Queer Geometry and Higher Dimensions: Mathematics in the Fiction of H. P. Lovecraft

Daniel M. Look

Introduction

> My cynicism and skepticism are increasing, and from an entirely new cause—the Einstein theory. The latest eclipse observations seem to place this system among the facts which cannot be dismissed, and assumedly it removes the last hold which reality or the universe can have on the independent mind. All is chance, accident, and ephemeral illusion—a fly may be greater than Arcturus, and Durfee Hill may surpass Mount Everest—assuming them to be removed from the present planet and differently environed in the continuum of space-time. . . . All the cosmos is a jest, and fit to be treated only as a jest, and one thing is as true as another. (*SL* 1.231)

Howard Phillips Lovecraft lived in a time of great scientific and mathematical advancement. The late nineteenth to the early twentieth century saw the discovery of X-rays, the identification of the electron, work on the structure of the atom, breakthroughs in the mathematical exploration of higher dimensions and alternate geometries, and, of course, Einstein's work on relativity. From his work on relativity, Einstein postulated that rays of light could be bent by celestial objects with a large enough gravitational pull.[1] In 1919 and 1922 measurements were made during two eclipses that added support to this notion. This left Lovecraft unsettled, as

1. This statement is a simplification: Newton's theories already posited that rays of light could be bent in this manner, but Einstein's theories disagreed with Newton in terms of the magnitude of this bending.

seen in the above quotation from a 1923 letter to James F. Morton.

Lovecraft's distress is that it seems we can no longer trust our primary means of understanding the world around us. The discovery of X-rays, for example, demonstrated the existence of an invisible reality beyond the reach of our senses. Lovecraft uses similar ideas in his stories to create an essence of fear by removing the sense of familiarity from the familiar, creating a landscape seemingly outside of human experience. This is Freud's concept of the uncanny (*Das Unheimliche*), taking the familiar and making it unfamiliar, creating a sense of "uncomfortable recognition." In "Notes on Writing Weird Fiction," Lovecraft states that "Horror and the unknown or the strange are always closely connected, so that it is hard to create a convincing picture of shattered natural law or cosmic alienage and 'outsideness' without laying stress on the emotion of fear" (C*E* 2.176). In "The Call of Cthulhu" the sense of the uncanny arises from twisting of the laws of geometry. Rather than the geometric notions we are accustomed to, Lovecraft describes geometries that are queer and non-Euclidean. Whether or not a reader understands the phrase "non-Euclidean" it has a chilling effect, giving the impression of a break in the natural order, a common theme in cosmic horror. Given that Euclid's *Elements* was a common text in geometry classrooms through the end of the nineteenth century, it is likely that many of Lovecraft's readers were at least familiar with Euclid.

Lovecraft's use of mathematics has been explored in previous papers. In particular, Hull's "H. P. Lovecraft: A Horror in Higher Dimensions" points interested mathematics students to the writing of Lovecraft. This is a brief piece intended for audiences familiar with certain mathematical concepts. Halpern and Lobossiere's "Mind out of Time: Identity, Perception, and the Fourth Dimension in H. P. Lovecraft's 'The Shadow out of Time' and 'The Dreams in the Witch House'" contains, among other things, a discussion of how and why Lovecraft used mathematics. The intent of these papers, however, is not to explain the mathematics referenced by Lovecraft. We provide an avenue for the non-mathematician to understand mathematical concepts utilized by Lovecraft. In particular, we focus on Lovecraft's use of dimension and geometry in "The Dreams in the Witch House," "The Call of

Cthulhu," and "Through the Gates of the Silver Key." We summarize the relevant portions of these stories, but primarily discuss the mathematics appearing in the stories, assuming a familiarity with Lovecraft's works on the part of the reader.

Dimension

To understand the geometric and dimensional terms employed by Lovecraft, we start with a story. In 1882 the memoirs of an individual named A. Square were published by Edwin A. Abbott in his novella *Flatland*. A. Square inhabits Flatland—a two-dimensional world inhabited by two-dimensional beings like A. Square who, unsurprisingly, is a square. Through Abbott, A. Square describes how inhabitants of Flatland perceive one another and organize their society. We won't discuss these details (which comprise roughly half of the original novella) as we are interested in the mathematics present in *Flatland*.

One night, A. Square encounters a being claiming to exist in three dimensions: the two of Flatland and a third for which A. Square has no name, but which the visitor, whom we refer to as A. Sphere, calls *height*. When A. Sphere first communicates with A. Square, he does so as a disembodied voice. Then, a dot appears to A. Square, and that dot becomes a circle with increasing radius, which reaches a maximum then begins to shrink, becoming a dot again prior to disappearing. This is confusing to A. Square, but can be understood if we think of Flatland as a two-dimensional space within a three-dimensional space.

Imagine Flatland is a plane, which we can picture as a piece of paper extending infinitely, with the inhabitants drawn on it. The inhabitants of Flatland reside in this plane and cannot see anything not intersecting it. If we, as three-dimensional beings, avoid the plane we are invisible to the Flatlanders. If we touch or put an arm through the plane, the inhabitants see only the two-dimensional cross-sectional intersection.

There are several implications to this scenario that are relevant to our discussion of Lovecraft. For instance, if we put a finger through Flatland the inhabitants would see a circular blob. To capture this creature they might build a rectangular enclosure. To them, it is not possible to escape such a structure, but we have access to a third dimension and can simply pull our finger out of the plane and re-insert it outside of the rectangle. To the Flatlanders, we will have teleported. But in reality, we are only making use of a dimension they cannot see.

We can now understand A. Sphere's appearance as described by A. Square. A. Sphere spoke to A. Square before intersecting Flatland. He then crosses Flatland, first intersecting only at a point when the sphere is tangent to the plane, then becoming a circle with varying radius when the sphere is cut by the plane, then becoming a point again just before disappearing as the sphere passes through the other "side" of Flatland (Figure 1).

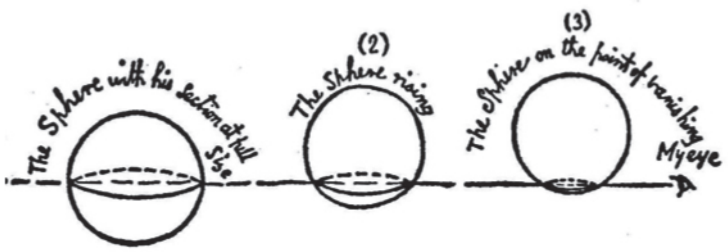

Figure 1: Edwin Abbott's drawing of A. Sphere passing through Flatland. *Ibilio: The Public's Library and Digital Archive*. ibiblio.org. 26 June 2003. Web. November 2014 http://www.ibiblio.org/eldritch/eaa/F16.HTM>

As an example of these ideas in Lovecraft we consider "The Dreams in the Witch House." This story follows Walter Gilman, a mathematics student at Miskatonic University, who rents a room in an old building that at one time housed a witch, Keziah Mason. Gilman begins obsessing over the strange angles of one corner of his room and is plagued by nightmarish dreams.

In one of his dreams, Gilman "observed a further mystery—the tendency of certain entities to appear suddenly out of empty space, or to disappear totally with equal suddenness" (*CF* 3.238). This could be accounted for by a being inhabiting more than three spatial dimensions intersecting our three-dimensional space. If the creature pulls itself "out" of our space, through a direction inaccessible to us, it would seem to disappear. Further, there are indications that Keziah's witchcraft is related to geometry:

> [Keziah] had told Judge Hathorne of lines and curves that could be made to point out directions leading through the walls of space

> to other spaces beyond, and had implied that such lines and curves were frequently used at certain midnight meetings in the dark valley of the white stone beyond Meadow Hill and on the unpeopled island in the river. . . . Then she had drawn those devices on the walls of her cell and vanished. (*CF* 3.233)

Dimension provides a possible explanation for Keziah's escape from her prison through strange angles and directions. If Keziah's "witchcraft" included a perception of a direction distinct from all known directions along with the ability to move through this "fourth dimension," she would appear to vanish and would have little trouble escaping a three-dimensional jail cell. In fact, Gilman posits that this is possible and that if individuals had the requisite mathematical knowledge they could

> step deliberately from the earth to any other celestial body which might lie at one of an infinity of specific points in the cosmic pattern. Such a step, he said, would require only two stages; first, a passage out of the three-dimensional sphere we know, and second, a passage back to the three-dimensional sphere at another point, perhaps one of infinite remoteness. (*CF* 3.240)[2]

These ideas appear in "Through the Gates of the Silver Key" by Lovecraft and E. Hoffmann Price. The story takes place at a gathering held to discuss the fate of Randolph Carter, whose mysterious disappearance is described in "The Silver Key." Through the narration of the Swami Chandraputra (who is actually Carter) we learn that Carter had journeyed through "gates" opened by the silver key. When beyond the gates Carter's sense of space and time become blurred, and Carter is told "how childish and limited is the notion of a tri-dimensional world, and what an infinity of directions there are besides the known directions of up-down, forward-backward, right-left" (*CF* 3.302).

In both of these stories we encounter the notion of directions other than the "known directions." We can visualize this by returning to Flatland. Figure 2 shows a direction that, to a Flatlander,

---

2. This idea is reminiscent of Einstein-Rosen bridges, or wormholes, a concept discovered by Ludwig Flamm in 1916. The name derives from a 1935 paper by Albert Einstein and Nathan Rosen on the same concept.

would be distinct from all known directions. As shown, each plane is a separate "universe." The known directions for the inhabitants of Flatland include the directions accessible to them: north, east, south, west, and all combinations of those directions. Thus, the arrow pointing from one universe to the other is perpendicular to each of the directional arrows contained in the first universe. In other words, this direction is different from all known directions (for the inhabitants of Flatland), and traveling in this direction would take Flatlanders "outside" of their universe.

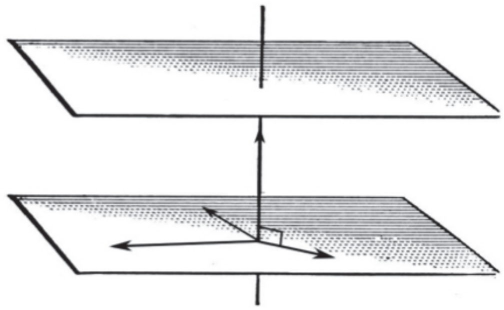

Figure 2: To the inhabitants of Flatland, the direction from one plane to the other is perpendicular to all their known directions. Adapted from G. A. Wentworth *Plane and Solid Geometry* (Boston: Ginn & Company, 1899) 263

Geometries

"The Dreams in the Witch House," "The Call of Cthulhu," and "Through the Gates of the Silver Key" all include uncanny geometric ideas. In each, there is mention of odd angles and geometric figures not behaving according to the properties typically ascribed them. To understand these ideas we explore some concepts from geometry, which will lead us to non-Euclidean and Euclidean geometries.

A beautifully accessible conversation similar to the following can be found in the introductory chapter of *The Shape of Space* by Jeffrey Weeks. To start, we return to Flatland. Intuitively, most people picture Flatland as an infinite plane. However, this may not be the case. Perhaps Flatland has an intrinsic shape that we would call a sphere. How would this appear to the inhabitants of Flatland? We don't have to stretch our imaginations to picture this, as we already experience a version by living on a roughly spherical planet.

What we see around us looks flat; the curvature and size of the Earth relative to our size make the curvature imperceptible. Likewise, the inhabitants of Flatland would not necessarily see the curvature of their universe. What they would be able to do is leave in one direction and, without turning around, come back to their starting point. And why limit Flatland to a sphere? Perhaps its inhabitants live on a torus (Figure 3).

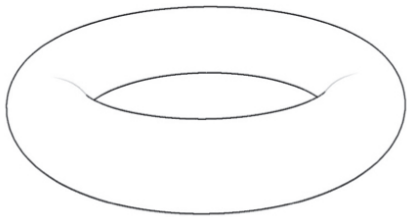

Figure 3: Perhaps Flatland is a torus?

A torus has properties in common with a sphere; for example, the landscape would still appear locally "flat" if the inhabitants were small enough relative to the torus. Also, Flatlanders could still leave in one direction and come back to their starting point. Are there differences that an inhabitant of Flatland could detect? We see a giant hole in the middle, but the inhabitants of Flatland would not see that as they are trapped on the surface. However, imagine two travelers leaving a common point walking in different directions until they return to the starting point. On a torus it is possible that both could return to the starting point without their paths crossing, which is not possible in the similar situation on the sphere. This is shown in Figures 4 and 5.

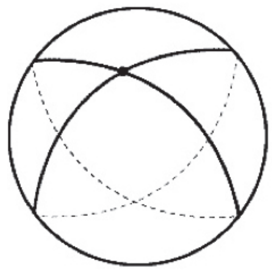

Figure 4: If we choose two directions and walk on a sphere, the paths must cross before returning to the starting point.

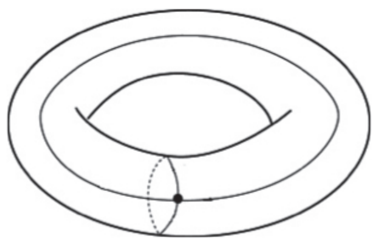

Figure 5: If we choose two directions and walk on a torus, both paths can return to the starting point without crossing.

These are only two of an infinite number of possible models for Flatland. Both the sphere and the torus are objects we would intuitively call "curved." Is there any way the Flatlanders could determine if their universe is curved? To this end, let's think about what a triangle would look like on a spherical Flatland. This will lead to a possible explanation for angles that appear "wrong" as well as providing a transition to non-Euclidean geometries.

Since a triangle can be defined as the region bounded by three distinct, non-pairwise parallel lines, we start by discussing lines on spheres. To this end we define a line segment as *the shortest distance between two points*. When trapped on the surface of a sphere, the shortest distance between two points always lies on a *great circle* containing those points, a great circle being a circle on the sphere whose center is also the center of the sphere. A great circle will always split the sphere into two equal sized pieces, unlike a *small circle*, whose center is not the center of the sphere. Figure 6 shows a sphere with a great circle and two small circles. On our (roughly) spherical world the lines of latitude, with the exception of the equator, are small circles while all lines of longitude are great circles.

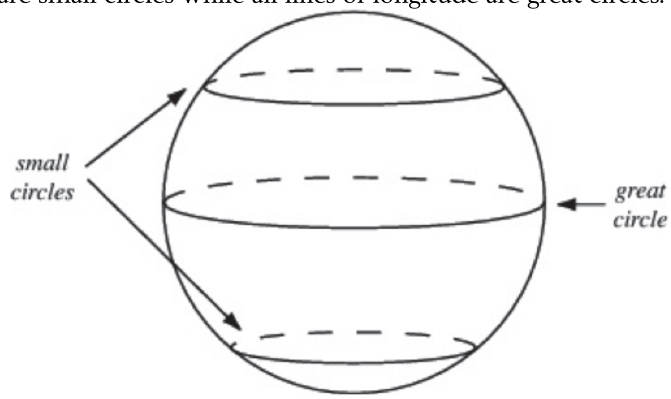

Figure 6: Two small circles and a great circle on a sphere. "Great Circle" *Mathworld*. Wolfram Research, Inc., 30 Nov. 2014. Web. 1 Dec. 2014. http://mathworld.wolfram.com/GreatCircle.html

In Figure 7 we see three great circles, a, b, c, intersecting at three points, A, B, C. This defines a triangle on the sphere with interior angles x, y, z. (Actually, those three "lines" divide the sphere into eight triangles, but we will only consider the triangle with sides a, b, c.) From the picture it seems intuitively obvious that unlike "regular"

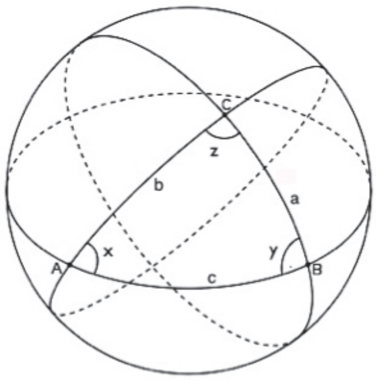

Figure 7: A triangle on a sphere. Note that the angles, x, y, and z add to more than 180 degrees. Adapted from Triangles on a Sphere. "Spherical Trigonometry" *Wikipedia*. Wikimedia Foundation, Inc., 13 November 2014. Web. 28 November. 2014. http://en.wikipedia.org/wiki/Spherical_trigonometry.

triangles, the interior angles for the spherical triangle sum to more than 180 degrees. So if the residents of Flatland were to construct a triangle, they could measure the angles to see if their world was curved. Before we think this is too easy we should keep in mind that this sphere is the entire universe for the Flatlanders. Unlike a flat geometry, the sum of interior angles for triangles on a sphere varies with the size of the triangle (although always remaining greater than 180 degrees). In order to make a triangle with interior angles whose sum is detectably greater than 180 degrees, the Flatlanders may need to make a triangle almost as large as their entire universe.

How does this conversation relate to Lovecraft and angles that seem "wrong" or queer? If this "curvature" is the explanation for strange angles in Lovecraft's work, then it is not only detectable to the characters but also detect1ble on a distressing magnitude. Imagine that Flatland is, in general, a plane. However, there are some "bumps,"[3] as in Figure 8. A resident of Flatland far from these

3. In his *Space Theory of Matter* (1870), mathematician William Kingdon Clifford proposed that small portions of space are of a nature analogous to little hills on a surface that is, on average, flat.

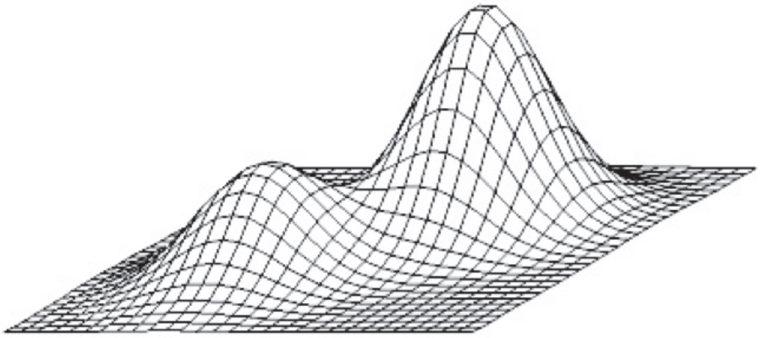

Figure 8. Curved Flatland. "Hill Climbing" *Wikipedia.* Wikimedia Foundation, Inc., 4 November 2014. Web. 28 November 2014. http://en.wikipedia.org/wiki/Hill_climbing.

bumps would find that the interior angles of a triangle add to 180 degrees. However, if the bumps were "curvy" enough, then the same resident could walk to one of these bumps and obtain triangles whose interior angles sum to something other than 180 degrees (this sum could be more or less than 180, as we will soon see). If this individual had lived its entire life in the flat portion of Flatland the geometry of this place would seem uncanny with angles that were "wrong."

What would it look like if our universe had pockets of varying curvature? This is difficult to picture in the same way that we picture a Flatland with bumps, but the key idea remains. Namely, if the curvature were high enough near a particular location, we may be able to discern a difference, one of these differences being perceptible changes in angles.

Lovecraft often mentions non-Euclidean geometry in conjunction with "strange" angles. In the next section we use the concept of curvature to explore non-Euclidean and Euclidean geometries. We then return to Lovecraft to discuss some of the instances where these ideas appear in his fiction.

Euclidean and Non-Euclidean Geometry

A little over 2000 years ago, Euclid wrote *Elements*, his treatise on geometry. *Elements* starts with twenty-three definitions, five axioms (common notions), and five postulates (geometric assumptions). From these Euclid was able to prove results that were in turn used to prove more results, until there arose an immense number of geometric theorems. All these theorems were based entirely, in theory, on the initial assumptions and definitions. It is no surprise that Euclid is sometimes referred to as the Father of Geometry. (We note, however, that one criticism of *Elements* is that some of the proofs involve implicit assumptions not listed.)

Euclid's *Elements* served as the standard geometry textbook in most places until the late nineteenth century. Thus, for Lovecraft and many of his readers "Euclid" is almost synonymous with "geometry." So it is not surprising that Lovecraft refers to Euclid when discussing geometries that somehow lie "outside" the "normal" laws of geometry. This occurs when Lovecraft references non-Euclidean geometries, but there are other examples. Lovecraft invokes Euclid in *At the Mountains of Madness* through a character's description of "geometrical forms for which an Euclid would scarcely find a name" (*CF* 3.80). Here we see Lovecraft's common theme of removing a character from the familiar. Referring to geometric forms gives the impression that the objects are simple, on par with squares or circles. However, they are somehow beyond our conception and even Euclid would not be able to categorize them, implying a character's inability to construct a complete picture of his surroundings. We will return to this theme when discussing "The Call of Cthulhu."

In mathematics, the idea is to use as few assumptions as possible when beginning an exploration. So mathematicians wondered if it were possible to prove any of the five initial postulates using the other four. If it were, then four postulates would suffice. Time and time again the assumption under scrutiny was the fifth postulate, which is equivalent to:

> Given any line and any point not on the line, exactly one line can be drawn through the point that is parallel to the first.

This is shown in Figure 9, where M is the only line through P that is parallel to the line N.

For centuries mathematicians tried proving the fifth postulate from the other four—but each effort proved futile. Eventually another approach was tried; namely, the exploration of a geometry for which the parallel postulate is not assumed. Most mathematicians felt the parallel postulate was a required assumption, so they approached this study looking for contradictions, implying the necessity of the fifth postulate. The mathematician Carl Friedrich Gauss worked on this problem, mentioning it to his friend Farkas Bolyai, who offered several (incorrect) proofs for the parallel postulate.

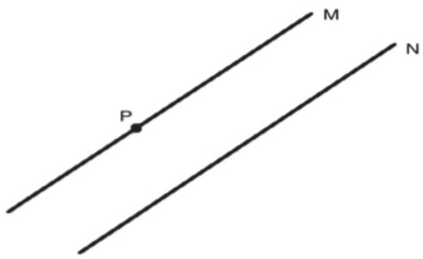

Figure 9: Given a line, N, and a point, P, not on the line, the parallel postulate implies that there is exactly one line, namely M, through the point parallel to the original line.

(Gauss did not present his ideas to the general mathematical community, as he believed the fifth postulate was independent of the other four—an idea that would cause a controversy Gauss preferred to avoid.) Bolyai taught mathematics to his son, János Bolyai, but warned him not to waste any time on the problem of the fifth postulate. János did not heed that advice and in 1823 wrote to his father saying, "I have discovered things so wonderful that I was astounded . . . out of nothing I have created a strange new world." Boylai's work (and that of other mathematicians) led to the discovery that three entirely consistent categories of geometries were possible, distinguished by the number of parallel lines:

- If there is precisely one parallel line we say the geometry is *Euclidean*, as it matches Euclid's original presentation.
- If there are no parallel lines we say the geometry is *elliptic*.
- If there are infinitely many parallel lines we say the geometry is *hyperbolic*.[4]

We are now able to give a definition of Euclidean and non-Euclidean geometries. A Euclidean geometry is one with exactly one parallel line. This is our "intuitive" geometry. A non-Euclidean geometry has either no parallel lines or an infinite number of par-

4. It can be shown mathematically that having two parallel lines implies there is an infinite number of parallel lines, so the only choices are none, one, or infinitely many.

allel lines through the specified point.

In terms of horror, we are accustomed to the geometry of our universe, be it Euclidean or non-Euclidean. However, the non-Euclidean geometries in Lovecraft's stories are not familiar to the characters. This implies that the geometry is not consistent with their expectations; they are accustomed to a Euclidean geometry and are now experiencing a non-Euclidean geometry. We note that in our last Flatland model the bumps cause a change in the local geometry. This means a creature living in a Euclidean region of space could move to a non-Euclidean one.

Since Euclidean geometry is the "standard" geometry, we won't spend time explaining it. The main concepts we use are that there is always exactly one parallel line through a given point not on a line and that the interior angles of a triangle sum to 180 degrees. In the following two sections we discuss the two other possibilities.

Elliptic Geometry

The spherical model discussed earlier is an example of an elliptic geometry. The geometry on a sphere, which is called *spherical geometry*, is not the only possible form of elliptic geometry. However, the spherical model allows visualization and we forgo more complicated models and explanations in favor of this intuitive approach.

Recall that the equivalent of a line on a sphere is a great circle. To make this more precise, the mathematical term for the shortest distance between two points is *geodesic*. In Euclidean geometries, the geodesic is a "straight" line. ("Straight" is in quotation marks to indicate our standard idea of a line; we have not defined what it means to be "straight.") On a sphere geodesics are great circles. Using the language of geodesics, the fifth postulate states that given a geodesic and a point not on that geodesic there exists exactly one geodesic through the point parallel to the first.

To see why the geometry on a sphere is elliptic, note that any two geodesics on a sphere must intersect, as shown in Figure 4. Hence, given a geodesic on a sphere and a point not on that geodesic, there are no geodesics through the point parallel to the first, implying this geometry is elliptic. Further, recall that the interior angles for a triangle on a sphere sum to more than 180 degrees. This is always the case with elliptic geometries.

Hyperbolic Geometry

The sphere makes a nice visual for an elliptic geometry and the plane does the same for a Euclidean geometry. For hyperbolic geometry we use a *hyperbolic paraboloid*, sometimes referred to as a saddle, as shown in Figure 10. On this surface, for any geodesic M and point P not on M we have an infinite number of geodesics passing through P and parallel to M. Figure 11 shows a geodesic M and a point P not on M with three geodesics parallel to M passing through P.

Before closing this section, we note that non-Euclidean geometries are not the mad fancy of mathematicians attempting to "break" conventional geometry. Although we only discussed two-dimensional models embedded in a three-dimensional space, there are also hyperbolic, elliptic, and Euclidean geometric models for three-dimensional space. In fact, one of Einstein's models involves a three-sphere (a four-dimensional analogue of our usual sphere), which implies a "curved" spacetime. A conversation on spacetime would bring us too far afield, so we simply note that time itself is now tangled up in the "curving." As one can guess, there is active research into the "shape" of our universe and spacetime. It is the advanced version of the question "Is the world flat?" (We refer interested readers to *The Shape of Space.*)

Queer Landscapes

We have already seen mention of queer geometries in "Through the Gates of the Silver Key" and "The Dreams in the Witch House." We now turn our attention to "The Call of Cthulhu," which involves some of Lovecraft's most explicit use of uncanny geometry and landscapes.

Figure 12 shows a pair of parallel lines and a triangle on the saddle surface. In this case we note that the interior angles of the triangle sum to less than 180 degrees.

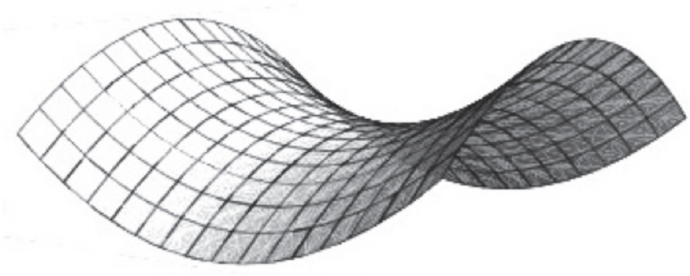

Figure 10: A Hyperbolic Paraboloid.

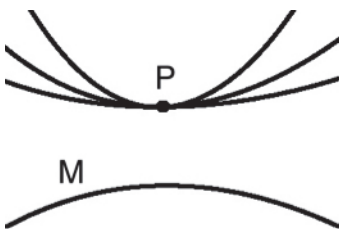

Figure 11: For any line M and point P not on M, there are an infinite number of lines through P parallel to M.

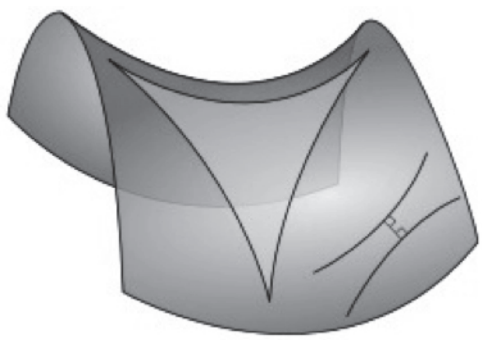

Figure 12: A hyperbolic paraboloid with a pair of parallel lines and a triangle. Adapted from Hyperbolic Triangle. "Hyperbolic Geometry" Wikipedia. Wikimedia Foundation, Inc., 15 September 2014. Web. 24 November 2014. http://en.wikipedia.org/wiki/Hyperbolic_geometry.

"The Call of Cthulhu" tells of George Gammell Angell's investigation of the cult of Cthulhu. In 1925 Angell had been approached by a sculptor, Henry Anthony Wilcox, plagued by dreams involving "great Cyclopean cities of titan blocks and sky-flung monoliths, all dripping with green ooze and sinister with latent horror" (*CF* 2.26). Wilcox reports hearing "a voice that was not a voice; a chaotic sensation which only fancy could transmute into sound, but which he attempted to render by the almost unpronounceable jumble of letters 'Cthulhu fhtagn'" (*CF* 2.26). Years earlier, Angell had met an inspector of police who told a tale of his encounter with the cult of Cthulhu, during which he heard those words included in a chant: "Ph'nglui mglw'nafh Cthulhu R'lyeh wgah'nagl fhtagn." A translation of this chant yields the confusing statement: "In his house at R'lyeh dead Cthulhu waits dreaming" (*CF* 2.34). One of the few cult members captured (and sane enough to give information) told of how Cthulhu's followers were waiting for a time when the stars would align, R'lyeh would rise from the Pacific ocean, and Cthulhu would wake.

Angell's investigation leads him to a report of Norwegian sailor Gustaf Johansen, who was discovered in a half delirious state clutching a "horrible stone idol of unknown origin" (*CF* 2.45). Johansen wrote a manuscript telling of how he and his crew stumbled upon the risen R'lyeh, which had buildings of strange Cyclopean masonry, and eventually encountered and repelled Cthulhu. Although most of the crew died, Johansen and a fellow crewmate manage to survive, adrift on the wrecked ship. When the ship is discovered, only Johansen remains alive.

Mathematically, the interesting part of this story occurs while the crew is exploring R'lyeh prior to encountering Cthulhu. Johansen's description of the city is reminiscent of the dreams of Wilcox, with a character noting that:

> Without knowing what futurism is like, Johansen achieved something very close to it when he spoke of the city; for instead of describing any definite structure or building, he dwells only on broad impressions of vast angles and stone surfaces—surfaces too great to belong to any thing right or proper for this earth, and impious with horrible images and hieroglyphs. I mention his talk about angles because it suggests something Wilcox had told me of

> his awful dreams. He said that the geometry of the dream-place he saw was abnormal, non-Euclidean, and loathsomely redolent of spheres and dimensions apart from ours. (*CF* 2.51)

This passage contains references to uncanny mathematics and echoes Lovecraft's unease at the eclipse experiment. Johansen is unable to describe any definite structure, giving only broad impressions. A complete picture of R'lyeh is beyond his ability to comprehend, creating a feeling of "mathematical insignificance" along with the cosmic insignificance common to Lovecraft.

Further, as we have seen, describing a non-Euclidean space as one that is suggestive of spheres can be viewed as consistent. The geometry of the space is familiar enough that one expects the normal rules to apply, but yet foreign enough to cause distress and confusion. This can also be seen when "Johansen swears [one of his crew] was swallowed up by an angle of masonry which shouldn't have been there; an angle which was acute, but behaved as if it were obtuse" (*CF* 2.53). We have seen examples of triangles whose interior angles sum to more than 180 degrees. In such a triangle there could be two angles summing to 145 degrees, implying that the remaining angle "should" be 35 degrees. However, in a hyperbolic geometry the final angle could be 120 degrees; meaning it should be acute, but behaves as if it is obtuse.

It also seems that Johansen is unable to compose a complete picture of his surroundings:

> The very sun of heaven seemed distorted when viewed through the polarizing miasma welling out from this sea-soaked perversion, and twisted menace and suspense lurked leeringly in those crazily elusive angles of carven rock where a second glance shewed concavity after the first shewed convexity. . . . As Wilcox would have said, the geometry of the place was all wrong. One could not be sure that the sea and the ground were horizontal, hence the relative position of everything else seemed phantasmally variable. (*CF* 2.51–52)

To understand this last description, we return to our model of Flatland with bumps (Figure 8). In this model, A. Square could travel from a region of Flatland with a locally Euclidean geometry to a region with a locally non-Euclidean geometry by approaching and "climbing" one of the bumps. In this model, the local curvature of A. Square's universe varies as A. Square moves across these regions. If A. Square is accustomed to the flat regions of Flatland, this change would be unsettling. Angles would change in degree measure as A. Square moves and usual constants (think of the flatness of the line of horizon) would distort and change.

Is it possible that R'lyeh was in a region of "bent" space, causing Johansen to question his senses and give the above descriptions? In Tipett's "Possible Bubbles of Spacetime Curvature in the South Pacific," the author posits that "all of the credible phenomena which Johansen described may well be explained as being the observable consequences of a localized bubble of spacetime curvature."

One of the effects of a curved spacetime is gravitational lensing, where the image of an object that lies outside a curved region becomes distorted as gravity bends the path of light (similar to the eclipse experiment). This can be used to explain many of the peculiarities in Johanson's report regarding uncertain perspective and geometric confusion. The bending of light rays would cause the horizon to take a curved appearance (which would make it difficult to tell if the sea and ground were horizontal) while some objects on the horizon would be distorted (a circular sun may "thin" as one moves, becoming elliptical in shape and continuing to thin as one approaches the center of the curved space).

Another effect of curved spacetime is time dilation. Basically, time moves at relative rates depending on where one is in relation to the bubble of curved spacetime. Tipett offers this as a possible explanation for the Cthulhu cult's belief that Cthulhu is neither dead nor alive. Perhaps Cthulhu is in a region of space where the passage of time is exponentially slower than it is outside the region. This would indeed happen at the center of the curved spacetime bubble Tipett describes.

We see these ideas in both "The Dreams in the Witch House" and "Through the Gates of the Silver Key." Time dilation could explain Gilman's comment that "Time could not exist in certain belts of space, and by entering and remaining in such a belt one might preserve one's life and age indefinitely" (*CF* 3.260), and the bending of light rays through gravitational lensing gives a possible interpretation for Randolph Carter's description of "great masses of towering stone, carven into alien and incomprehensible designs and disposed according to the laws of some unknown, inverse geometry. Light filtered from a sky of no assignable colour in baffling, contradictory directions" (*CF* 3.290). Although a model for such a geometry is presented, Tipett states that a type of matter is required that is "quite unphysical" and has "a nature which is entirely alien to all of the experiences of human science." Clearly, though, we are not considering the limits of human science. For example, Gilman brings a curious piece of metal found in the Witch House to a certain Professor Ellery who finds

> platinum, iron and tellurium in the strange alloy; but mixed with these were at least three other apparent elements of high atomic weight which chemistry was absolutely powerless to classify. Not only did they fail to correspond with any known element, but they did not even fit the vacant places reserved for probable elements in the periodic system. (*CF* 3.258)

Conclusion

In many instances, Lovecraft's use of non-Euclidean geometry and dimension seems an educated one, with the accompanying descriptions from characters matching at least one possible mathematical interpretation. However, there are instances where Lovecraft uses mathematical phrases in ways that are difficult to interpret. For example, in "Dreams" Gilman feels that he was "certainly near the boundary between the known universe and the fourth dimension" (*CF* 3.243). By most interpretations of dimension, it is nonsensical to speak of being "close" to the fourth dimension.

Although he frequently employed mathematical concepts, Lovecraft did not consider himself an adept mathematician. In fact, in a letter to Maurice W. Moe in 1915 Lovecraft remarked: "Mathematics I detest, and only a supreme effort of the will gained for me the highest marks in Algebra and Geometry at school. In everything I am behind the times" (*SL* 1.9). Although Lovecraft professed to dislike mathematics, he was very interested in astronomy and physics and picked up mathematical notions through these interests. Lovecraft used these mathematical ideas, it would seem, in part because he himself found the "toppling" of Newtonian physics by Einstein's theory of relativity unsettling. As Halpern and Labossiere state:

> Rather than breaking the laws of science with supernatural means and thus generating fear, [Lovecraft] creates a feeling of horror by showing that the common sense views of physics and nature (that is, the old Newtonian views) are the comforting fantasy. In contrast, the counterintuitive "new physics," the true scientific reality, provides the source of horror. (513)

When sight and time are relative, Lovecraft felt all perception was in question. He described landscapes utterly alien to humanity by altering something as fundamental as geometry. Our insignificance and ignorance are underscored by the notion that we exist in a space much bigger than we imagined, with entire spatial dimensions we cannot perceive, natural laws we cannot understand, and geometric forms so alien they escape description.

Works Cited

Abbott, Edwin A. *Flatland: A Romance of Many Dimensions.* 3rd ed. New York: Dover, 1992.

Burleson, Donald R. *H. P. Lovecraft: A Critical Study.* Westport, CT: Greenwood Press, 1983.

Halpern, Paul, and Labossiere, Michael C. "Mind out of Time: Identity, Perception, and the Fourth Dimension in H. P. Lovecraft's 'The Shadow out of Time' and 'The Dreams in the Witch House.'" *Extrapolation* 50 (2009): 512–33.

Hull, Thomas. "H. P. Lovecraft: A Horror in Higher Dimensions." *Math Horizons* 13, No. 3 (2006): 10–12.

Tipett, Benjamin T. "Possible Bubbles of Spacetime Curvature in the South Pacific." *arXiv* (2012): n.p. Web: http://arxiv.org/abs/1210.8144. Accessed 5 June 2013.

Weeks, Jeffrey R. *The Shape of Space.* 2nd ed. New York: CRC Press, 2012.