Inventing Reality: Week #6 Handout, 2004.03.01
by Douglas Leonard

Announcements

• Note: Wednesday’s class will meet at 1 PM at the Hampshire Observatory, where we have done all of our observing, out past the art barn. We will spend the first part of class looking at sunspots through the telescope, and then go to Cole 333 for the remainder of class.

Assignment for Wednesday, March 3

• Nothing to turn in, just remember to go first to the Hampshire Observatory at 1 PM for the start of class!

Assignment for Monday, March 8

• Reader: p. 48 – 53. Tycho Brahe, a pictorial salute.
  Tycho was a most curious individual who was arguably the most careful naked-eye astronomer since Hipparchus, and perhaps in all of history. Of course, someone had Tycho’s actual writings checked out from the library and has since refused to return it despite my pleadings. So I created a pictorial version of his life instead. In all, it’s no great loss – Tycho is not remembered for his actual writings, nor for his cosmological scheme (a compromise between Copernicus and Aristotle), but rather for his incredibly accurate observations that allowed Kepler to at last smash the circle. Also note his painful demise, as retold by Kepler.

• Reader: p. 101 – 105. Abell’s Text, on Tycho Brahe and Johannes Kepler (Sections 2.2 and 2.3).
  This section covers much of what we discussed in class on Monday and Wednesday. Before tackling Kepler’s writings directly, it is good to read about his findings. From this reading, first read some more about Tycho Brahe, and the wonderful observational data that he left to Kepler. Next, read about Kepler’s search for the Harmony of the Worlds, and his resulting 3 Laws of Planetary Motion, that were painstakingly extracted from his writings by Isaac Newton years later. As we discussed in class, notice just how great an influence the Pythagorean and Platonic tradition was for Kepler. Note: Some of the Figures in this section did not reproduce well in the Reader. Better versions are given in the Reader Supplement #1 handout.

• Reader: p. 54 – 56. Johannes Kepler, from his Personal Writings.
  Although reading about Kepler is useful, the best witness to his life was Kepler himself, and these first few pages are autobiographical in nature. Here he describes many of his relatives for the purpose of better constructing his own horoscope late in life, as well as his own personality and physical traits. Is this a very flattering portrait that he paints? His writings are always amusing and very personal in nature: in all his works, he presents not only his final discoveries, but also all the blind alleys he went down in getting there. We are able to see his mind at work in a way not afforded to us by many other major thinkers in history.

  This work is really the climax of Kepler’s lifelong obsession with trying to lay bare the ultimate secret of the universe in an all-embracing synthesis of geometry, music, astrology, and astronomy. It was the first attempt of this kind since Plato, and it is the last to our day. Harmonies is divided into 5 books. The first two deal with harmony in math; the following three with the applications of this concept to music, astrology, and astronomy, in that order. Naturally, we are most interested in his fifth book, and it’s from there that we take our excerpts.
  Kepler starts with quite a grandiose opening: check out the underlined final sentence on p. 56 – he certainly believed he was writing an important work! You need not read the rest of the excerpts all that carefully: they are included just to give you the flavor of his writings, and to let you witness his obsession with musical and geometrical harmony firsthand.
  Although not included in the Reader, note that Kepler’s 3 famous Laws of planetary motion were not gathered together by Kepler; rather, they occur almost incidentally in this highly ornamented Baroque landscape of a musical dream. For instance, his famous 3rd law occurs humbly as ‘Proposition No. 8’ in
a chapter characteristically called ‘A Summary of Astronomical Doctrine Necessary for Speculation into the Celestial Harmonies’. Again, the Laws we cherish from Kepler were just footnotes to his overwhelming search for harmony in the Universe.

We are entering the most mathematical part of the course, and so a little review is in order before plunging in. We will not spend a great deal of time on this in class, so you are expected to read, understand, and ask questions on this material as you need to. This section covers all of the basics that you will be expected to understand for the remainder of the course. The most important topics are basic algebraic manipulation (“solving for $x$”); understanding linear equations and being able to graph them; and understanding the basic geometric equations for area of a plane figure, area of a circle, and surface area and volume of a sphere. I strongly encourage you to work the Exercises that are given in this section – a little effort put in at the start here will pay off in spades later on!

If there is one topic that trips up students more than any other, even at the advanced level, it is understanding how units are transferred from one part of a problem’s solution to another. This section goes through all of the rules for you. Again, work slowly through all of the examples given, and bring any questions you may have to class, or to an office hour – either mine or one of the TAs. After this week, we shall not be reviewing math any more – we’ll be using it!


Weekly Thought Question

From your reading, it is clear that Johannes Kepler, one of the great forefathers of modern science, believed passionately in astrological predictions. Do you think that astrology itself can be considered a science, one that can or should be tested using the “scientific method”? Do you personally believe in astrological predictions?

Assignment for Wednesday, March 10

- Turn in an index card stating the name of the book that you are choosing to review for the book review (book review due Wednesday, March 24), and a brief statement giving your idea for your final project. Briefly outline the nature and format that you envision your project taking, and don’t worry, your topic idea is not written in stone at this point, just on an index card. We will give you the index card to use for this on Monday, March 8.
- Answer the following questions from your Reader, being sure to circle final answers, and put labels on all answers, where appropriate.

1. p. 110, Question 6.
2. p. 111, Problem 12. Note that this planet is assumed to be orbiting the Sun.
3. p. 111, Problem 16. This one is a bit challenging, and will be a good test of your mathematical skills, so here are some hints. Start by very clearly defining the variables that you are going to need, $P_1, P_2$ for the periods of the two moons’ orbits about Jupiter, and $R_1, R_2$ for the distances of the 2 moons from Jupiter’s center. From the given information, we know that $P_1 = 5.196P_2$. Now, Kepler’s 3rd Law must apply to both moons in the system, so the constant $k$ must be equal to $P_1^2/R_1^3$ as well as to $P_2^2/R_2^3$. And from Euclid’s axioms, things that are equal to the same thing are equal to each other. OK, from here, now, use your mathematical might to show that the ratio $R_1/R_2$ must be equal to 3. Carefully show all of your steps. Along the way, it will be helpful to know that $5.196^2 = 27$. Really try to solve this one – you can do it!