4. Followed by a paper in the very next issue announcing the reflecting telescope and arguing that it will provide a way around chromatic aberration
    a. Newton's reflecting telescope used in Cambridge from 1668 on, but this the first public announcement
    b. Sharp edges and clear images, impressing all
    c. Nevertheless had little impact on astronomy over the next 25 years, while it was being technologically developed; but had major impact in the 18th century
5. One unfortunate by-product of these two papers was a sharp, public dispute with Hooke, and various others (including Huygens, though more subdued), who rejected Newton's interpretation of his results (within the particle theory of light)
    a. More specifically, ignored Newton's distinction between what the experiments established as fact -- white light composed of light of the several colors -- and its conjectured explanation
    b. Newton was already maintaining a sharp distinction between conjectured hypotheses and experimentally established fact, something others did not maintain
    c. Left Newton thoroughly displeased with Hooke, whom he probably regarded as a fool, and reluctant to participate further in the sort of critical give-and-take of the Royal Society
    d. No more contributions after Newton withdrew from the controversies in the mind 1670s until the "De Motu" manuscript in 1684, the forerunner of the *Principia*

C. Flamsteed and the Greenwich Observatory
1. The other key figure to gain prominence at this time was Flamsteed, who because of illness had not gone through university, but had instead taught himself astronomy during the 1660's
    a. From a wealthy family in Derby, and hence able to acquire some telescopic equipment and pursue the subject in his spare time
    b. Began communicating with others in the late 1660's
    c. Established himself as a first-rate observer, at least in Cassini's eyes, in 1672 when he reported his measurements of the parallax of Mars to him
2. At Flamsteed's instigation, and to some extent at his expense, the Royal Observatory was founded in 1675, under the aegis of the Royal Society, and he became the first Royal Astronomer
    a. Building designed by Wren, and equipment purchased with his own money and generous support of Sir Jonas Moore
    b. Carefully designed in spite of limited funds, as attested to by his own description
3. Flamsteed's observatory never had the quality of equipment of Paris -- causing him to leave planetary astronomy primarily to them, since he could not compete, and instead to concentrate on a star catalogue
    a. Had a 7 ft sextant, two telescopes (7 and 15 ft long), a 10 ft mural arc designed by Hooke that never worked especially well

b. Continued to add improved equipment, usually at his own expense, over the years -- e.g. 7 ft mural arc in 1688

4. What Flamsteed lacked in the way of excellence of equipment, he more than made up for with his painstakingly high standards as an observational astronomer
   a. Enormous care and dedication, coupled to great patience, over a 44 year career
   b. Throughout that time recognized both in England and abroad as one of the two top observational astronomers along with Cassini
5. A falling out with Newton and Halley in the early 1700's led them to attempt to discredit him via a premature publication of part of his Star Catalogue, purloined from him
   a. Crosthwaite published his full *Historia Coelestis Britannica* posthumously in 1725
   b. It remained the basic catalogue worldwide for the next 100 years

D. Changing Attitudes in Observational Astronomy
1. Thus by the late-1670's there were two Royal Observatories -- one in Paris and one in Greenwich -- that were professional in every sense of the word
   a. Headed by exceptionally capable astronomers, Cassini and Flamsteed
   b. Professionally designed to serve the purpose, with fully modern equipment, even if not the best in the case of Greenwich
2. Flamsteed and Cassini had the highest respect for one another as observational astronomers, and remained in close communication from the early 1670's on
   a. In effect, allowing the two observatories to cross-check one another, providing independent support of any exceptional findings
   b. This, of course, had the effect of insuring high standards at both observatories -- something that probably would have occurred anyway, given Cassini's and Flamsteed's predilections
3. This interaction between the two observatories and Royal Astronomers accordingly raised the standards in observational astronomy throughout the world
   a. A new sense of joint endeavor, with obligations to the discipline itself since sloppy work was rightly viewed as something that would just set everyone back
   b. A new guardedness in the statement of conclusions, with great attention given to ways in which findings were still open to further revision and refinement, if not outright rejection
4. This was especially true of Cassini and Flamsteed themselves as individuals, both of whom were always preoccupied with not overstating the case
   a. Constant attention to the potential implications of any imprecision of measurement and continual cross-checking using alternative approaches
   b. Staying up-to-date so far as possible with what was going on at other observatory and elsewhere
   c. Both much more preoccupied with observation than with theory
      (1) Flamsteed a Copernican, Cassini apparently a Tychonist

(2) But for both this irrelevant to their work

5. The resulting new attitude had benefits for all, for one could now turn to either observatory and get extremely reliable information about what was and was not known
   a. Newton, for example, could write Flamsteed rather than having to search through books and journals or do observations himself
   b. Helped make possible increasing attention to discrepancies between prediction and observation as a source of evidence, for could now rely on statements about the discrepancies themselves

E. Observational Anomalies: The Speed of Light

1. The increased attention to precision in observational astronomy during the 1670's revealed a number of small anomalies that were taken at the time to be a basis for further empirical discovery
   a. E.g. Picard had discovered the "movement" of the North Star in his expedition at Uraniborg
      (1) Hooke detected a similar movement in the 1670s, announcing that it was the long sought annual stellar parallax, but didn't follow it up with supporting measurements and others did not replicate
      (2) An anomaly that was not resolved until after 1725 with Bradley's discoveries of the aberration of light followed by the nutation of the Earth
      (3) This anomaly limited the level of precision in astronomy until then
   b. Also Flamsteed's observations of Jupiter and Saturn, the vagaries in the movement of which he initially thought could be accommodated through improved orbital elements, but whether they could remained open
2. One such anomaly was a perceptible delay in the onset of eclipses of Jupiter's innermost satellite, Io, versus Cassini's tables
   a. This was first noticed by Cassini in the early 1670's, with delays in the range of 10 min (of time)
   b. Cassini apparently at first suggested that a speed of light effect was involved, but dropped this idea because no similar anomaly was noticed with the other three Galilean satellites
   c. Cassini instead concluded that there is an irregularity in the movement of Io, a view he continued to hold long after others had become persuaded by Roemer
   d. (Important because the eclipses of Io were providing a simultaneously observable phenomenon that could be used to determine longitude differences around the Earth, as originally proposed by Galileo, but brought to fruition in expeditions supported by the Royal Academy)
3. Cassini's predictions of eclipses for August to November of 1676 were published in the *Journal des Sçavans* in August, and Roemer then predicted, on the basis of his theory that the effect was due to a finite speed of light, that the 16 November eclipse would be 10 minutes late
   a. The prediction was successful, and the December issue of the *Journal* carried Roemer's brief paper, announcing the view that the speed of light is finite and using the delay to measure it (see Appendix for *Phil Trans* translation of paper)