NOW that the so-much-dreaded cholera is rapidly approaching our shores, it behoves everyone to be able to recognise the preliminary symptoms of the disease and to guard against them. We would therefore most strongly recommend all who can to read a most valuable and instructive paper by Mr. John Murray, the Inspector-General of Indian hospitals, on "Cholera: its Symptoms and Early Treatment," which was read at the recent meeting of the British Medical Association at Plymouth. It would be a very great boon to society, and probably the saving of many lives, if this paper could be published as a penny pamphlet.

THREE exhibitions, giving free education, and tenable in the department of General Literature and Science, or in that of Engineering and Technical Science, will be open to new students at the Hartley Institution, Southampton, at the commencement of the autumn term next month.

AN earthquake took place in Chiriqui in the State of Panama on the 26th June, at 7.50 P.M. It was rather severe, but no damage was done.

THE U.S. sloop of war *Jamestown* sailed from Valparaiso on the 3rd June, to determine the position of certain reefs and islands reported to have been discovered between the Equator and 24° N.

THE district round Wagga-Wagga, in Australia, was disturbed on June 8 by a somewhat violent earthquake shock; and, owing to the rarity of the occurrence of such phenomena, it has caused much interest. The shock consisted of a succession of sharp but continuous vibrations, lasting altogether for about twenty seconds, the motion appearing to be from the N.W. to the S.E. There was felt, at 16 minutes to 3 P.M. (local time), a slighter second shock, preceded like the first, by a dull rumbling sound.

IN a letter to the *American Journal of Science and Art*, Dr. B. A. Gould reports satisfactory progress with respect to the Cordova Observatory. Although the enterprise has met with an exceptional amount of obstacles, Dr. Gould, who writes on the 26th of April last, expected to begin the mounting of the instruments in the course of a few days. We shall probably recur to his interesting communication.

OBSERVATIONS OF LUMINOUS METEORS IN THE YEARS 1870-71 *

THE object of the Committee was, as last year, to present a condensed report of the observations which they have received, and to indicate the progress of Meteoric Astronomy during the interval that has elapsed since the last report. A valuable list of communications on the appearances of luminous meteors has been forwarded to the Committee in the course of the year, as well as regular observations of star showers. The heights and velocities of thirteen shooting-stars obtained by the co-operation of Mr. Glaisher's staff of observers at the Royal Observatory, Greenwich, during the watch for meteors on the nights of the 5th to the 12th of August last, are sufficiently accordant with the velocity of the Perseids, as previously determined by similar means in the year 1863, to afford a satisfactory conclusion that the results of direct observation are in very close agreement with those derived from the Astronomical Theory of the August Meteor Stream. On the mornings of the 13th to the 15th of November last, a satisfactory series of observations of the November star shower (as far as its return could be identified), recorded at the Royal Observatory, Greenwich, and at several other British Association stations, concurs with very similar descriptions of its appearance in the United States of America, in showing the rapid decrease of intensity of this display, since the period of greatest brightness which it attained in the years 1866 and 1867.

Notices of the appearance of more than twenty fire-balls and small bolides have, during the past year, been received by the Committee; fourteen of the former were compared to the apparent size and brightness of the moon, and the latter include three detonating meteors of the largest class. Descriptions of some of the largest of these meteors are given at length in the report. No notice of the fall of an aërolite during the past year has been received, although the occurrence of large meteors during the Autumn and Spring months was unusually frequent. The locality of one of these, which appeared with unusual brightness in the South of England, on the evening of the 13th of February can be determined at least approximately, as also the elevation of its path.

A table of the height of sixteen shooting stars doubly observed in England during the meteoric shower of August 1870 (independently of the observations made at the Royal Observatory, Greenwich), appeared in the last volume of the British Association Reports. A comparison of the observations made at the Royal Observatory, Greenwich, on that occasion, with those recorded at the other stations, enables the paths of thirteen meteors, seen by Mr. Glaisher's staff of observers (ten of which are new to the former list), to be determined; and the heights and velocities of the meteors thus identified are entered in the Report. The results are as follows: The average height of 16 meteors contained in the last report was 74 miles at appearance and 48 miles at disappearance; of 13 meteors (given in the present list), 72 miles at appearance and 54 miles at disappearance; of 20 meteors (observed in August, 1863), at appearance 82 miles, at disappearance 58 miles. The present average heights are thus somewhat less than those observed in 1863, but they agree more closely with the general average height at first appearance, viz., 70 miles, and that at disappearance, viz, 54 miles. The average velocity of the Perseids (relatively to the earth) observed in the year 1863 was thirty-four miles per second, and that of three Perseids in the present list was thirty-seven miles per second; while the velocity on the astronomical theory, as calculated by Prof. Schiaparelli, was thirty-eight miles per second.

A considerable shower of shooting-stars was also noted on the night of April 20 last, of which preparations were made to record the progress, with satisfactory results.

The report, which was full and elaborate, contained a description of the new meteor-showers noted during the few last years by Prof. Schiaparelli, agreeing in many points with previous determinations by the Committee from the observations contributed to the British Association, and suggesting considerations of novel and important interest in relation to the probable explanation of certain facts regarding the radiant points of shooting-stars. These are in some cases (more or less exactly) simple, double, or multiple points; and in other cases present a wide central space or region of "diffuse radiation." On the other hand, distinct radiant points of ordinary shooting stars, observed on several closely adjacent nights, although apparently exhibiting no other connection with each other by meteors observed on the intervening dates, sometimes including many days, are yet so nearly identical in their positions as to make it almost certain that they belong to distinct families or systems of meteor-streams. Prof. Schiaparelli shows, in a preliminary discussion of these results, that if the particles of a small meteor-cloud, entering from extraplanetary space the region of the sun's attraction, is deflected from its primitive course by the attraction of one of the larger planets into an elliptic orbit round the sun, the velocities of its particles, in their elliptic orbits, will, in general, differ slightly among themselves; and the meteor-group will, in consequence, extend itself into a continuous stream of gradually increasing length along the orbit of the group. Although the continuity of the group will be preserved along its whole length during this extension, yet the stream will only form a continuous meteor-ring (when the foremost particle overtakes the hindmost one in its course) if, while gaining one complete revolution upon the latter, this and the foremost particle of the stream continue to describe the same orbit round the sun, or an orbit which undergoes the same perturbations by the planets. But since the two ends of the stream, during its extension, occupy very different positions in space, the orbits of the extreme particles are, in general, very differently affected by the attractions of the planets; and, when the particles in advance have gained one entire revolution upon those in the rear, the group will not, in general, form a closed ring; but an open, spiral curve, the ends of which, instead of exactly meeting, will generally overlap each other. When the first particle has gained a second revolution in advance upon the last, a second convolution of the coil will generally be added to the spiral curve; and no perfect meteor-annulus, for the same reason as before, will generally be formed by this circuit, or by any succeeding circuits of the meteor-stream, until its length and the number of its circuits are indefinitely increased. Since the thickness and

* Report of Committee, British Association, 1871.

density of the stream diminish as its length increases, its interlacing wreaths will give rise to a group of meteor-showers, more and more difficult to distinguish from each other, as their number becomes greater, until at last the condition of a meteor-belt so formed becomes that of innumerable meteor-particles revolving in orbits apparently independent of each other, and intersecting each other in all possible directions within the general boundaries of the elliptic ring. The appearance presented by a meteor-group of this description, during its first encounters with the earth, will be a periodic star-shower (like that of the November meteors), diverging, whenever it is visible, from a nearly exact and single radiant point. At the end of a certain number of cyclical returns, the star shower will be annually visible on a particular date, diverging from the same, or nearly from the same, radiant-point, but much less abundantly than at first; and a twin meteor-shower with a time of maximum, and a radiant point closely adjacent to the former ones will, at intervals, make its appearance with the original shower. This also, like the latter, after an equal lapse of time, will become annual; and both diminishing together will present the appearance of a double meteor-shower, appearing simultaneously, or very nearly together, with a double or twin radiant-point; while at intervals, a third meteor-shower, of the same general features as the previous two, will begin to be added to the group. Proceeding in this manner, as the antiquity of the meteor-ring increases, the star-shower will resolve itself into a more or less well-defined group of slender streams, producing alternate short lulls, and flights of meteors from a great multiplicity of radiant points, contained within a limited region of diffuse or multiple radiation. The ordinary appearance of the star-shower on the nights of the 9th and 11th of August, answering very closely to the description of a meteor-stream in an already far-advanced stage of its development, the much higher antiquity of the August than that of the November star-shower, already shown by its regular annual return, and by the ancient times in which it appears to have been recorded, must now also be regarded as satisfactorily confirmed by the frequently-recorded multiple, and more commonly observed diffuse character of its radiation. Among the star-showers of less ancient date, of which the November meteors appear to present a conspicuous example, Prof. Schiaparelli includes a meteor-shower observed by Zezioli on October 12, and two others on November 10, 1868; one star-shower on each of these dates radiating very exactly from points in the neighbourhood of the constellation Taurus, as well as the star-shower of October 18, and 20, 1864 and 1865, the radiant point of which was very exactly marked in those years in Orion.

Continued observations of the best-known star-showers being calculated to afford such important information on the present conditions, and on the probable antiquity of their connection with the solar system, the committee propose to re-examine the principal meteor-showers during the coming year, with suitable means for registering the meteors observed on each of the following dates, viz., August 9 to 11, October 18 to 21, November 13 to 15 (A.M.), December 11 to 13, 1871, and January 1 to 3, and April 19 to 21, 1872, and to determine, as exactly as possible, the moments of maximum frequency, the rates of appearance, and the principal points of radiation of the meteors visible on those days.

THE LATE REV. W. V. HARCOURT'S RESEARCHES ON GLASS *

THE subject of the preparation and optical properties of glasses of a great variety of chemical positions, formed, for nearly forty years, a favourite study with the late Mr. Harcourt. As stated in a report published in the British Association Reports for 1844, some experiments on the subject were commenced in 1834, which he was encouraged to pursue further by a request published in the fourth volume of the Transactions of the Association. A report on a gas furnace, the construction of which formed a preliminary inquiry, was published in the reports, but the results of the actual experiments on glass have never yet been published.

My own connection with these experiments commenced at the meeting of the Association at Cambridge in 1862, when Mr. Harcourt placed in my hands some prisms formed of the glasses which he had prepared, to enable me to determine their character as to fluorescence. I was led incidentally to observe the fixed lines of the spectra formed by them; and as I used sunlight which he had not found it convenient to employ, I was enabled to see further into the red and violet than he had done, which was favourable to a more accurate determination of the dispersive powers. This inquiry being in furtherance of the original object of the experiments, seemed far more important than that as to fluorescence, and the increased definiteness caused Mr. Harcourt to resume his experiments with the liveliest interest, an interest which he kept up to the last. Indeed, it was only a few days before his death that his last experiment was made. To show the extent of the inquiry I may mention that at least 166 masses of glass were formed, and cut into prisms for measurement, each mass doubtless involving in many cases several preliminary experiments, besides discs and masses for other purposes.

It is well known how difficult it is, in working on a small scale, to make glass which is free from striæ and imperfections of the kind. Of the first group of prisms, 28 in number, 10 only showed a few of the principal dark lines of the solar spectrum; the rest had to be examined by the bright lines in artificial sources of light. These prisms seemed to have been cut at random by the optician from the mass of glass furnished to him. Theory and observation alike showed that striæ interfere comparatively little with an accurate determination of refractive indices when they lie in planes perpendicular to the edge of the prism. Accordingly, in the rest of the research the prisms were formed from the glass mass that came out of the crucible by cutting two planes passing through the same horizontal line a little behind the surface, and inclined 22½° right and left of the vertical, and polishing the enclosed wedge of 45°. In the central portion of the mass the striæ have a tendency to arrange themselves in nearly vertical lines by the operation of currents of convection, and by cutting in the manner described the most favourable direction of the striæ is secured for a good part of the prism. This attention to the direction of cutting, combined no doubt with increased experience in the preparation of glass, was attended with such good results that now it was quite the exception for a prism not to show the principal dark lines. Some of the latest prisms were almost equal to prisms of good optical glass.

On account of the difficulty of working with silicates, arising from difficult fusibility and the pasty character of the glasses, Mr. Harcourt's experiments were carried on with phosphates, combined in many cases with fluorides and sometimes with borates, tungstates, molybdates, and titanates. The glasses formed involved the elements potassium, sodium, lithium, barium, strontium, calcium, glucinium, aluminium, magnesium, manganese, zinc, cadmium, tin, lead, thallium, nickel, chromium, uranium, bismuth, antimony, tungsten, molybdenum, titanium, vanadium, phosphorus, fluorine, boron, and sulphur. A very interesting subject of inquiry presented itself collaterally with the original object, namely, to ascertain whether glasses could be formed which would achromatise each other so as to exhibit no secondary spectrum, or a single glass which would form with crown and flint a combination achromatic in that sense. This inquiry presented considerable difficulties. The dispersion of a medium is small compared with its refraction, and if the dispersion be regarded as a small quantity of the first order, the irrationality between the two media may be regarded as depending on small quantities of the second order. If striæ and imperfections of the kind present an obstacle to a very accurate determination of dispersive power, it will readily be understood that the errors of observation thus occasioned go far to swallow up the small quantities, in the observation of which the determination of irrationality depends. Accordingly little success attended the attempt to draw satisfactory conclusions as to irrationality from the direct observation of refractive indices; but by a particular mode of compensation, in which the experimental prism was achromatised by a prism built up of a combination of slender prisms of crown and flint, I was enabled to draw trustworthy conclusions as to the character, in this respect, of these prisms, which were good enough to show a few of the principal dark lines of the solar spectrum.

Theoretically any three different kinds of glass may be made to form a combination which shall be achromatic as to secondary as well as primary spectra; but for a long time little hope of a practical solution seemed to present itself. A prism containing molybdic acid was the first to give fair hopes of success. Mr. Harcourt warmly entered into the subject, which he prosecuted with unwearied zeal. The earlier molybdic glasses prepared were many of them rather deeply coloured, and most of them of a perishable nature. At last, after numerous experiments, molybdic glasses were obtained nearly free from colour, and permanent. Titanium had not yet been tried, and about this time a glass

* Paper read by Prof. Stokes in Section A, British Association, 1871.