ON THE APPEARANCES PRESENTED BY THE SATELLITES OF JUPITER DURING TRANSIT.

A PAPER was read by Mr. Edmund J. Spitta, at the November meeting of the Royal Astronomical Society, of especial interest to those who have devoted their attention to Jovian phenomena. As the paper itself is a long one, being the result of over four years' work, we must refer our readers for details to the paper itself; but, speaking briefly, the author observes that since the discovery of the satellites by Galileo in 1610, astronomers have been puzzled by their discordant appearances during transit, but more especially by the fact that these phenomena do not apply equally to all the satellites, or even in some instances to the same satellite in two successive revolutions. It appears that notably the fourth—the farthest from its primary—as it approaches the disk of Jupiter, becomes rapidly and increasingly fainter until it arrives at contact. When once on the limb it shines with a moderate brilliancy for about ten or fifteen minutes, then becomes suddenly lost to view for another period of about the same duration, and lastly reappears, but as a dark spot which grows darker and darker until it equals the blackness of its own shadow on the planet. The appearance presented by the second satellite, however, is entirely different, for it seems never to have been seen otherwise than pure white during transit; whereas the first and third differ yet again from the preceding two. The former is sometimes a steel-gray, and at others a little darker, whereas the latter has been seen perfectly white, and yet so black as to be mistaken for the fourth; both appearances having been witnessed by Maraldi as far back as 1707, and that too in successive revolutions.

The author seems to have spent some years in examining these phenomena on all possible occasions, and under different conditions, such as before, during, and after opposition; and to have collected all published and unpublished observations; and also to have devised an occulting eye-piece—movable shutters in the focus of a Ramsden eye-piece—for the express purpose of shutting off the light of Jupiter; but, to use his own words, "without adding to the pre-existing knowledge of the subject."

The fact of having witnessed, when on the banks of the Rhine in 1886, the transit of a brilliantly illuminated ship's lantern as a dark spot on the disk of the rising full moon, suggested the carrying out of a series of experiments to ascertain the proportions of light which two bodies must possess, so that the smaller should appear gray or black when superimposed on the larger; and it was hoped that if the facts and figures thus experimentally obtained corresponded with the albedos of the satellites themselves as compared with Jupiter, it would not be unreasonable to suspect that the abnormal appearances presented by the satellites depended on functional idiosyncrasies of the eye itself, rather than upon physical peculiarities of the Jovian system.

Space will not allow a description of the experiments, which were somewhat numerous, the photometer employed being an adaptation of that arranged by Prof. Pritchard, of Oxford; but, speaking in short, small disks of different tintings of Indian ink, representing the satellites, were superimposed on larger ones of various sizes of pure white cardboard, and it was found that, with certain restrictions, the difference of albedo (a term expressing "the relative capacity for reflection of diffused light from equal areas") between the smaller and the larger caused the gray and black appearances, and that they were not due to any difference in the *quantity* of light reflected from either. For a moon to appear gray or black, a difference of albedo was required of 0·42 in the first case, and of 0·87 in the second, whilst moons of a superior albedo remained white during transit.

Further, the effect of one moon approaching another, was gone into, and the fading of the smaller was likewise found to be in direct proportion to the relation its albedo bore to that of the greater, and was in no way connected with the *amount* of light reflected by either. The effects in the appearance of the same little moons when in transit over different portions of a sphere were also studied, and, strange as it may seem, *the whole of the phenomena of the dark transit were thus accidentally reproduced*, and this caused much surprise, seeing it was brought about by such simple means. The concluding experiments consisted in photometrically ascertaining, for the first time, the reflective ability of different portions of an unpolished sphere; and the results obtained are set forth in the following abridged table; column 1 giving the exact angle of the observation, and column 2 the resulting albedo.

30°	...	...	·735
40	...	...	·500
50	...	...	·367
60	...	...	·323
65	...	...	·261
70	...	...	·172
75	...	...	·133
80	...	...	·080
83	...	...	·049
86 30′	...	...	·027

A large number of facts and figures having been ascertained, attention was then directed to obtaining the relative albedos of the real satellites themselves as compared with Jupiter. The reduction of the observations was attended with several difficulties, each of which had to be dealt with; but one of them especially deserves a passing mention, and it is this, viz. that the eye does not seem to be impressed in the photometer with the light coming from an object of sensible area, such as Jupiter, to the same extent as it is from a point of light such as is shown by the satellites. A suggestion from Capt. Abney, however, relieved the difficulty, and, this systematic error removed, the results came out in an extremely satisfactory manner, for it was then found that the albedos of the satellites corresponded very approximately with the requirements of the experiments, as the following abridged table shows; in column 1 is shown the number of the satellite, in column 2 its difference in magnitude with that of Jupiter, and in column 3 the resulting albedo.

I.	...	8·12	...	·656
II.	...	8·40	...	·715
III.	...	7·88	...	·405
IV.	...	8·73	...	·266

Thus is it shown to be more than probable that the reason the fourth satellite is uniformly black during transit, when it has passed its period of disappearance, is owing to its albedo being so low as to grant the difference between it and the background necessary for a body to appear black when superimposed on another as ascertained by the experiments. Its preliminary whiteness and disappearance are also shown to be a question of relative albedo, for they are due to the fact that a sphere at its limb and edges loses so much in reflective ability, that up to that moment, the satellite possesses sufficient albedo (as compared with the background in that situation) to maintain its whiteness. So too with the second satellite: its albedo proves to be so high that it is capable of preserving its brilliancy throughout the entire transit. The third and first satellites evidently possess sides of differing albedo, one high enough to maintain a brighter aspect than the other, or even, as in the case of the third, to make it appear white when one side is presented to the earth, and dark when the other. In conclusion, to quote from the original paper, "it is not unreasonable to conclude that these anomalous phenomena are due to functional idiosyncrasies in the eye itself, rather than to physical peculiarities of the Jovian system."