

- a. Merely because the question of the course -- how did we first come to have high quality evidence in any of the sciences? -- imposes that bias from the outset
  - b. And also because of the focus on Newton's *Principia*, which itself is presented not just as pursuing that aim, but as an exemplar for how to do it
7. An important consequence of this bias is my not even attempting to present an account of Descartes' vortex theory in the detailed form that made it so plausible to him
- a. In other words, I have not even attempted to give the sort of account Kuhn calls for, in which the claims made by the science come to be viewed in the context of the contextual scheme and external circumstances that gave them the force they had at the time
  - b. The goal of this semester is to put us in a position to read Newton's *Principia* in this manner, but considerations of time have then forced me not to do so for Descartes in particular, and Kepler and Galileo to a lesser extent
  - c. A model of a Kuhnian account of Descartes' vortex theory can be found in Schuster (2005), worked out by focusing not on his *Principia*, but on the genesis of the theory leading up to the version of it in *Le Monde*
- G. 1651: A Transition into "Modern" Science
1. The remainder of this course will take a seemingly abrupt turn toward science as we know it now, with many "textbook" elements of science emerging, one right after another
    - a. Not just in contrast to Descartes, but to Kepler and Galileo as well
    - b. The obvious question, granting its premise, is why, seemingly so suddenly, at this juncture of the seventeenth century
  2. The basic answer is that a new post-Scholasticism generation emerges, with little felt need to build anew from the ground up, choosing instead to proceed from where their predecessors left off
    - a. Galileo dies in 1642, Torricelli in 1647, Mersenne in 1648, Descartes in 1650, Gassendi in 1655
    - b. The new generation, which came of age after Galileo's trial, was more post-Galilean than post-Copernican
    - c. In particular, the new generation had no need to fight the old battles all over again
    - d. Horrocks as an example of picking up from where Kepler left off and pushing forward
  3. That alone, however, does not explain why a different sort of science seems to emerge so abruptly; to explain that we need to identify what it was in the heritage received from their predecessors that at least enabled, if not automatically engendered a different sort of science
    - a. The recognition of how different science became is surely retrospective, for other than Newton those at the time seem to have seen themselves as continuing along existing lines
    - b. In other words, they did not see that matters had changed as much as we can now see it
  4. Let me propose, from very much a retrospective standpoint, that the following five elements having become part of the scientific culture, so to speak, were why science changed in mid-century

- a. The full recognition that apparent celestial motions grossly underdetermine the true motions: spearheaded by Copernicus, Tycho, and Kepler
  - b. The demand that theories of those motions match observed longitudes and latitudes at all times -- a new standard: spearheaded by Tycho and Kepler (and young Horrocks)
  - c. A shift away from the two-millennium-old tradition of compounding curvilinear motions out of uniform circular motions to compounding them out of rectilinear motions: spearheaded by Galileo, Gassendi, and most of all Descartes
  - d. A shift toward employing artifice, like the telescope and pendulum timers, and intricate design of experiments in “putting the question” to nature (Bacon’s phrase): spearheaded by Galileo and Mersenne, but Riccioli as well
  - e. The stress on what Aristotelians would have called “efficient causes” -- that is, “external” causation, as the sole proper form of answer to why- and how-questions: spearheaded by Bacon, Mersenne, and Descartes
5. Several factors within the scope of social history also fed into the change
    - a. The English Civil War and the subsequent Protectorate of Cromwell had undercut the authority of the Anglican Catholic Church within the English universities
    - b. This opened the way to new thought in the class room and to ties, especially between those at Oxford and London, that led to what became called the new “invisible university”
    - c. In Paris, the discussion group Mersenne had formed in the 1640s continued to flourish after his death, initially under the leadership of Gassendi
    - d. The new sciences were the principal subject, and the participants extended to a wide group of intellectuals, including many women
    - c. And In Italy, perhaps in part because Urban VIII had died in 1644, new interest in empirical approaches to questions, especially among the Jesuits at the University of Bologna
  6. 1651 seems to me an appropriate year to mark this transition, not merely because it is the year after Descartes died, but also because it is the beginning of Huygens’s scientific career, and even more so because it was the year of publication of Riccioli’s *New Almagest*
    - a. Usually ridiculed, wrongly I think, as the last gasp of the old, pre-modern science
    - b. The book, as we have already seen, reviews the claims Galileo made in the *Dialogue*, asking which among them had by 1650 become established beyond dispute, but always putting the burden of proof on the new science
    - c. Its Tychonism notwithstanding, the answer it gives is -- quite a lot -- tantamount to an imprimatur for the new science, coming from a Jesuit