XLVII. *A Letter from* Richard Price, *D. D. F. R. S. to* Benjamin Franklin, *L L. D. F. R. S. on the Effect of the Aberration of Light on the Time of a Tranſit of* Venus *over the* Sun.

DEAR SIR,

Read Dec. 20. 1770. I Cannot doubt but that the obſervation made by your ingenious friend in the paper * you ſent me is right. The aberration of Venus muſt, I think, affect the phaſes of a tranſit, by retarding them, and not by accelerating them. This retardation is $55\frac{1}{2}''$; for that is the time nearly which Venus, during a tranſit, takes to move over $3''.7$. This, however, is by no means the whole retardation of a tranſit occaſioned by aberration. There is a retardation ariſing from the aberration of the Sun, as well as from that of Venus. The aberration of the Sun, it is well known, leſſens its longitude about $20''$. and the aberration of Venus, agreeably to your friend's demonſtration, increaſes its longitude at the time of a tranſit $3''.7$. Venus, therefore, and the Sun, at the inſtant of the true beginning of a tranſit, muſt be ſeparated from one another by aberration $23''.7$; and, ſince Venus then moves nearly at the rate of $4'$ in an

* The paper which occaſioned this letter, and which is here referred to, may be found in p. 358 of this volume.

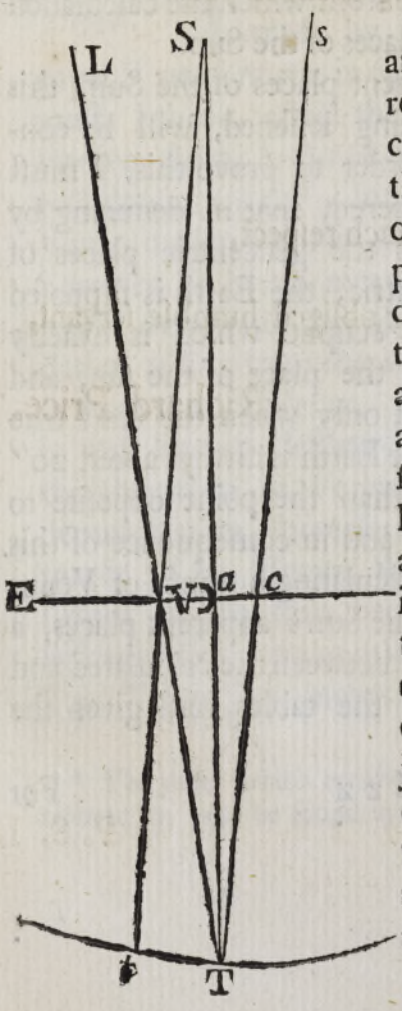
hour,

hour, it will move over $23''.7$ in $5' : 55''$. And conſequently, from the inſtant of the *real* beginning of a tranſit, $5' : 55''$ muſt elapſe before it can begin *apparently*.

It may, I know, be objected here, that the aberration of the Sun ought not to be taken into conſideration, becauſe the calculations from the ſolar tables give the apparent places of the Sun, or its longitude with the effect of aberration included, and therefore always about $20''$ too little. But from this obſervation a concluſion will follow very different from that which the objection ſuppoſes. The retardation I have mentioned is properly the time that the calculated phaſes of a tranſit of Venus will precede the apparent phaſes, ſuppoſing the tables from which the calculation is made to give the true places of the Sun.

If they give the apparent places of the Sun, this retardation, inſtead of being leſſened, will be conſiderably increaſed. In order to prove this, I muſt deſire it may be remembered, that in deducing by trigonometrical operations the geocentric places of a planet from the heliocentric, the Earth is ſuppoſed to be in that point of the ecliptic which is exactly oppoſite to, or $180°$ from the place of the ſun, and that this ſuppoſition is juſt only when the ſun's true place is taken. In reality, the Earth is always about $20''$ more forward in its orbit than the point oppoſite to the Sun's apparent place; and in conſequence of this it will happen, that in calculating a tranſit of Venus from tables which give the Sun's apparent places, a greater difference will ariſe between the calculated and the obſerved times than if the tables had given the Sun's true places.

For, let S be the Sun, T the Earth, V Venus. Were there no aberration of light, the Sun would be always ſeen in its true place, or in the direction TS. But, in reality, in conſequence of aberration, it will be ſeen 20″ leſs advanced in the ecliptic, or in the direction T*s*, ſuppoſing ST*s* to be an angle of 20″. Now a calculation from tables giving the true places of the Sun, would fix the moment of a conjunction, to the time that Venus gets to TS; but this, though the time of the true conjunction, would not be the time of the obſerved conjunction; for the Sun being then really ſeen in the direction Ts, Venus, after getting to TS, muſt move 20″, or from *a* to *c*, before the apparent conjunction can take place.



But if the calculations are made from the apparent places of the Sun, the conjunction will be fixt to the time Venus gets to *t* S, or a line drawn through S parallel to *s* T, for in this caſe t will be the point of the ecliptic oppoſite to the apparent place of the Sun, and the longitude of the ſun ſeen from *t* will be 20″ leſs than its true longitude, and therefore the ſame with its apparent longitude. But the Earth being then really at T, Venus will, at the calculated time of a conjunction, be obſerved at a diſtance from the Sun equal to the angle L T *s*. This angle, ſuppoſing V T 277, and V S 723, may be eaſily found

found to be 72″.2. Add to this 3″.7, the proper aberration of Venus at the time of a tranſit, removing it more towards E, and the whole viſible diſtance of Venus from the Sun's center at the calculated moment of a conjunction, will be 75″.9, over which it will move in 19 minutes of time. And this, conſequently, will be the retardation of the phaſes of a tranſit of Venus occaſioned by aberration, on the ſuppoſition, that in calculating, the Sun's apparent, and not his true place is taken.

I believe theſe obſervations have not been attended to by aſtronomers; and therefore I am the more deſirous of communicating them to you.

I am,

Dear Sir,

with much reſpect,

your obliged humble ſervant,

Richard Price.

P. S. In

P. S. In a former letter which I ſent you, I gave, by miſtake, the error occaſioned by aberration leſs than I have now given it. The diſcovery of this miſtake I owe to the kind aſſiſtance and correction with which Mr. Maſkelyne, the aſtronomer royal, has been pleaſed to favor me.

I have, for the ſake of more diſtinctneſs and clearneſs, ſuppoſed Venus to move in the plane of the ecliptic. Some differences will ariſe from the inclination of the path of Venus to the ecliptic, and alſo from taking the aberration of the Sun, and the proportion of Venus's diſtance from the Earth to her diſtance from the Sun, exactly as they really are at the time of a tranſit. Thus, at the time of the laſt tranſit of Venus, ſuppoſing light to come from the Sun to the Earth in 8′,2, the aberration of the Sun was 19″.8. The diſtance of Venus from the Earth was to its diſtance from the Sun as 290 to 726, and therefore the retardation 18′ : 16″.

Mr. Canton has obſerved, that in the *Con. des Temp*, Mr. De la Lande makes the effect of aberration at the inferior conjunction of Venus and Mercury to be an augmentation of their longitudes. Indeed, Mr. Bliſs himſelf obſerves this; and yet, through an overſight, makes the effect as to time to be an acceleration. Vid. Phil. Tranſ. vol. LII. p. 249.