include micrometers

a. Cassini's review of the results, combined with (in some ways) more useful results obtained from time-synchronized measurements in Europe, led him to propose a value of solar parallax of 9.5 sec (21,600 earth radii), though not published until the 1680s

b. Flamsteed, working by himself in England, but with great care, obtained essentially the same value, reinforcing the finding and giving welcome support to Cassini

5. The net effect of the expedition, then, which was not fully reported until 1684, was to institute a substantial reform needed for precise measurements

   a. A new obliquity of the ecliptic, the line of reference for latitude and longitude; a sufficiently small value of solar parallax to make parallax corrections less important; and a standardized correction for refraction (influenced by Snel's law, as published by Descartes)

   b. Also such side benefits as Richer's discovery that the carefully calibrated pendulum clock he took with him lost around 2 and 1/2 min every 24 hours in Cayenne

      (1) Implying a 0.35% decrease in the acceleration of gravity between the equator and Paris, contrary to Galileo

      (2) Which Richer then confirmed via repeated measurements with a 1 sec pendulum over several months, revealing a need to shorten the pendulum by 1.25 lines

   c. Richer's report giving the observations was published in the late 1670s, a few years before Cassini's on the conclusions drawn from the expedition

B. Newton on Refraction: the Newtonian Reflector

1. Newton appears publicly on the empirical science scene for the first time during the expedition to Cayenne, submitting two papers (letters) to the Royal Society

   a. Lucasian Professor of Mathematics at Cambridge, following Barrow's resignation in 1669

   b. Had not published his work in math, but had allowed it to circulate among some British mathematicians, establishing him as one of the leading, if not the leading mathematician in England

2. First paper in 1672 describes some extraordinary experiments in refraction, using prisms and yielding compelling empirical evidence that white light is composed of light of the several colors

   a. Brought the constituents of the spectrum back together to form white light in an extremely delicate experiment, though one successfully duplicated by Hooke

   b. Part of the basis for his particle theory of light -- i.e. for the conjecture that light is composed of different kinds of particles, corresponding to different colors

3. Paper also explained the phenomenon of chromatic aberration -- a consequence of different refractions of the different colors, resulting in misaligned focus

   a. Incorrectly concluded that chromatic aberration not correctable in a refracting telescope -- an over hasty conclusion, since proper use of Huygens's eyepiece will permit correction

   b. But still a major breakthrough, for now know what source is

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