The following PRESENTS were announced, and the thanks of the Members returned for the same:—

FROM

Lords Commissioners of the Admiralty—Professor Piazzi Smyth's Report on the Teneriffe Astronomical Experiments of 1856. 4to. 1858.
American Philosophical Society—Proceedings, Nos. 57, 58. 8vo. 1857.
Anonymous—The Mutinies and the People; or Statements of Native Fidelity, exhibited during the Outbreak of 1857-8. By a Hindu. 8vo. Calcutta, 1859.
Arts, Society of—Journal for May 1859. 8vo.
Astronomical Society, Royal—Monthly Notices, May 1859. 8vo.
Barlow, Rev. John, M.A. F.R.S. V.P. & Sec. R.I.—Rev. T. Reynolds, Iter Britanniarum: or, that Part of the Itinerary of Antoninus which relates to Britain, with a New Comment. 4to. 1799.
Bell, Jacob, Esq. M.R.I.—Pharmaceutical Journal for May 1859. 8vo.
Boosey, Messrs. (the Publishers)—The Musical World for May 1859. 4to.
British Architects, Institute of—Proceedings for May 1859. 4to.
Editors—The Medical Circular for May 1859. 8vo.
The Practical Mechanic's Journal for May 1859. 4to.
The Journal of Gas-Lighting for May 1859. 4to.
The Mechanics' Magazine for May 1859. 8vo.
The Athenæum for May 1859. 4to.
The Engineer for May 1859. fol.
The Artizan for May 1859. 4to.
The Horological Journal, No. 10. 8vo. 1859.
Faraday, Professor, D.C.L. F.R.S.—Rèpertoire de Chimie, par C. Barreswil und A. Wurtz. No. 8. 8vo. Paris 1859.
Franklin Institute of Pennsylvania—Journal, Vol. XXXVII. No. 5. 8vo. 1859.
Geological Society—Proceedings for May 1859. 8vo.
Holland, Sir Henry, Bart. M.D. F.R.S. V.P.R.I.—M. F. Maury's Sailing Directions. 8th Ed. 2 vols. 4to. Washington, 1858-9.
Lincoln's-Inn, Hon. Society of—Catalogue of the Printed Books in the Library. By W. H. Spilsbury, Librarian. 8vo. 1859.
Mosley, Sir Oswald, Bart. M.R.I. (the Author)—A Short Account of the Ancient British Church. 16to. 1858.
Newton, Messrs.—London Journal (New Series), for May 1859. 8vo.
Novello, Mr. (the Publisher)—The Musical Times, for May 1859. 4to.
Photographic Society—Journal, No. 85. 8vo. 1859.

WEEKLY EVENING MEETING,

Friday, June 10, 1859.

THE PRINCE CONSORT, Vice-Patron, in the Chair.

JOHN TYNDALL, ESQ. F.R.S.

PROFESSOR OF NATURAL PHILOSOPHY, ROYAL INSTITUTION.

On the Transmission of Heat of different qualities through Gases of different kinds.

SOME analogies between sound and light were first pointed out: a spectrum from the electric light was thrown upon a screen—the spectrum was to the eye what an orchestra was to the ear—the different colours were analogous to notes of different pitch. But beyond the visible spectrum in both directions there were rays which excited no impression of light. Those at the red end excited heat, and the reason why they failed to excite light probably was that they never reached the retina at all. This followed from the experiments of Brücke and Knoblauch. These obscure rays had been discovered by Sir Wm. Herschel, and the speaker demonstrated their existence by placing a thermo-electric pile near to the red end of the spectrum, but still outside of it. The needle of a large galvanometer connected with the pile was deflected and came to rest in a position about 45 degrees from zero. A glass cell, containing the transparent vitreous humour of the eye of an ox, was now placed in the path of the rays: the *light* of the spectrum was not perceptibly diminished, but the needle of the galvanometer fell to zero, thus proving that the obscure rays of the spectrum, to which the galvanometric deflection was due, were wholly absorbed by the humours of the eye.

Reference was made to the excellent researches of Melloni. In a simple and ingenious manner he had proved the law of inverse squares to be true of radiant heat passing through air, and the eminent Italian inferred from his experiments that for a distance of 18 or 20 feet, the action of air upon radiant heat was totally inappreciable. This is the only experimental result now known regarding the transmission of radiant heat from terrestrial sources through air; with regard to its transmission through other gases it was believed that we were without any information.

It was, however, very desirable to examine the action of such media—desirable on purely scientific grounds, and also on account of certain speculations which had been based upon the supposed deportment of the atmosphere as regards radiant heat. These speculations were originated by Fourier; but it was to M. Pouillet's celebrated Memoir, and the recent excellent paper of Mr. Hopkins, to which we were indebted for their chief development. It was supposed that the rays from the sun and fixed stars could reach the earth through the atmosphere more easily than the rays emanating from the earth could get back into space. This view required experimental verification, and the more so, as the only experiment we possessed was the negative one of Melloni, to which reference has been already made.

The energetic action of the solid and liquid compounds into which the element hydrogen enters, suggested the thought that hydrogen gas might act more powerfully than air, and the following means were devised to test this idea. A tube was constructed, having its ends stopped air-tight by polished plates of rock-salt held between suitable washers, which salt is known to be transparent to heat of all kinds; the tube could be attached to an air-pump and exhausted, and any required gas or vapour could be admitted into it. A thermo-electric pile being placed at one end of the tube, and a source of heat at the other, the needle of an extremely sensitive galvanometer connected with the pile was deflected. After it had come to rest, the air was pumped from the tube, and the needle was carefully observed to see whether the removal of the air had any influence on the transmission of the heat. No such influence showed itself—the needle remained perfectly steady. A similar result was obtained when hydrogen gas was used instead of air.

Thus foiled, the speaker put his questions to Nature in the following way: a source of heat, having a temperature of about 300° C., was placed at one end of the tube, and a thermo-electric pile at the other—a large deflection was the consequence. Round the astatic needle, however, a second wire was coiled, thus forming a so-called differential galvanometer; a second pile was connected with this second wire, so that the current from it circulated round the needle in a direction opposed to that of the current from the first pile. The second pile was caused to approach the source of heat until both currents exactly neutralised each other, and the needle stood at zero. Here then we had two powerful forces in equilibrium, and the question now was whether the removal of the air from the tube would disturb this balance. A few strokes of the air-pump decided the question, and on the entire removal of the air the current from the pile at the end of the tube predominated over its antagonist from 40° to 50°. On readmitting the air the needle again fell to zero; thus proving beyond a doubt that the air within the tube intercepted a portion of the radiant heat.

The same method was applied with other gases, and with most remarkable results. Gases differ probably as much among themselves with regard to their action upon radiant heat as liquids and solids do. Some gases bear the same relation to others that alum does to rock-salt. The speaker compared the action of perfectly transparent coal-gas with perfectly transparent atmospheric air. To render the effect visible to the audience, a large plano-convex lens was fixed between two upright stands at a certain height above a delicate galvanometer. The dial of the instrument was illuminated by a sheaf of rays from an electric lamp, the sheaf being sent through a solution of alum to sift it of its heat, and thus avoid the formation of air-currents within the glass shade of the instrument. Above the lens was placed a looking-glass, so inclined that the magnified image of the dial was thrown upon a screen, where the movements of the needle could be distinctly observed by the whole audience. Air was first examined, the currents from the two piles being equilibrated in the manner described, the tube was exhausted, and a small but perfectly sensible deflection was the result. It was next arranged that the current from the pile at the end of the tube predominated greatly over its antagonist. Dry coal-gas was now admitted into the tube, and its action upon the radiant heat was so energetic, the quantity of heat which it cut off was so great, that the needle of the galvanometer was seen to move from about 80° on one side of zero to 80° on the other. On exhausting the tube the radiant heat passed copiously through it, and the needle returned to its first position.

Similar differences have also been established in the case of vapours. As representatives of this diverse action, the vapour of ether and of bisulphide of carbon may be taken. For equal volumes, the quantity of heat intercepted by the former is enormously greater than that intercepted by the latter.

To test the influence of *quality*, the following experiment was devised. A powerful lime light was placed at one end of the tube, and the rays from it, concentrated by a convex lens, were sent through the tube, having previously been caused to pass through a thin layer of pure water. The heat of the luminous beam excited a thermo-electric current in the pile at the end of the exhausted tube; and this current being neutralised by the current from the second pile, coal-gas was admitted. This powerful gas, however, had no sensible effect upon the heat selected from the lime light; while the same quantity of heat, from an obscure source*, was strongly affected.

The bearing of this experiment upon the action of planetary atmospheres is obvious. The solar heat possesses, in a far higher degree than that of the lime light, the power of crossing an atmosphere; but, and when the heat is absorbed by the planet, it is so changed in quality that the rays emanating from the planet cannot get with the same freedom back into space. Thus the atmosphere admits of the entrance of the solar heat, but checks its exit; and the result is a tendency to accumulate heat at the surface of the planet.

In the admirable paper of M. Pouillet already referred to, this action is regarded as the cause of the lower atmospheric strata being warmer than the higher ones; and Mr. Hopkins has shown the possible influence of such atmospheres upon the life of a planet situated at a great distance from the sun. We have hitherto confined our attention to solar heat; but were the sun abolished, and did stellar heat alone remain, it is possible that an atmosphere which permits advance, and cuts off retreat, might eventually cause such an accumulation of small savings as to render a planet withdrawn entirely from the influence of the sun a warm dwelling-place. But whatever be the fate of the speculation, the experimental fact abides—that gases absorb radiant heat of different qualities in different degrees; and the action of the atmosphere is merely a particular case of the inquiry in which the speaker was at present engaged.†

[J. T.]

---

* The *quantity* of heat is measured by the amount of the galvanometric deflection which it produces; its power of passing through media may be taken as a test of *quality*.

† While correcting the proof of this abstract, I learned that Dr. Franz had arrived at the conclusion that an absorption of 3·54 per cent. of the heat passing through a column of air 90 centimeters long takes place; for coloured gases he finds the absorption greater; but all colourless gases he assumes show no marked divergence from the atmosphere.—*Poggendorff's Annalen*, xciv. p. 337.