twice as far from the sun's centre; and, therefore, though the sun, according to the various situation of the planets, is variously agitated, and always wandering to and fro with a slow motion of libration, yet it never recedes one entire diameter of its own body from the quiescent centre of the whole system. But from the weights of the sun and planets above determined, and the situation of all among themselves, their common centre of gravity may be found; and, this being given, the sun's place to any supposed time may be obtained.

About the sun thus librated the other planets are revolved in elliptic orbits, and, by radii drawn to the sun, describe areas nearly proportional to the times, as is explained in prop. 65. If the sun was quiescent, and the other planets did not act mutually one upon another, their orbits would be elliptic, and the areas exactly proportional to the times. (by prop. 11, and cor. 1, prop. 13). But the actions of the planets among themselves, compared with the actions of the sun on the planets, are of no moment, and produce no sensible errors. And those errors are less in revolutions about the sun agitated in the manner but now described (by prop. 66, and cor. prop. 68), especially if the focus of every orbit is placed in the common centre of gravity of all the lower included planets; viz. the focus of the orbit of Mercury in the centre of the sun; the focus of the orbit of Venus in the common centre of gravity of Mercury and the sun; the focus of the orbit of the earth in the common centre of gravity of Venus, Mercury, and the sun; and so of the rest. And by this means the foci of the orbits of all the planets, except Saturn, will not be sensibly removed from the centre of the sun, nor will the focus of the orbit of Saturn recede sensibly from the common centre of gravity of Jupiter and the sun. And therefore astronomers are not far from the truth, when they reckon the sun's centre the common focus of all the planetary orbits. In Saturn itself the error thence arising does not exceed 1′ 45″. And if its orbit, by placing the focus thereof in the common centre of gravity of Jupiter and the sun, shall happen to agree better with the phaenomena, from thence all that we have said will be farther confirmed. . . .

To Immense Distances

Thus I have given an account of the system of the planets. As to the fixed stars, the smallness of their annual parallax proves them to be removed to immense distances from the system of

ISAAC NEWTON
As he appeared at the time the "Principia" was published.

the planets: that this parallax is less than one minute is most certain; and from thence it follows that the distance of the fixed stars is above 360 times greater than the distance of Saturn from the sun. Such as reckon the earth one of the planets, and the sun one of the fixed stars, may remove the fixed stars to yet greater distances by the following arguments: from the annual motion of the earth there would happen an apparent transposition of the fixed stars, one in respect of another, almost equal to their double parallax; but the greater and nearer stars, in respect of the more remote, which are only seen by the telescope, have not hitherto been observed to have the least motion. If we should suppose that motion to be but less than 20″, the distance of the nearer fixed stars would exceed the mean distance of Saturn by above 2000 times. Again; the disk of Saturn, which is only 17″ or 18″ in diameter, receives but about 1/2,100,000,000 of the sun's light; for so much less is that disk than the whole spherical surface of the orb of Saturn. Now if we suppose Saturn to reflect about ¼ of this light, the whole light reflected from its illuminated hemisphere will be about 1/4,200,000,000 of the whole light emitted from the sun's hemisphere; and, therefore, since light is rarefied in the duplicate ratio of the distance from the luminous body, if the sun was $10,000\sqrt{42}$ times more distant than Saturn, it would yet appear as lucid as Saturn now does without its ring, that is, something more lucid than a fixed star of the first magnitude. Let us, therefore, suppose that the distance from which the sun would shine as a fixed star exceeds that of Saturn by about

100,000 times, and its apparent diameter will be 7^{v}. 16^{vi}. and its parallax arising from the annual motion of the earth 13″ ″: and so great will be the distance, the apparent diameter, and the parallax of the fixed stars of the first magnitude, in bulk and light equal to our sun. Some may, perhaps, imagine that a great part of the light of the fixed stars is intercepted and lost in its passage through such vast spaces, and upon that account pretend to place the fixed stars at nearer distances; but at this rate the remoter stars could be scarcely seen. Suppose, for example, that ¾ of the light perish in its passage from the nearest fixed stars to us; then ¾ will twice perish in its passage through a double space, thrice through a triple, and so forth. And, therefore, the fixed stars that are at a double distance will be 16 times more obscure, viz. 4 times more obscure on account of the diminished apparent diameter; and, again, 4 times more on acocunt of the lost light. And, by the same argument, the fixed stars at a triple distance will be 9 x 4 x 4, or 144 times more obscure; and those at a quadruple distance will be 16 x 4 x 4 x 4, or 1024 times more obscure; but so great a diminution of light is no ways consistent with the phenomena and with that hypothesis which places the fixed stars at different distances.

Science News Letter, June 18, 1932

One Acre of Forest Yields Browse For One Deer

HOW much ranging land does a deer need if it is to find sufficient food? This question, perplexing to foresters and others associated with game reserves, has been answered for the Pennsylvania woodlands by Drs. E. B. Forbes and L. O. Overholts of Pennsylvania State College.

Their observations indicate that at least one acre of the best forest browse, or greenery, is needed during the growing season to support a single deer, while during the winter a much larger area of sparser browse is required.

The investigators obtained their data from the study of four deer who were confined in a woodland inclosure of 4.87 acres from one spring through the following autumn. The results, they state, represent the upper limit of the very wide range of variation in the capacity of forests to support deer.

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