time when the student receives it until he has made his last note, every operation ought to be in an order for which very definite reasons can be given, and the completed work ought to be of such a character that anything added to it would be superfluous; anything taken from it would leave it imperfect; and any change in the order of its various parts would be to its detriment. This character of work is generally sought after in the separation of metals from a solution; but the rest of a qualitative analysis, namely the preliminary examination and the testing for acids, is too often a collection of odd operations, which, if the student is lucky, will lead him sooner or later to the desired result, but if he is unlucky may fail to do so through no fault of his own.

CHAPMAN JONES.

POPULAR LECTURES ON PHYSICAL
SUBJECTS.

Gemeinverständliche Vorträge aus dem Gebiete der Physic. Von Prof. Dr. Leonhard Sohncke. (Jena: Gustav Fischer.)

IT is a matter of common remark that the books on scientific subjects which reach us from Germany are, as a rule, so special and detailed in character as to be totally devoid of interest, except to those immediately concerned with the subjects of which they treat. This being the case, it is all the more refreshing to meet with such a collection of popular addresses as Prof. Sohncke has gathered together in the volume before us. He has not restricted himself in his choice of subjects to any one branch of physics; on the contrary, the nine lectures of which the book is made up represent as many different divisions of natural philosophy, and were delivered quite independently before various audiences in Germany.

The first lecture of the series bears the somewhat obscure title, "What then?" and was suggested by a great strike among the coal-miners of Westphalia, which led to a temporary cessation of the German coal supply. The author depicts what would be the consequences if the world's coal supply were exhausted, in terms almost as pathetic as those of Prof. Jevons which moved an English Parliament to appoint a commission on the subject. But recognizing that, after all, coal is only stored up solar energy, Prof. Sohncke endeavours to look at the brighter side of the question by discussing the possibility of utilising the sun's energy in other forms, and so enabling man to remain "lord of creation" even in those days when the entire available coal supply of the world reposes on the shelves of some scientific museum.

Equally spontaneous is the lecture on "Migratory Mountains," in which an account of a holiday visit to the north-east corner of Germany gives an opportunity of describing the formation and movements of the mammoth sand-dunes in that locality.

Of the other lectures, that entitled "The revolution in our views concerning the nature of electrical actions" will probably commend itself to most readers because it treats of a subject now exciting general interest. It con-

tains a short history of the arguments and experiments which led to the substitution of the ether theory of electrical action in the place of the older action-at-a-distance theories. While admitting the existence of a medium which transmits both optical and electrical disturbances, the author thinks it more probable that gravitation is a true action-at-a-distance, and in so doing he tacitly denies that a medium is a necessity. The notion of an empty space is so foreign to English men of science of this generation, that we certainly consider Prof. Sohncke's summing-up of the question to be worthy of attention. He says:—"Even if we could finally succeed in proving that action-at-a-distance is really the result of a transmission through some medium, we must not suppose that all difficulties are then removed. For the process of such a transmission is by no means simple, and cannot be explained without further assumptions; on the contrary, very formidable difficulties arise even here. Directly we try to give a concise explanation of the compression of a body and its subsequent expansion when performing elastic vibrations, we find that a choice must be made between two assumptions equally hard to accept. Either matter is itself capable of compression and expansion, or else it consists of separate vibrating atoms to which we must assign the property of exerting mutual forces on each other at a distance."

From a purely scientific standpoint, the lecture on "Newer theories of atmospheric electricity and thunderstorms" is undoubtedly the most valuable of the series, the subject being one on which Prof. Sohncke can speak with some authority. After describing the older theories of the origin of electrical charges in the atmosphere, he discusses those newer ones which were suggested by the discovery of Hertz that ultra-violet light facilitates the discharge of electricity from a charged body. Of these the best known is that of Arrhenius, who supposes the air, ordinarily a dielectric, to be rendered feebly-conducting by the action of light. According to this theory, the earth is negatively charged, and when its atmosphere is illuminated some of the charge is conducted away to the clouds. The conduction must be electrolytic, otherwise the air would become charged. Prof. Sohncke objects to this theory mainly on the ground that the discharging action of light cannot be considered as due to the air in any way, since it is manifested only when the light vibrations fall on, and are absorbed by, the negative electrode. Further, it is not easy to see how elementary gases such as oxygen and nitrogen can be electrolytes. In concluding he defends his own theory, according to which atmospheric electricity is produced when a cloud laden with particles of ice meets another charged with water drops, the electrification being due to the friction of ice against water. In support of his view the author quotes the fact that hailstones are found to be electrified on reaching the ground.

The appearance of a volume like the present one invariably gives rise to some regrets that the whole earth is no longer of one language and one speech, but we hope that some friend of popular science may be induced by the contents of the book to furnish a translation for English readers.

JAMES L. HOWARD.