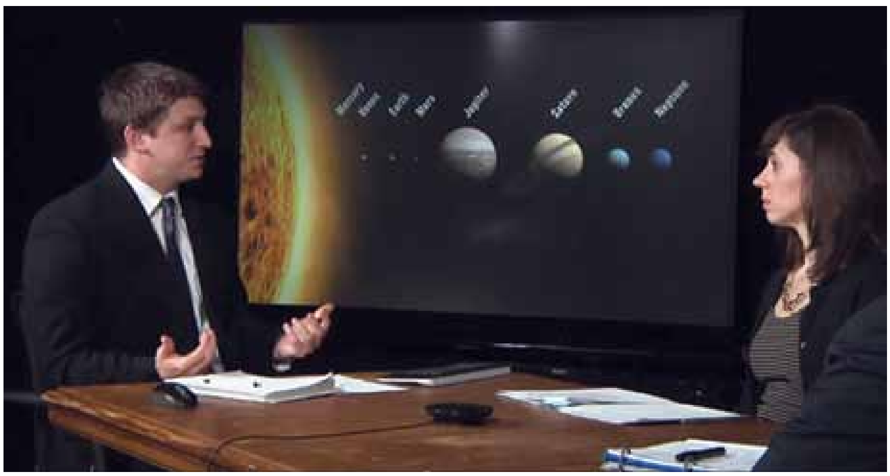
To Explain the Solar System, First Understand Creativity

In last week's issue, we published the presentation by Megan Beets, on the LaRouchePAC Science Team's New Paradigm weekly show (Feb. 25), in which she discussed the work of Nicholas of Cusa and Johannes Kepler. We continue here with the second part of the program, which also included Science Team members Benjamin Deniston and Jason Ross. A video is posted at https://larouchepac.com/new-paradigm.



LPAC-TV

Benjamin Deniston and Megan Beets of the LaRouchePAC Science Team discuss the continuity of revolutionary thought from Nicholas of Cusa to Johannes Kepler to the present day. Webcast on Feb. 25.

Megan Beets: . . . Johannes Kepler, in his discovery of the Solar System, took what Nicholas of Cusa knew to be true in principle, in concept, and Kepler actually discovered scientifically that this was the case, and gave man a completely new concept of the Solar System.

Benjamin Deniston: This continuity is critical—this direct connection, the methodological approach. All of Kepler's discoveries, his revolution, were from this standpoint. This is what he was rooted in, this is how he thought, this is the unique quality of thought, of method, he brought to the investigation, which then allowed him to make the breakthroughs that other people couldn't make, didn't make. And, in a certain sense, really demonstrated and validated Cusa's philosophical conception of how the universe was organized, and how mankind relates to it.

I wanted to go through some developing hypotheses on how to look back today at some of Kepler's work on the organization of the Solar System, but really homing in on this central thesis: that it's not a blank slate conception, it's not numbers, it's not mathematics, but science; and our understanding of the universe is premised upon our understanding of the human mind as, as Cusa put it, a microcosm of the macrocosm, of God the Creator. There's a unique potential that the human mind has, that we can't define by other metrics. We can't

FIGURE 1a
Kepler's Early Model of the Solar System

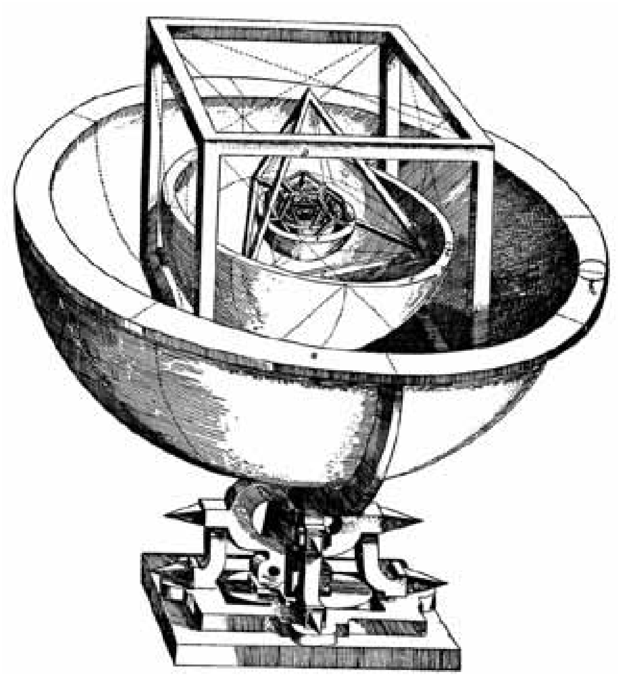


FIGURE 1b

define it by sense perception, we can't define it by chemistry, or biology, or anything else. We have to study it, itself, what the human mind is; how does human society function? That tells more about mankind's relationship to the universe, and the universe as a whole, than anything that's just based on sense perception could.

Kepler: It's Not Just Numbers

Kepler looked at how the Solar System is organized (**Figure 1a**). This is from an early work, the *Mysterium Cosmographicum* [1596]. He asked the question: Why are the planets distanced from each other at the distances that they are? We have six planets [known at that time], five distances between those six planets. So why are those distances the particular values they are?

And just to refer back to this not being a mathematical or numerical approach, he plays with that at the beginning: Could we just have a ratio of numbers? Could it be a simple proportion—one planet is to the next planet, as that planet is to the next? And he shows that that doesn't work. Which is interesting, because the Titius-Bode relation was developed later, to try to explain it that way.

But early on, he shows that just working with the ratios of numbers doesn't work, and he's forced to go to the idea of these [Platonic] solids, these regular shapes in three-dimensional visual space, as defining the distance between the planets. That's what he plays with in this first major work, the *Mysterium Cosmographicum*.

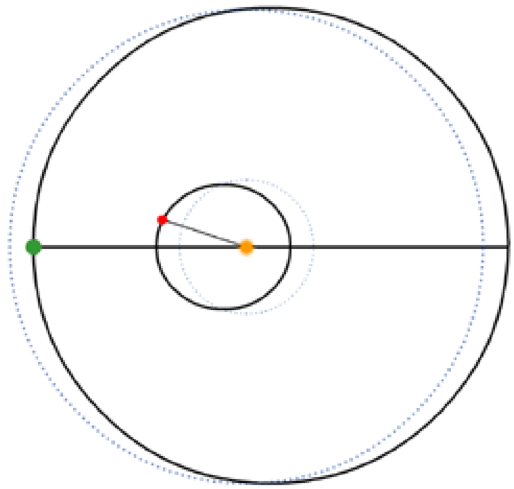
And then, as he makes his revolution with the *New Astronomy* [1609], and really gets into the causes of the motions of the individual planets, he defines this idea that the planets are eccentric—they don't move in circles. They have a constantly changing distance from the Sun. So now you don't just have one distance from the Sun. He was able to further explore that in the *Harmony of the World* [1619], where you have not just one distance from the Sun for each planet, but a range of distances—you have an aphelial distance farthest from the Sun, and a perihelial distance closest to the Sun, for each planet.

You can see it represented here (**Figure 1b**). The top orbit is the Saturn orbit. You have three circles, each representing different distances from the Sun that Saturn reaches—the farthest, the closest, and the middle.

Towards the end of his life, Kepler takes up again this question of why these distances are what they are. These differing distances in any one planet's orbit are attributed to how eccentric its orbit is. So he takes up the question, why do the planets have these particular eccentricities? Why do they have the distances they do, and why do they have the particular eccentricities they do? And he comes to the conception that we have to take this from a *musical* standpoint. We have to look at the intervals created by the extreme motions of the planets: one planet to itself, and then planets to other planets.

And so you have here (**Figure 2**), for example, two planets—an inner planet and an outer planet. You can see that, if they were circular orbits, they'd correspond

FIGURE 2



to the blue dotted line; but they're elliptical, and they have a certain amount of eccentricity, so you can see that they vary in their distance from the Sun.

What Kepler looks at, are the relationships between the perceived motion of these planets at their extremes. So, for example, the inner planet, the red one, is pretty close to what would be its farthest distance from the Sun, at which point it would be going its slowest. The outer planet, the green one, is just about at its closest distance from the Sun, where it would be going its fastest. And Kepler says, what if we look at the ratio of how they would appear to move, from the Sun, at those extreme positions, and see if those create the type of harmonic intervals you get in music?

Musical Harmonies

I'm giving a very quick overview of a 600-plus-page work (which should obviously be worked through in detail), to set up looking at some more recent discoveries from this standpoint, I just want to give a quick overview. He's got this idea that you have to look at the apparent perceived motions at these extremes and look for the harmonic organization, look for characteristics that we associate with harmonies in music. And he says, for any one orbit, you want to compare the extreme motions—its fastest and its slowest. That defines a certain interval, and he investigates that by looking for the harmonic intervals defined there.

Then look at neighboring planets, the outer planet and the inner planet. And in that case, you have four relationships that are kind of the boundary conditions. Each planet has a fastest and a slowest point, so you can compare fastest to fastest; slowest to slowest; fastest to slowest; slowest to fastest. He calls them the converging motions, when their speeds are the closest to one another; the diverging motions when you have the biggest difference between the speeds; aphelial when they're both at their respective farthest distances, and perihelial when they're both at their respective closest distances.

So again, he's asking, why is the system organized the way it is?

We have some conception with the solids defining the distancing of the planets, but we know that the planets have these particular eccentricites. Why are those eccentricities what they are? And he develops a whole system of examining the relations between the extreme motions, and defines an entire harmonic organization to the system: that a musical, harmonic system is necessary to understand why the eccentricities are what they are. And that allows him to go back, having defined the Solar System from these harmonic ratios—which are exhibited here—and recalculate, re-derive the distances and the eccentricities from the harmonics.

So by the end, he starts with what he defines as the necessary harmonic intervals for any individual planet, and certain pairs of planets; he asks why those are what they are; and from there is able to derive and define the Solar System as a product of this required harmonic organization.

Beets: By "required"—I was thinking that it's similar to what Cusa does in what I read from the *De Docta Ignorantia* [see last week's issue]. Cusa wasn't basing his thoughts on any data or any observations; he was just thinking about what ought to be, based on first principles. And Kepler did that too. Informed by the data, informed by his knowledge of the planetary motions, he then puts the motions aside and thinks from the standpoint of first causes: What *ought* the motions be, in order to have the most harmonically tuned system possible?

And then from these, he derives what the distances would have to be to make those motions.

Deniston: Right. The one example that sticks in my mind is his examination of the motions of the Earth and Venus, because he says the system should express the distinction between major and minor—or hard and soft, as he says. That's something that is part of music; it's part of a musical system. So therefore, it should be expressed somewhere in the system, from first causes, as

TABLE 1

Kepler's Charting of the Harmonic Characteristic of the Solar System

Harmonic Proportions of Pairs	*Values of Extreme Motions*		*Individual planets' own props.*	*Means of individual motions continued: Arithmetic*	*Means of individual motions continued: Geometric*	*Halves of difference*	*Value of mean motion in own measure*	*Value of mean motion in common measure*
1	Saturn	139968.	64	72.50.	72.00.	25.	71.75.	156917.
1	Saturn	177147.	81					
30 2	Jupiter	354294.	6561	7280.5.	7244.9.	178.	7227.1.	390263.
5	Jupiter	432000.	8000					
24	Mars	2073600.	25	30.50.	30.00.	25.	29.75.	2467584.
2	Mars	2985984.	36					
32 3	Earth	4478976.	2916	3020.500.	3018.692.	904.	3017.788.	4635322.
5	Earth	4800000.	3125					
5	Venus	7464960.	243	246.500.	246.475.	125.	246.4625.	7571328.
1 3 8	Venus	7680000.	250					
5	Mercury	12800000.	5	8.500.	7.746.	377.	7.369.	18864680.
4	Mercury	30720000.	12					

you're saying. The system has to be reflective of our conception of musical harmony. So therefore, that has to be expressed somewhere. We see it in the Venus/Earth relationship.

So, he's going not just going from the data, but from what should be required if the universe is organized by this harmonic conception, which mankind can uniquely define and understand.

I think an introduction to this table (**Table 1**) is fun. He says something to the effect of, now we're going to try a calculation which has never before been attempted in human history before. That is, starting from the harmonies and deriving the distances and the eccentricities from the harmonic organization of the Solar System.

A lot could be said about that work. It's a revolutionary work. His whole life is a revolutionary work, demonstrating Cusa's conception to be valid: that we have to start from an understanding of the human mind as an expression of the organization of the universe in its most fundamental sense, and that that is the basis for science.

Now, in looking into this, one thing that I've been provoked by for a few years is—following Kepler's revolution, in his creation of a whole new era of science—people are not unaware that we found a couple of new planets, particularly Uranus and Neptune. We have the asteroid belt, which we probably have to save for another show, and some other interesting things. But you also have two significant planets which were discovered following Kepler's time.

So, in Kepler's time, Mercury, Venus, Earth, Mars, Jupiter, and Saturn were all known. If you were to ask when any of these planets were discovered, you wouldn't have an answer, because we don't know. As far back as we have records, these planets have been known. Kepler was dealing with a certain understanding of the Solar System that goes back as far as we have records, in terms of recognizing that there are these five observable objects in the sky—six planetary bodies of the system. It was only after Kepler's discovery, and then with the development really of telescopes, and with the application of Kepler's discoveries—his laws of planetary motion—that we were able to discover and identify these two additional planets.

FIGURE 3

Uranus was discovered some time around the 1780s, by William Herschel, and he had a nice seven-foot-long telescope (**Figure 3** is a replica). He built it himself. He had to use it to identify Uranus. This is not something you could just perceive easily; you had to develop a pretty sophisticated telescopic system to find it.

Jason Ross: We can't see it at all without one, right?

Deniston: I don't think so. Maybe if you knew exactly where it was, and it was a perfectly clear sky, and you had very good visibility, you might be able to see something that looked like a very faint star. But I think there's clearly a reason why we've known about these other six for so long. It was only with the development of telescopic systems that we had the ability to identify Uranus as a planet.

And Neptune came in a little bit less than a century later, in a rather interesting way. Some people noticed a deviation of Uranus's motions, relative to what they would expect, and hypothesized that maybe there's another planetary body acting on Uranus. And then they were able to approximate where in the sky to look for this other body, and were able to find Neptune. Pretty interesting work went into these things, and it's all work that came out of the context of Kepler's work. Even the telescope. Kepler did work on optics, some very interesting things on sense perception, and vision, and the principles of these things. The discovery of Neptune itself required understanding of the planetary laws of Uranus, which led to its discovery.

In the aftermath, and as a consequence of, Kepler's work, we discovered these two additional planetary bodies. The question here that I want to examine is, how do they fit into Kepler's harmonic system? I'm going to pose some hypotheses—more work needs to be done to get something we might call conclusive on the matter, but I think the evidence just presented is rather provocative, and really points in a clear direction.

The Anomaly of Uranus and Neptune

So, we're going to look at Uranus's and Neptune's motions from the standpoint of this method of the apparent extreme motions that Kepler uses (**Table 2**). So, for example, if you take the apparent motion of Uranus at its closest point to the Sun, when it's moving its fastest, and if you take Uranus's apparent motion when it's at its farthest place from the Sun, when it's going its slowest, and you take a ratio of those—you say, what interval is that? You just take the raw data of the current understanding from NASA, observational systems and calculations, and you get that interval there—.83308 etc., which is extremely close to a harmonic interval, a minor third. And then, if you put the closest harmonic in decimals, then you can see how many "commas" (a relatively small musical interval, far smaller than two steps on a piano) it takes just to measure how far this closest harmonic is, the distance between Uranus and Neptune. You can see it's hardly anything. It's almost precisely a minor third.

Beets: Just to clarify—because people probably aren't used to thinking of planetary motions as intervals—it would be as if you had two strings—let's say two strings on a 'cello. And when they vibrate, they move, and notes which are lower vibrate more slowly, and notes which are higher vibrate more quickly. So if you tuned those strings such that the ratio between those strings was the same as the ratio between Uranus's extreme motions, the sound that you would hear would be almost identical to a musical harmony, the notes of the musical scale.

Deniston: Right. Then we can do the same with Neptune, and you get something extremely close to what Kepler calls a melodic interval, 24/25ths, which is a kind of a half-step. It's the difference between a major and a minor third, or a major and a minor sixth.

So we look at the internal motion dividing these planets, and they come up to pretty clean, interesting values.

Then we take the next step and say, what's the relationship between Uranus and Neptune? These two outer planets, unknown until the very recent period—what is their interval? And again, we have four: the converging and diverging, aphelial and perihelial. Farthest to farthest, closest to closest; farthest to closest, closest to farthest. There are four combinations among them. So, in examining the intervals between Uranus and Neptune, how are they "singing" between each other? What are the intervals at their extreme motions?

You get an array of rather interesting values, a whole array of these melodic intervals, which are not harmonics in the same way. If you played any of these on a keyboard, it wouldn't sound all that great, but they're a required part of the musical

TABLE 2

	Calculated Interval	Closest Harmonic	Closest Harmonic	Commas Off
Uranus	0.8330854826	5/6	0.8333333333	0.02
Neptune	0.9609627366	24/25	0.96	0.08

TABLE 3

The Uranus to Neptune Relationship is Characterized by Melodic Intervals			
	Interval		*Commas Off*
Converging	Seventh (major tone short of an octave)	9/16	1.14 flat
Diverging	An octave plus a minor tone	9/20	1.2 flat
Aphelial	Seventh (minor tone short of an octave)	5/9	1.06 sharp
Perihelial	An octave plus a diesis	24/50	0.79 sharp

TABLE 4

The Saturn to Uranus Relationship is Characterized by Dissonance			
	Interval		*Commas Off*
Converging	An octave plus a minor third (very out of tune)	~ 5/12	2.52 flat
Diverging	An octave plus a seventh (major tone short of two octaves)	9/32	1.63 flat
Aphelial	An octave plus a lydian	1/(2√2)	1.04 flat
Perihelial	An octave plus a lydian	1/(2√2)	2.08 sharp

system. They're half-steps, or sevenths. You can see here (**Table 3**), we have the converging motions—between Neptune's slowest motion and Uranus's fastest motion, makes a seventh—which is a melodic interval. The diverging motions—between Uranus's slowest and Neptune's fastest, the farthest apart they get—makes an octave and a whole step, an octave plus a minor tone, as Kepler called it. The aphelial motions make another seventh. The perihelial motions makes an octave, and this diesis again, this half step.

So all of the motions between Uranus and Neptune are melodic intervals.

Beets: Positions in the musical scale, but if you sounded them together, they would be dissonant. So they're not random; they do take positions in the scale, but they're not beautiful and harmonic, like the other planets were.

Deniston: Just alone by themselves, yes. But you really have to go through Kepler's work as a whole. He does a lot defining the melodics as a necessary part of the harmonic system, starting with the harmonic intervals, and those defining the melodics, and that allows you to define the whole scale, the whole musical system. So they're kind of one step removed, kind of derived, from the harmonic intervals.

So that's Uranus and Neptune.

Now, let's look at Saturn to Uranus. Saturn is a planet that Kepler knew about, and Uranus is the first of these new planets that we've discovered. So, it's the boundary condition between the new ones, and the ones we've known about since antiquity.

What intervals do we have here?

We have an array of rather dissonant intervals (**Table 4**). The converging motion is very flat, from an octave plus a minor third. (We'll look back at this later.) It's two and a half commas—so very far from the closest harmonic, which would be an octave and a minor third. The diverging motion—the most extreme interval between the two planets—is a little flat, and not quite an octave plus a seventh. So it's not quite an octave and a melodic interval.

The aphelial and perihelial values are very close to a very dissonant interval called the Lydian, which is between a fifth and a fourth, a uniquely dissonant interval which has an important role in the overall musical system, but in and of itself, if it's played, it's a very harsh, dissonant tone.

So, the Uranus-Neptune values were all these melodic values, but Uranus-Saturn appears to be a whole array of dissonant values.

The third thing to look at before coming back, and asking the interesting question—which is, why do they have these particular characteristics—is looking at the relationship between Uranus, Neptune, and the rest of the planets, the whole system.

When I first looked at this a couple of years ago, I was thinking, "Oh, they're going to fill in some new notes in the system, and provide some new things that were absent from the notes provided by just the planets that Kepler was dealing with." When I first looked at it, they actually didn't: They actually sang the same notes as all the other planets, but off by a certain number of octaves. So, if you defined Uranus, its perihelion is singing the note C; Venus also, at its perihelion, will sing the note C, but seven octaves higher. So, all of the extreme motions of Uranus and Neptune sing an octave difference with other planets.

TABLE 5

			Octaves	Commas			Octaves	Commas
Uranus Per	-	Venus Per	7	0.96				
Uranus Ap	-	Merc. Ap	8	0.52				
Neptune Per	-	Venus Ap	8	0.95	-	Merc. Per	10	1.25
Neptune Ap	-	Jupiter Per	4	1.90				

You can see the comparison here (**Table 5**): Uranus to Venus, Uranus's aphelion to Mercury's aphelion, Neptune's to Venus, and to Mercury in its perihelion, and Neptune's aphelion to Jupiter's perihelion. These are all octave relationships. It's the same note, but up an octave in the musical system.

So, we have three very distinct sets of characteristics in each of these examinations. You look at the Saturn to Uranus pair, the region bridging the planets known for thousands of years, to these new ones, and they're all dissonant intervals. Looking at Uranus and Neptune, the relation of the two new planets to themselves, they're all melodic intervals. And then you look at these two planets relative to the whole system, and they sing these octave relationships.

Which I think is very fascinating—because in looking at the relation of Neptune and Uranus to all the planets, it's not like you get some dissonances, some melodics, and some octaves—these are all octaves. If you look at just Saturn and Uranus, it's not like you get some melodics, some octaves—it's dissonant. If you look at Uranus and Neptune, it's not like you get some Lydian intervals, some octaves, and then a couple of melodics—it's all melodics. Each of these analyses has a particular characteristic to it, which seems to express itself very clearly.

So you get a very distinct quality to these three ways to look at how these two new planets relate to each other, and relate to the whole system.

Where Does the Dissonance Come From?

Then comes the question, "Why?" We want to look at first causes, and why were these necessary? From the standpoint of a Cusan conception of mankind's relation to the universe, as Kepler developed that with his conception of a harmonic organization of the Solar System, why is it necessary that these two new planets create this particular three characteristics?

First, let's look a little more closely at the Uranus to Saturn relationship, the one that has all these dissonant intervals (**Figure 4**). If we take Uranus as what we're measuring against, we can see that they're all more than an octave, but the closest motions don't quite reach an octave and a third, but they exceed an octave, so they land in this dissonant range.

The diverging motion is a little bit better—it's closer to an octave and a seventh, but doesn't quite reach the seventh, and falls significantly above an octave and a major sixth, so they don't reach these harmonic intervals.

And what I think is most interesting, the aphelial and perihelial ratios both converge closely in this Lydian range, this very dissonant interval, with its dissonant characteristics. This is the only pair of planets that has this type of dissonant structure to the intervals. None of the planets that Kepler looked at—there might be one problem here, but that's what's necessary to

FIGURE 4

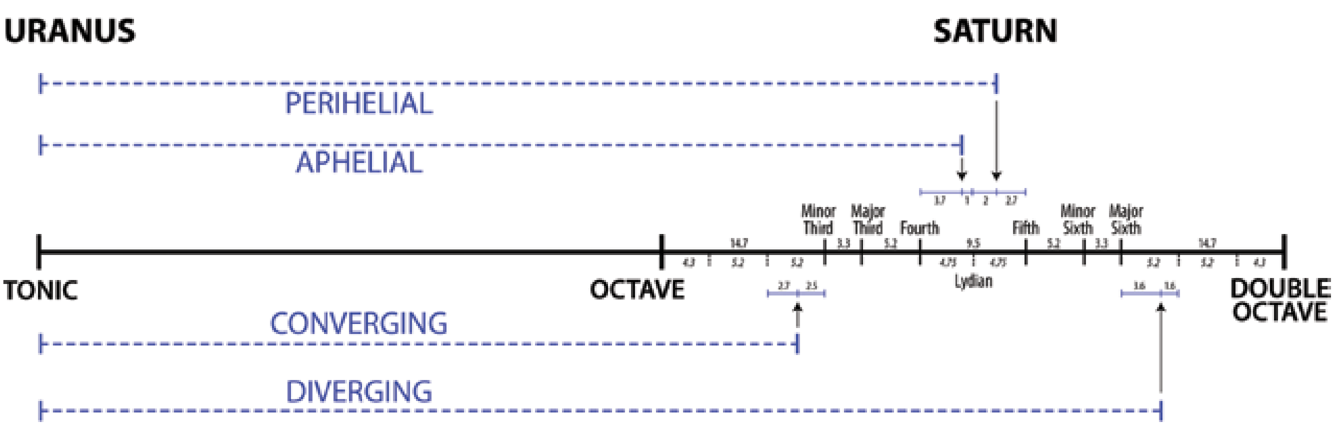


TABLE 6

The Uranus to Neptune Relationship is Characterized by Melodic Intervals			
	Interval		*Commas Off*
Converging	Seventh (major tone short of an octave)	9/16	1.14 flat
Diverging	An octave plus a minor tone	9/20	1.2 flat
Aphelial	Seventh (minor tone short of an octave)	5/9	1.06 sharp
Perihelial	An octave plus a diesis	24/50	0.79 sharp

keep the whole system in tune. But no single pair of two planets anywhere else is totally characterized by this kind of dissonance.

Ross: And Uranus to Neptune, you showed before, is not as dissonant.

Deniston: No, they're characterized by all being very close to these melodic intervals.

So why would there be this dissonant quality between Saturn and Uranus?

Well, there's also a dissonance in mankind's relation to the Solar System, which is, I think, where we have to go to understand these two system. Again, these six other planets were known for thousands of years, and there was a qualitative shift in mankind's relationship to the Solar System, and to the universe, which is associated with the boundary between these six planets known to the ancients, and these two discovered in the modern era.

That expresses a shift, not just in the number of planets that mankind knows about, but a shift in mankind's—that's the post-Kepler/Cusa quality of mankind's relationship to the Solar System, a different qualitative stage of mankind's mental capabilities, his relationship to the universe. So, it's a dissonance in that sense. It expresses the boundary condition in the change of mankind's relationship to the Solar System as a whole, as it represents a dissonance in the intervals themselves, directly.

If you go back to the Uranus-Neptune relationship, you have this dissonance separating the two new ones, from those known before—a dissonance both in the musical intervals themselves, and a dissonance in the relation of mankind to the Solar System (**Table 6**). And then, when you go again to the Uranus-Neptune relationships, the intervals defined by these two new planets themselves, and again, there are all these melodics—they have a certain characteristic of not being really accessible to the senses themselves.

It's like if you have a tight string on a monochord, and you're playing with that, you can, just by your ear, define and find the harmonic intervals, by creating sounds that sound nice. You can identify it by listening to it; you couldn't do that with melodics. Maybe if you already knew what they should sound like, you could then identify them; but with no *a priori* sense of what they should be, you couldn't identify them.

Beets: The harmonic intervals have a natural resonance. Two strings tuned in a harmonic interval physically resonate with one another; but two strings tuned to melodic intervals—like a note and then a step above—are dissonant, and they're not going to resonate with each other.

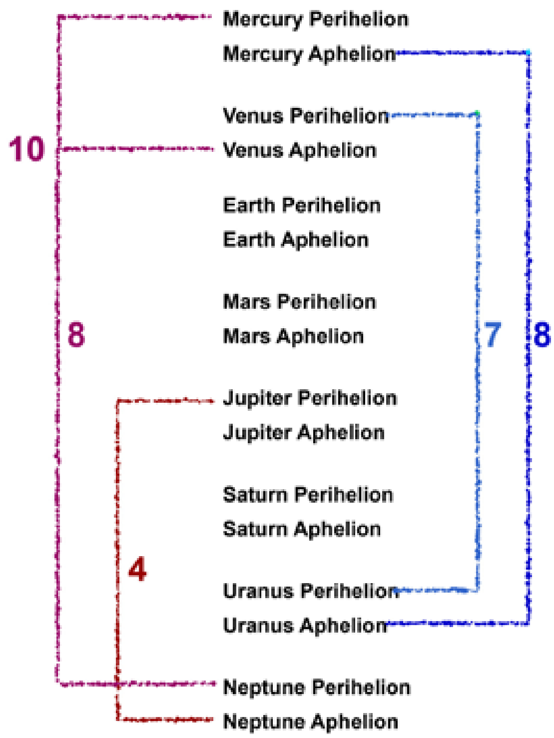
Mankind's Mind and the Solar System

Deniston: But, in developing a musical system from the harmonic intervals system, as Kepler does in Book 3 of the work [*Harmony of the World*], now applying mankind's reason and analysis to try to understand, how can I create a system out of this, you define the melodic intervals as important characteristics of the system. You create them as necessary components. But to define them requires moving beyond just a sensory capability, and more to the application of analysis and reason and boundings to the system, as an actual system.

If you want to discuss the general characteristic of the melodic intervals, that's what they are. They're a product of mankind working with harmonic intervals and defining a system, which allows you to identify them as something that exists that's important, that's part of the system. But not directly from sense perception.

So, that's the quality of the intervals that Uranus and Neptune sing, that they make, between them. That's also the quality of our relationship to those planets. I think the resolution can only be found by starting from the standpoint of mankind's relationship to the Solar System, the relationship of mankind's mind to the Solar System.

FIGURE 5



Uranus and Neptune were not accessible to unaided sense perception, but they required the development of synethetic instrumentation, telescopic systems. In the case of Neptune, it required an understanding of Kepler's planetary motions, and of how the planets should work as a system, which then allowed mankind to identify it. So, in an interesting sense, the quality of mankind's relationship to Uranus and Neptune is a similar generalized quality of the relationship of the melodics, to the harmonics.

This provides a certain resolution to the dissonance. This kind of boundary condition between those planets known for thousands of years, and those recently discovered, is a boundary condition both in our relationship to the whole Solar System, and it's a boundary condition in the dissonant characteristic of the harmonic intervals.

When we go beyond that boundary condition, we resolve this dissonance, but to a new characteristic quality, which transcends sense perception. When we move beyond this dissonance, in terms of mankind's relationship to these outer planets, it's a function of mankind moving beyond the capabilities of direct sense perception, and into a domain where our sense-perceptual system is augmented and subsumed by higher principles. Which is a similar quality that the intervals of Uranus and Neptune themselves have, which also kind of transcends sense perception.

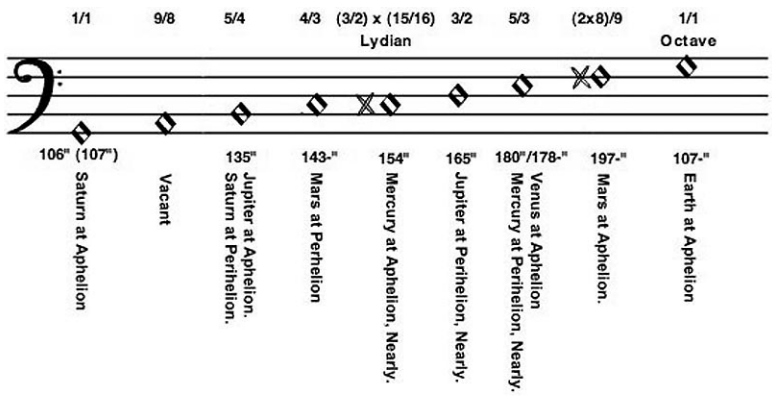
So, it's a boundary condition and a certain type of resolution, both in terms of the intervals expressed by the planets themselves, but also in terms of mankind's relation to those planets.

Then the third unique quality in analyzing the relations to these two new planets, is all these octaves. When we compare Uranus and Neptune, compare their motions with other planets of the system as a whole, you get a series of octave relationships (**Figure 5**).

This also defines a very fascinating bounding to the system as a whole: that the pair of farthest planets sing a series of octave intervals bounding the system, with the innermost two planets. Neptune sort of bounds that interval directly, because it sings both with Mercury's perihelion, and Venus's aphelion. At the same time, Neptune's aphelion kind of bounds the outer planets, by singing with Jupiter's perihelion—the trans-asteroid belt outer planets. And then Venus comes in and fills in the other two.

So, taken as a whole, we have this dissonant characteristic between Saturn and Uranus; we have the unique melodic characteristic between Uranus and Neptune; and then we have Uranus and Neptune in relation to the

FIGURE 6
Kepler's Diagram of the Harmonies



Here the major scale started with Saturn at aphelion and contains both Venus and Mars at aphelion.

innermost planets, bounding the whole system with the octaves.

This points in a very provocative direction: that these two new planets do work in a very important way in Kepler's system, but they only work in Kepler's system, if you start from the Cusa/Kepler premise, that what we're dealing with in terms of science, is understanding the creative power of the human mind, as something that reflects and expresses the nature of the universe as a whole.

That as Cusa discusses, and Kepler discusses—his life's work is centered on this—you're looking at how the human mind is a reflection of the intention in the creation of the universe as a whole. To paraphrase, Kepler has one statement where he said, it was as if the Creator was looking to man who was to be, in his initial creation of the Solar System. That the characteristics of mankind, the human mind, reflect something about the universe as a whole. If you take that as a premise, then these qualities of Uranus and Neptune are completely consistent with that, because they show you, in the Solar System, a boundary in mankind's relation to the Solar System. And to understand it, you can't separate those two.

You can't separate the Solar System from mankind's relation to the Solar System. . . .

Ross: Not to overdo it with connections, but the interval of the visible planets, from Mercury's perihelion to Saturn's aphelion, is seven and a half octaves, which is the exact size of a piano. The total size of what you brought up, going from Mercury's perihelion all the way out to Neptune'sis about ten octaves, which is roughly the range of human hearing. This is an interesting thing. It could have been far beyond anything, but it is along the lines of what even our bodies are able to do.

Morality and Science

I wanted to go back to Aristotle and a reflection on this. Because people ask, "Why do you pick on people? Wasn't Aristotle just old-fashioned? And yes, he thought those terrible things about people being slaves and about women, but he was a product of his time. Progress was natural. Why do you guys pick on people like Aristotle or Newton? They were just a step in the process."

The ability to recognize that there are people who are evil in politics—that's not really up for debate. But the idea that there is a sense of morality that should be in *science* or in *music*, is absent. Maybe a sense of morality in science in terms of whether you should use the fruits of science—Was using the bomb bad?—okay, that's a real thing. But the idea of scientific ideas not being connected to morality.

Did Aristotle just reflect an "old" approach? No. This is the time of Plato and Socrates. So, deliberately going against that outlook isn't just being old-fashioned. It's been a fight the whole time.

For example, what you went through would be totally controversial. Kepler is totally controversial. The *Harmony of the World* is totally controversial. Kepler's considered to be as old-fashioned as Aristotle might be on some of these things. People say, yes, in the *New Astronomy*, Kepler figured out how the planets moved—that's great. But then he had this sort of mystical stuff where he looked at music, and spheres, and this kind of thing. He connected how we operate with how the universe operated. He said that God would have to come in and plan things that would look good to us—this is preposterous.

That's the typical approach.

You said, Ben, the idea that the difference between the observable planets and then the ones that were discovered later, reflects that process of discontinuity or discovery that, Megan, you had brought up as being the basis of Cusa's understanding of how thought progresses, in opposition to Aristotle; that that discontinuity is itself a substance of the universe, insofar as it's the substance of how our thought progresses. That's very controversial! That's shocking. It's a tough concept to get. But it should make you feel somewhat ill at ease if you got it.

One other thing, which I thought was important about the nature of discovery itself, because you're likening this to discovery itself being seen in the planets. The operation of the mind, the motion forward of the mind, is seen in the planets in this way. It goes along with, and it goes a step beyond, what Kepler had already shown.

Beets: I think it opens the door for entirely new hypotheses, taking the nature of dissonance in music in the way that it's generated by the intersection of many modes, and polyphony, with many voices singing at the same time. And the subsuming of those many different modes in a single musical idea. I think it invites some new work, looking at things like this—ironies, discrepancies like this, which have a certain resonance with principles of man.