3. From that Copernicus obtains the ratio of the mean distances of the planet and the Earth from the mean sun: 1090/10000 in the case of Saturn, "very little different" from Ptolemy's 0.1083
    a. Taking the Earth-Sun radius to be 1.0, it also gives him the distances of Saturn from the mean sun and the Earth at the time of observation: 9.601 and 9.254; and given the eccentricity of the true sun from the mean sun in the Earth orbit, the distance of Saturn from it as well
    b. Ptolemaic astronomy could obtain such a relative distance from the Earth, but had no means of obtaining a relative distance from the mean (or true) sun
4. Still, the comparatively good agreement with Ptolemy for the radius ratio for Saturn should not be surprising, for it was essentially built into Copernicus's theories of heliocentric longitudes
    a. The triangulation presupposes those theories, making them theory-mediated in a manner that comparison with Ptolemy amounts to just a check on Copernicus's transform of Ptolemy
    b. For that reason, even repeated triangulations with different observations, yielding a trajectory of Saturn around the sun, cannot show that Saturn, contrary to Ptolemy, describes a nearly circular orbit about the mean sun
    c. What the comparison with Ptolemy showed, therefore, was that the added complications still left the overall system observationally consistent with Ptolemy's
5. As the Copernican account of the distance to Saturn (in Appendix) displays, the combined orbits of the Earth and outer planets involved complications absent from Ptolemy's account
    a. These made Copernicus's account difficult to understand, witness whereunto is the struggle Kepler had in the 1590s, turning to his teacher Maestlin for help
    b. Maestlin's account, published as an Appendix to Kepler's first book, was likely the best explanation for Copernicus's individual orbital theories from the time, even though strictly speaking it was an exposition of Rheinhold's calculations for the Prutenic Tables
6. But what if there were some independent way of verifying Copernicus's theories of heliocentric longitudes, or even better some account of those longitudes that does not presuppose those theories
    a. Then any nearly circular trajectory for Saturn determined by triangulations using sequences of observations would be evidence that Saturn describes a nearly circular orbit around the mean sun, and not at all so around the Earth
    b. And observations of sufficient precision might even provide evidence deciding between his minor epicycle and a Ptolemaic equant for that heliocentric orbit

G. Philosophic Issue: Grounds for Preferring It?
1. Given all these features and shortcomings, the obvious question is why anyone ought to have preferred the Copernican system before, say, 1600
    a. Several key astronomers did, often with intensity, and they managed to persuade some of their best students to become Copernicans
    b. E.g. Rheticus, Digges, Reinhold, and most notably Mästlin, Kepler's teacher

c. Though some of these -- e.g. Reinhold -- not committed to the reality of heliocentrism, only to the many other reforms

2. Definitely no reason for preferring it before 1600 on the basis of its being more accurate than a correspondingly updated Ptolemaic theory
   a. Comparatively little interest in specific inaccuracies before 1575, so no collection of growing discrepancies until Tycho and his followers begin developing one
   b. But do not need comparison of observation and theory to realize that Copernicus not more accurate, for to too great an extent just a transformation of Ptolemy, as every trained astronomer could see (especially after Mästlin's explanation in Kepler's *Cosmographicum Mysterium*)
   c. Though should note some corrections, like treatment of moon; but these irrelevant to heliocentrism
3. Usual reason given from 17th century on is that Copernican theory more simple than Ptolemaic, and hence preferable
   a. Philosophic worry: why should more simple theory be preferable
   b. Willing to put this worry aside for the moment, and trust intuitive sense that simpler theory preferable
   c. Don't gain much, for still have to face further philosophic question: what do we mean when we say one theory -- e.g. Copernican -- is simpler?
4. Some, like Galileo and even Copernicus in his opening passages, argue that Copernican simpler in the sense that the basic phenomenon of retrograde motion can be explained without (major) epicycles
   a. I.e. to the extent that we ignore real complexities in the observed motions, Copernican theory is simpler, at least in that it requires fewer circles and hence has fewer degrees of freedom
   b. But as soon as we consider the further anomalies, Copernican ceases to be clearly simpler: at least as many circles, though eliminating the equant, and often more circles
   c. And do not fail to notice that the moon now adds a further kind of motion with consequent question: why does the moon circle the Earth when everything else circles the sun?
   d. And the earth itself is engaged in three separate perpetual natural motions
5. Copernican not simpler from a calculational standpoint, nor is it simpler in the sense of raising fewer worries about the underlying physical mechanism
   a. Eliminating equant allows truly uniform circular motion throughout, which may have seemed to pose less of a physical problem through appeal to crystalline spheres
   b. But note that epicycles on epicycles would have provided the same thing for Ptolemy, as shown by Ibn al-Shāţir, and Copernicus allows this in his theory of the moon
   c. And with all the eccentricities and special devices, no reason to think easier to give an account of the underlying physics
6. Copernicus himself emphasizes another "aesthetic" feature that is at least related to simplicity,

namely the way in which different aspects interlock to form a system, so that many effects that have to be individually built into Ptolemaic theory are obtained "for free" in Copernican

a. E.g. why planets brightest during retrograde, why Venus and Mercury never far from sun, why motions on epicycles of outer planets have to be keyed to mean sun, etc.
b. A type of appeal that still carries weight in science today, and certainly was a major factor among converts in the century after *De Revolutionibus*
    (1) The "Pythagoreanism" of Copernicus (a term applied derogatorily by the Church at the time)
    (2) But methodological principle can be stated independently of appeals to classical authority
c. Principle: a theoretical move put forward to account for some one phenomenon gains support when it provides, as corollaries, answers to why-questions regarding other phenomena
    (1) The more such answers to why-questions "for free" and the wider the range of phenomena so covered by the answers, the better
    (2) Theoretical moves that do this preferable to ones that do not
d. An intuitively universally accepted methodological principle, but controversy in philosophy of science over why it is a proper principle
    (1) On view of science as inference to the best explanation: a unified explanation of many separate features better than separate explanations for separate feature
    (2) On a Popperian view of science: wider the range of items covered by a theoretical move, the more opportunites to falsify it

H. Another Answer: Opening a New Path for Research

1. Let me suggest an alternative, extremely sophisticated reason why Copernican ought to have been preferred to Ptolemaic before 1600
    a. Doubt that anyone at the time ever came close to verbalizing this reason, for too much at odds with how people talked about astronomy etc. at the time
    b. But still might have been what tacitly persuaded several of the most sophisticated astronomers to abandon Ptolemy well before decisive empirical evidence to do so started coming in
2. If one adopts the Copernican system, even provisionally, then in a position to use triangulation to infer at least rough sun-planet distances from observations, which ought to coincide with distances inferred from retrograde motions
    a. Inference theory-dependent, for need to use heliocentric longitudes from theory, and need to include eccentricity and varying distance from earth to sun
    b. At first glance, then, question-begging
    c. But suppose Ptolemaic true; then extremely unlikely that distances obtained via triangulation, using heliocentric longitudes that do not beg the question, will be well-behaved at all, much less will support conclusion that planets basically in circular orbits about sun