reject Copernicus. The major conflict was between an old, entrenched science and a new, revolutionary science. Theology played a role in that conflict, but theology played a role in nearly all facets of intellectual life back then. The astronomers and theologians we have

considered all believed that both science and theology could reveal the truth. Theologians of that era were prepared to adapt their biblical interpretations to demonstrated scientific truths. But when the astronomical, physical, and theological evidence seemed stacked against Copernicus there did not seem to be any need to adapt biblical interpretations to the Copernican system.

If we think back to Barbour's four categories it would seem that conflict is the one category into which none of our astronomers and theologians fall. A few argued for separation, but most would fall into either the dialogue or integration camps. Indeed, if there is an inherent conflict visible in this story it is the conflict between a centralized authority and free thinkers who seek to overturn the *status quo*. And the Bible itself, especially in the Gospels, teaches that it is not just scientists who have suffered from that type of conflict.