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XII. *On the Question, whether the Sun, the Moon, and other heavenly Bodies are surrounded by Atmospheres.* By T. W. A. MURHARD*.

THIS question is of the utmost importance to the philosopher as well as the astronomer; and the more so at the present period, as the dispute between the so-called Atmosphericians and Anti-atmosphericians, which has been continued ever since the beginning of this century, is not yet ended. It relates in particular to the atmosphere of the moon, which was so strenuously maintained by Plutarch. But it would be as ridiculous to refer the contest to reason, as if we should endeavour to give a decisive opinion respecting a circumstance with which we are totally unacquainted. It is certain that nothing on this point can be determined *a priori*; and therefore such conclusions as are drawn from analogy must be considered as decisive. The senses must here be our guide; but it is much to be lamented, that our organs are often too weak, and our instruments too imperfect, notwithstanding the great precision to which the latter have been carried in modern times.

But we must first endeavour to establish what we mean in general by the term *atmosphere*. By atmosphere, I understand that delicate subtile body which immediately surrounds the planets, and which is mixed with those heterogeneous particles dissolved on their surfaces, or which evaporate from them. By this definition it is evident, that, according as the nature of the planet, and the particles dissolved on its surface, are different, the atmospheres must necessarily be different also; so that, by knowing the physical nature of the surface of any of the planets, we can form a conclusion respecting the nature of its atmosphere, and *vice versa*. Of this we have a sufficient number of instances in regard to the earth. Let us here only compare the pure air of the dry districts of Arabia with the air of marshy watery districts, which is continually filled with vapours, clouds, and rain, and we shall soon be convinced of the truth of this position. But

* From *Neues Journal der Physik*, by F. A. C. Gren, Vol. III. part 4.

whether

whether each of the planets is surrounded by such a subtle mass or not, is another question, which our experience hitherto has left in the greatest uncertainty, and respecting which we can form only probable conclusions *a priori*.

If we consider the heavenly bodies at the period of their formation, it must naturally occur, that, when created, they must have had atmospheres; for, as soon as the fixed stars began to burn, let their substance be what it might, a great many particles must have thereby been disengaged from them, and have formed a kind of atmospheres. Now, if each of these fixed stars is surrounded by a certain number of planets, its action on them must have separated from them abundance of particles, which, on account of their levity, would immediately ascend and form atmospheres around them: but as the disengaged particles could not all have the same gravity, the lighter would rise to a greater height than the heavier; and, on that account, the rarity of these atmospheres must have increased according as the distance from the planet was greater. The different aqueous, earthy, saline, sulphureous, and mineral particles form therefore in the air, belonging to each planet, what ought properly to be called its atmosphere

That the sun has an atmosphere is admitted by all the modern astronomers. Peyroux de la Coudreniere has in particular asserted, in modern times, and his opinion has been almost universally adopted, that the sun is not a ball of fire, but that his light comes entirely from a luminous atmosphere by which he is surrounded, and which is filled with a highly inflammable vapour that forms a continual covering of fire. According to him, therefore, the sun is a prodigious burning mirror, which can effect with less waste much more than it could do were it a globe of fire. M. Schröter concludes also, from his observations, that the light of the sun arises from the luminous matter by which he is surrounded; so that hopes are entertained that, in the course of time, by making fre-

* Heinius, in his *Betrachtungen über den kometen von 1744*, *Priesterberg* 1774, 4to. p. 101, makes the boundaries of each atmosphere to be in that point where the particles extricated from the planet are in equilibrium between it and the sun,

quent observations of the spots and faculæ, we shall be able to obtain a chart of the sun, as we have obtained one of the moon: for, according to this hypothesis, the spots of the sun are not clouds and thick vapours that arise from the opaque body of the solar orb. According to Peyroux de la Coudreniere, all the planets are still approaching nearer to the nature of the sun; and, in his opinion, Venus, Jupiter, and Saturn, would not exhibit such a luminous appearance were they enlightened merely by the sun. He concludes, therefore, that abundance of inflammable vapour must ascend into their atmospheres, and, by taking fire, increase their light. According to him, our earth acquires a considerable light from a like cause: and this indeed is not altogether improbable; for I myself, with a telescope of a great magnifying power, have frequently observed the heavens, by day as well as night, for this purpose alone, and have seen, in a quarter of an hour, a great many inflammations of this kind in the atmosphere. Peyroux de la Coudreniere, however, goes too far when he believes that Saturn, the remotest of the planets, seems as if inclining to remove from our system altogether; to convert himself into a sun, and to have planets revolving around him. This conceit is sufficiently refuted by the discovery of Uranus (the *Georgium sidus*) by Dr. Herschel.

Upon the whole, we have no certain grounds on which we can reason respecting the atmospheres of the planets. Because our earth has one, and is a planet, it does not thence follow that the rest must have atmospheres. We indeed find every where in nature the greatest diversity and variety; and if we always formed conclusions from analogy, we should fall into the greatest absurdities and errors.

M. Schröter, from the alternate obscurity and bright appearance of Jupiter, which he has observed, thinks himself authorised to conclude, that the atmosphere of Jupiter, in general, has a great similarity to ours*. It is very remarkable, adds he, that the whitish and light zones are not always perfectly bright, but in common seem to be covered with a thin atmospheric matter, and to have sometimes a more luminous appearance than at others. It is not impro-

* See his *Beobachtungen zu den astronomischen Entdeckungen*, Berlin 1788. 1vo.

bable that the surface of Jupiter may reflect a very lively and white light, according to the nature of its component parts, with which we are unacquainted. The stripes observed on the surface of that planet lie in a position parallel to his equator; are subject to a great many variations; and, in general, are considered to arise from atmospheric matter liable to accidental changes. The same thing may be conjectured in regard to Saturn, on which there are stripes of the same kind, according to the late discoveries of Dr. Herschel. But in regard to the atmospheres of Mercury, Venus, Mars, and Uranus, our conclusions must be attended with still less certainty. If they have any, they must be far more subtle, and finer, than that of our earth; else these bodies would not always appear with so much brightness. The existence of an atmosphere around Mars has, indeed, been rendered highly probable by Dr. Herschel and Mr. Schröter; and the latter thinks he observed a crepusculum of $15\frac{1}{2}^{\circ}$ in Venus, which seems to suppose that it has an atmosphere*.

In regard to comets, I can the less venture to hazard any assertions, as some of our modern philosophers consider them to be merely nebulous bodies; I shall therefore confine what I have to say, to the moon, which still remains to be taken into consideration, and respecting the atmosphere of which there has been the most dispute. Towards the end of the sixteenth century it was strenuously maintained by Kepler. In the seventeenth the same opinion was entertained by Kircher, Scheiner, Möstlin, Fabricius, Bulliald, Hevelius, &c. In the present it has been adopted by Louville, Maraldi, Fontenelle, Bianchini, Carbone, Wolf, Bosovich, Euler, Du Séjour, Herschel, Schröter, &c. Those who opposed this opinion were, Huyghens, Cassini, Malczien, De la Hire, De l'Isle, Mylius, Tobias Mayer, Grandjean de Fouchy, &c.

Those who maintain that the moon has an atmosphere found their opinion on the following grounds:—

1. During total eclipses of the sun, a light ring has been seen around the moon parallel to her limb. This pheno-

* See *Bodes Astronom. Fabribuch* 1793, p. 251.

menon was observed, in particular, during those remarkable total eclipses of the sun in the years 1706 and 1715. That of the 12th of May 1706 was observed in London by Halley; in Paris, by Cassini and De la Hire; at Montpellier, by De Plantade; at Berlin, by Hofmann; at Leipzig, by Baron Von Wolf; at Dresden, by Tschirnhausen; at Nuremberg, by Wurzelbau; at Jena, by Hamberger; at Zeitz, by Teuber; and at Breslau, by P. Heinrich.

On this occasion Cassini, De la Hire, De Plantade, Wolf, Wurzelbau and Heinrich observed, during the greatest darkness, a light ring around the moon; but, on the other hand, Hofmann and Teuber perceived nothing of the kind; and those who saw the ring differ very much from each other in the accounts they have given of its magnitude and colour.

The eclipse of the sun on the 3d of May 1715 was observed at London by Halley and Louville in particular, and a ring of the same kind was observed. Rings of the like kind have been observed also at various periods.

2. Many astronomers observe, that the planets sometimes when they approach the moon's limb have a coloured appearance, change their round figure, and seem to assume that of an ellipse. It has often happened that a planet at its ingression has appeared perfectly round, and at its egression quite distorted; or, *vice versa*, distorted at its ingression, and round on its egression. The latter case I once observed myself, in regard to Venus; the former was seen, in regard to Jupiter, by M. Kaffner at Leipzig. This phenomenon takes place not only with the planets but also with the fixed stars, as is proved by a multitude of instances both old and new; so that it seems to be a fact established beyond all dispute.

3. It is said to have been remarked during solar eclipses, that the limb of the sun trembles before the moon entirely touches it.

4. The diameter of the moon is said to have been observed small at the beginning and end of the darkness during eclipses, and greater at the time of the greatest darkness. On this circumstance Teuber founds his proof for the existence of a lunar atmosphere. Euler, from the diameter of the sun ap-
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pearing to be magnified during the annular solar eclipse of 1748, concluded also that the moon has an atmosphere*.

5. The moon, during serene weather, when stars of the seventh magnitude could be seen, has totally disappeared, so that she could not be discovered by the best telescopes. Several instances of this kind are related by Kepler in his *Astronomiæ pars optica*†, and by Copernicus in his *Epitome of Astronomy*‡. The same thing was observed by Hevelius, Riccioli, &c. It is worthy of remark, that at the time when the moon disappeared to Riccioli, she disappeared suddenly also in Holland.

6. Several astronomers have found that the moon does not always appear equally bright and clear. Hevelius says, that at various times, though the weather was equally serene; though the moon had the same altitude, and was at the same distance from the earth; and though he used the same telescopes, her spots did not appear equally bright and distinct, but were more apparent at some times than at others. The same thing was observed by Erasmus Francisci, and Bulliald; and before them, by Möstlin.

7. Fiery phenomena have been seen on the moon; and from this circumstance some have concluded that she has an atmosphere. Kolben saw in 1705, not far from the line, thirty hours after new moon, the two horns of that luminary touch each other; so that she formed, as it were, a bright ring. It is related in the Breslau Collections§, that some people saw the moon, the day after she had been new, as bright as if she had been full; and Siegesbec says, in the same work||, that in 1724, two days after new moon, he saw the same phenomenon as that observed by Kolben.

From all these circumstances it might be concluded that the moon has an atmosphere; but to these grounds, others, perhaps equally strong, might be opposed. These proofs for the other side of the question may be found in Mylius's

* See Sur l'Atmosphère de la Lune prouvée par la dernière Éclipse annulaire du Soleil, par M. Euler, in the Mem. de l'Acad. Royale des Sciences de Berlin 1748, p. 103.

† Pages 227, 297.

‡ Lib. V. p. 825.

§ See Breslauischen Sammlungen, XV. p. 270.

|| XXVI. p. 522.

Thoughts on the Lunar Atmosphere*, and T. Mayer's Proofs that the Moon has no Atmosphere†: but, without transcribing them, I shall here give a short view of them, and in the same order as I have related the grounds on which the opinion of the lunar atmosphere is founded.

In regard to the bright ring (1) which has appeared round the moon during total solar eclipses, it is evident that, even if we admit that the moon has an atmosphere, it must have been occasioned by its refraction. But experience has shown that bright rings of the like kind are produced around all opaque bodies when they are placed opposite the sun or any strong light. This was found to be the case by De la Hire, who opposed this circumstance to the opinion of Louville, who was a strenuous advocate for the lunar atmosphere. For this purpose he took an unpolished globe of stone, and, placing it between his eye and the sun, saw the interior edge of the ring, which was formed around it, broken and uneven, as Louville had seen the interior part of the ring around the moon. A like experiment was made by De l'Isle junior. He caused the rays of the sun to pass through a small hole into a darkened room; held a circular piece of lead between him and the sun; and observed, on a sheet of white paper, that the shadow of the lead was evidently surrounded by a luminous ring‡. John Cassini explained the ring seen around the moon during total eclipses of the sun from the solar atmosphere; and this was carried still farther by De Plantade. But this explanation is not necessary, as it appears that the whole phenomenon may be explained as well, if not much better, from refraction. Du Séjour, however, is of opinion, that refraction of the sun's rays at the moon's limb cannot be admitted unless we first admit a lunar atmosphere: and he shows, from Short's Observation of the Solar Eclipse in 1764, that the refraction of the sun's rays which touched the moon's limb amounted to $4\frac{1}{2}''$.

* Gedanken über die atmosphäre des mondes, *Leipfic* 1746, 4to.

† Kosmologische nachrichten und sammlungen auf das jahr, 1748. *Nurn.* 1750, 4to. p. 397.

‡ See his Paper on the Atmosphere of the Moon, in the *Memoires de l'Academie des Sciences* for 1715. *Paris* 1718, p. 147.

One of the latest instances of such a ring around the moon is that seen on the 24th of June 1778, by Don Antonio de Ulloa, between Tercera and Cape St. Vincent*. Five or six seconds after the sun was completely covered, a very bright ring began to be seen around the moon; and this ring seemed to be in a continual and violent motion round the moon's circumference. The nearer the moon approached to the centre of the sun, it always became brighter and more luminous. Its colour was not every where the same: next to the moon's limb it was reddish; then of a pale or gold-yellow colour; and towards the exterior edge it always became whiter; but it was every where equally luminous and beautiful. All the parts of the ring seemed to be carried round the moon with the same velocity, without the order of the colours being confounded. Every thing before observed, in regard to this luminous ring, might be explained from refraction; but the circumstance, never observed on any other occasion, of its moving with a continual and uniform motion around its centre, if this was actually the case, and if it did not arise from some deception in the organs of sight, makes a new, and, according to every appearance, an almost insuperable difficulty in the explanation. It is much to be lamented that we are likely to remain in this uncertainty a considerable time; for, according to a calculation of M. Du Vaucel †, a total eclipse of the sun, visible at Paris, will not take place for 120 years, and none can occur visible in any part of Europe till the year 1816 ‡. From the above observation Don Antonio de Ulloa does not hesitate to conclude that the moon has an atmosphere.

I shall now proceed to the second point, adduced as a proof

* See his *Observation de l'Eclipse du Soleil totale du 24 Juin 1778*, in Rozier's *Journal de Physique*, Vol. XXV. part 1. April 1780, p. 319; also *Mem. de l'Acad. Royale des Sciences à Paris* 1778, Paris 1781, p. 64; and Don Antonio de Ulloa's Observations on the total Eclipse of the Sun on the 24th of June 1775, in the Swedish Transactions, Vol. XL. *Leipfic* 1783, p. 225.

† Vol. V. Des Memoires presentés.

‡ See Peter Wargentin's Paper on the luminous Ring with which the Moon seems to be surrounded when she entirely covers the Sun, in the Swedish Transactions for 1778, Vol. XL. p. 251.

of the moon having an atmosphere. Some suspicion is excited in regard to the accuracy of this observation, because many astronomers, during the same celestial occurrences at other times, have never observed the smallest change of figure in the stars either during their ingresses or egresses. De la Hire *, however, observed, during an occultation of Jupiter by the moon, that when Jupiter was at the distance of 12' from the moon, he showed the same lively colours as when he approached nearer. But, to make these colours appear, it was necessary that Jupiter should be at the edge of the aperture of the telescope; for when he was in the middle of it none were seen. From this circumstance he naturally concludes, that the colours did not proceed from the moon, but from the glasses of the telescope, which, as they are convex, form at their edges a sort of circular prism. Venus, which appeared soon after, exhibited the same colours as Jupiter. T. Mayer, therefore, gives this excellent rule: Make the experiment without prejudice, and take care to use the telescope with the necessary precaution: it will then, perhaps, be found, that the planets and fixed stars approach the moon at all times in their proper form. De l'Isle ascribed this phenomenon to the inflexion of the rays alone †.

We now come to the third argument adduced in favour of the lunar atmosphere, or the tremulous motion of the sun's limb before he touches the moon during a solar eclipse. This undoubtedly arises from our atmosphere alone; and we have so many instances of such quivering on other occasions, that I do not think it necessary to say any thing farther respecting it. This is certainly one of the weakest proofs advanced in favour of a lunar atmosphere.

In regard to the fourth proof, that the diameter of the moon at the commencement and end of eclipses has been observed to be smaller, and at the time of the greatest darkness to be greater, it appears to be almost void of foundation; and indeed we have more instances of such a phenomenon not being seen, than of its being observed. During the total

* *Memoires de l'Acad. de Paris* 1715, p. 148.

† *Mem. pour servir à l'Histoire et au Progrès de l'Astronomie. Paris* 1738, p. 249.

solar eclipse of 1669, nothing of the kind was discovered; and this was the case in regard to that of 1706, which Hofmann observed at Berlin. Tobias Mayer, also, during the great total eclipse of the sun in 1748, though he made his observation with the utmost attention, could perceive no such thing.

I must now say a few words respecting the fifth and sixth proofs. The cause of both these phenomena lies, no doubt, in our atmosphere, and not in that of the moon; for the phenomena have been seen in one place and not in another.

These are the grounds on which the existence of the lunar atmosphere may be contested: but it appears to me, that we should decide too rashly were we to deny altogether that the moon has an atmosphere; for we may still admit one, though it may be of such a nature as to elude our senses. There are many things in nature which our imperfect organs of sense are incapable of perceiving; but it would be ridiculous on that account to deny their existence. I need only request the reader to recollect the phenomena of general gravity or attraction, magnetism, &c. This much, at any rate, is certain, that if the moon has an atmosphere, it must be of a nature totally different from that of our earth. This will appear the more evident, if we consider that, according to all the observations hitherto made, the moon does not abound with such seas and rivers as our earth. M. Schröter conjectures, that as the moon, in regard to the sun, turns round her axis only once in 29 days 12 hours, this monthly change of day and night may probably have a considerable influence on the lunar atmosphere, and supply the place of our seasons. Of this he is the more convinced by the monthly change in the colour and spots of the moon which he has remarked. The atmosphere of the moon must be different from that of the earth, not only in regard to its brightness and transparency, but also in regard to its power of weakening and breaking the rays of light. But on this subject nothing decisive can be obtained from all the observations hitherto made*.

* See Schröter's Observations on the Atmosphere of the Moon in the *Götting. gel. Anzeig.* 1792, No. 86.

We are equally ignorant in regard to the solar atmosphere, which is said to give rise to the so called zodiacal light. In that case, however, it must not be of a globular form, like our atmosphere, but extend round the sun's body like a kind of zone. From this solar atmosphere M. Mairan * deduces the northern lights; but this opinion has been, in some measure, refuted by d'Alembert †.

The result of what has been here said, is, that respecting the atmospheres of the celestial bodies we know very little; and as the observations on this subject require to be made with the utmost accuracy and attention, it will be a long time before our knowledge on this head can be much enlarged. It is to be hoped, however, that those who possess acuteness of sight, and good instruments, will endeavour to determine this point, for which no person seems fitter than Dr. Herschel.

XIII. *On the Advantages which result from substituting Oak Bark for Gall Nuts in dyeing Black, especially in dyeing Hats.*

DIMO STEPHANOPOLI, a Corsican, and a surgeon in the French army so far back as the year 1782, proposed oak bark as a substitute for galls; and the examination of his process was referred by the Government first to Macquer, who gave a favourable report of the result, and afterwards to Berthollet, who was of a different opinion. Several other means for determining the advantages or disadvantages likely to result from a general adoption of the process were had recourse to. Lately it was revived by the Lyceum of the Arts, from whose report we extract the following account:—

“Experiments were made, by order of the College of Pharmacy, at the manufactory of Beaujolin and Morel. Two boilers, of about two hundred and twenty hats each, were made ready, one for the gall nuts and the other for the

* See his *Traité Physique et Historique de l'Aurore Boreale*, second edit. Paris 1754, 4to.

† See his *Opuscules Mathématiques*, Vol. VI. p. 334.