



# XXVII. Note on shooting stars

Sir J.W. Lubbock

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every instance of motion in which powers of the velocities above the first may be neglected. Now in the case before us it is clear that no part of the velocity can be constantly the same at a given point for any length of time; for in proportion as the earth recedes from the point, the velocity will become less and less and ultimately vanish. This is true whether the æther be disturbed by the earth or its atmosphere. Hence we shall have

$$C=0, \quad C'=0, \quad C''=0.$$

Consequently, substituting  $\phi$  for  $-a^2 \int s dt$ , we have

$$u = \frac{d\phi}{dx}, \quad v = \frac{d\phi}{dy}, \quad w = \frac{d\phi}{dz},$$

and  $u dx + v dy + w dz$  an exact differential.

Cambridge Observatory, Feb. 8, 1848.

## XXVII. *Note on Shooting Stars.*

*By* Sir J. W. LUBBOCK, *Bart.\**

I WISH here to correct an oversight in p. 85 of the last Number, where it is implied that the same *shooting star* may be observed to disappear at different instants of time by different observers. It is obvious that if the moving body cease to shine by reason of its entering the shadow of the earth, this event is entirely irrespective of the position of the observer; and therefore if it should be observed by more than one person, such observations will furnish the parallax, and may determine whether this mode of accounting for the disappearance of the star is correct or not. If it has been attempted to determine the difference of terrestrial longitude by such observations, probably the materials exist somewhere by which the accuracy of the hypothesis can at once be tested. It may possibly however be again observed on the same night, either by the same or different observers, after an entire revolution.

It has been the subject of speculation whether such bodies can owe their origin to violent action at the moon's surface. But observers are, I believe, agreed that the surface of the moon offers no evidence of great agitation. The indentations of the surface remain unchanged, and no phænomena have, I

\* Communicated by the Author.—The calculation in p. 83 of  $q$  should stand thus:—

$$\text{if } R' = 441500 \quad R = 3958 \quad D = 95,000,000$$

$$\log \frac{R' - R}{D} = 7.36227 \quad \frac{R' - R}{D} = q = .002302.$$

believe, been seen which indicate the existence of volcanos, which might discharge small bodies with great force, and thus give rise to satellites of the earth.

The case is widely different as regards the sun. Changes of enormous magnitude are continually witnessed on its surface, which indicate the action of forces agitating the mass probably in a state of fluidity. Recently I have observed spots which were even visible to the naked eye, and of which, on the following and succeeding days, not a trace could be found by a good telescope.

If a body were thrown up from the sun's surface, it must, omitting all consideration of the planets, describe an ellipse having the centre of the sun in one of the foci; and thus, however great the force by which the body may be supposed to have been discharged, it must return to the sun, and, impinging upon it, would not perform even one entire revolution. If however we consider the action of the other planets, and especially of Jupiter, it seems by no means impossible that in returning, a body so discharged might *clear* the sun, and perform many complete revolutions round the primary, that is, it might become a comet (or *shooting star*). It would be interesting to ascertain how much the perihelion distance of such a body might be lengthened under given circumstances by the action of Jupiter; or whether, under any hypothesis of the configuration of the planets, the perihelion distance of any known comet could be brought under  $\cdot 004647$ . Le Verrier suggests that some of the comets may have become fixed to our system and retained by the action of Jupiter; and that in consequence of the same action, they may again wander in space and cease to belong to this system\*. But may not such bodies owe their origin to the same forces, of which the existence is indubitable, which operate on the surface at any rate of the sun's mass? and if so, it is by no means impossible that by calculating the perturbations of some comet for the past, especially one whose perihelion distance is small, it may be traced back to its origin, and the very year ascertained when it left the solar mass.

The phænomena of *shooting stars* may possibly throw light upon the question of the extent to which an atmosphere extends capable of affording any sensible resistance to the mo-

\* "Dans un certain nombre de siècles toutefois, elle atteindra de nouveau l'orbite de Jupiter, dans une direction opposée à celle par laquelle elle a pu arriver dans le système planétaire: et son cours sera certainement encore une fois altéré. Peut-être même Jupiter la rendra-t-il aux espaces auxquels il l'avait dérobée."—Le Verrier, *Comptes Rendus*, Dec. 20, 1847, p. 925.

tion of such bodies, and may thus afford an interesting illustration of the connexion which exists between different branches of physical science. In my Treatise on the Heat of Vapours, p. 43, I have given a table, showing, upon the hypothesis I there adopted, the density and temperature for a given height above the earth's surface. According to that hypothesis, at a height of fifteen miles the temperature is  $240^{\circ}6$  F. below zero, the density is  $\cdot 03573$ , and the atmosphere ceases altogether at a height of 22.35 miles. In the *Comptes Rendus des Séances de l'Académie des Sciences*, tom. viii. p. 95, M. Biot has verified a calculation of Lambert, who found from the phænomena of twilight the altitude of the atmosphere to be about eighteen miles. The constitution of the higher regions of the atmosphere, according to the hypothesis adopted by Ivory, is very different, and extends to a much greater height. See p. 3 of the Supplement to my Treatise on the Heat of Vapours, where I have given a table showing the constitution of the atmosphere according to Ivory. Such a table for the constitution due to Laplace's hypothesis is still wanted.

XXVIII. *Researches into the Identity of the Existencies or Forces—Light, Heat, Electricity and Magnetism.* By JOHN GOODMAN, Esq.\*

*On Thermo-Electricity.*

IT was discovered some years ago by Mr. Sturgeon, that thermo-electricity does not require more than one metal for its development.

In confirming this discovery, I have found that the current was developed only by the more *crystalline* metals, bismuth, antimony, iron, steel, zinc, &c., as will appear on inspecting the accompanying table.

I found also that each metal possessed its own distinctive and peculiar amount of current, as indicated by the galvanometer, and that always in the same direction: that when two opposing metals were united in producing a thermo-current, the minor current would be found to neutralize the opposing current, precisely to the amount of its own powers, and with as much exactitude as if it had been done by arithmetical calculation.

Thus iron alone gave  $7\frac{1}{2}^{\circ}$  current. Conjoined with zinc  $5^{\circ}$ ; zinc alone  $2\frac{1}{2}^{\circ}$  in the opposite direction.

It was also discovered that a minor current conjoined to one

\* From vol. viii. of the Manchester Literary and Philosophical Society's Memoirs, and communicated by the Author.