metrical and bathymetrical map of the Western Mediterranean and surrounding countries, curved to show the figure of the earth; (2) relief map of a part of the valley of the Semois in the neighbourhood of Rochepaut, Belgian Ardennes. These maps have been prepared under the direction of Prof. Elisée Reclus by Mr. E. Patesson. The map of the Mediterranean, in aluminium, is drawn on the scale of 1 : 5,000,000. It is curved to show the exact figure of the earth. Elevations of land and depths of water are shown by a system of contours and tinting. The second map is in copper, and represents the relief of the district without exaggeration of the vertical scale, and with the surface features carefully laid down. Both maps are intended for educational purposes.

Pictures shown by Mr. Arthur J. Evans, F.R.S., illustrated excavations at Knossos, in Crete, and included: (1) general plan of the palace, showing excavations to June, 1902, and general section, showing successive terrace levels, &c.; (2) photographic views; (3) coloured drawings of palace frescoes.

Other exhibits were chloroformed calf lymph; method of its preparation (from the Government Lymph Laboratories), Dr. Alan B. Green; development and variation of the colour-pattern in Mexican species of lizards (Cnemidophorus and Ameiva), Dr. H. Gadow, F.R.S.; (1) true (glandular) hermaphroditism in a domestic fowl; (2) microscopic sections of prehistoric human bone, and of a prehistoric human urinary calculus, Mr. S. G. Shattock. Mimicry in butterflies from British East Africa and Uganda, Mr. S. A. Neave; specimen of Trypanosoma found by Dr. Castellani in cerebro-spinal fluid from sleeping sickness patients (Uganda), Dr. Aldo Castellani; specimens of a remarkable radiolarian of complex structure, Dr. G. H. Fowler; restored models of extinct fishes, the Director, British Museum (Natural History); preparations illustrating the cell-phenomena met with in apogamy, Prof. J. B. Farmer, F.R.S., Mr. J. E. S. Moore, and Miss L. Digby (see p. 71); remains of pigmy elephant and pigmy hippopotamus obtained from caves in Cyprus, Miss Dorothy M. A. Bate (see p. 71); (1) photographs illustrating the late eruptions in St. Vincent and Martinique; (2) volcanic dusts, ashes, and other ejecta of the West Indian volcanoes, West Indies Volcanoes Committee of the Royal Society; micrographs of volcanic dust from Mount Soufrière, St. Vincent, eruption, May 8, 1902, Mr. Thomas Andrews, F.R.S.; (1) the experimental demonstration of the curvature of the earth's surface recorded by photography; (2) photograph of ship hull-down at sea, Mr. H. Yule Oldham.

During the evening lantern demonstrations were given by Sir Benjamin Baker, K.C.B., F.R.S., illustrative of the Nile Dam Works, and by Prof. Harold B. Dixon, F.R.S., on the analysis of explosion flames by photography. The latter demonstration included (1) photographs of explosion flames, taken on very rapidly moving films, showing the genesis of the explosion-wave as the flame travels from the point of ignition, and the influence of reflections from the ends of the tube; (2) photographs of sound-waves moving through the explosion-flame, by which the approximate temperature of the flame may be calculated.

COOPERATION IN ASTRONOMY.

THE suggestions contained in the subjoined extracts from a paper by Prof. E. C. Pickering on "The Endowment of Astronomical Research," recently issued from Harvard College Observatory, will, we hope, be taken up by one of the many generous benefactors of science and higher education in the United States. The fundamental idea is the organisation of the forces which exist for the advancement of knowledge of astronomy. Many gifts have been made to astronomy in the United States, but in some cases the results have been disappointing, because the donors have not consulted astronomers as to the best way to promote scientific advance.

Imposing observatories are useless without instruments, and fine telescopes and spectroscopes depend upon "the man at the eye end" for the return they will give for the expenditure upon them. To obtain the best results, the astronomer with original ideas and progressive spirit should be placed in a position where he can carry on his work to the best advantage, and instruments should be used by men who require them for the increase of knowledge. This is the object of the plan proposed by Prof. Pickering. Money, materials and men available for astronomical research are to be brought together so that each is used to the best advantage.

In the United States, where the liberal benefactor has endowed scientific work to an extent unparalleled in any other country, the scheme will probably be taken up. Though the gifts to higher education and research have been so many and generous in the past, Prof. Pickering remarks that owing to the industrial prosperity of America "gifts may be expected ten times as large as those of the last century, during which Harvard College Observatory received three funds exceeding one, two, and three hundred thousand dollars respectively." He has therefore considered how a gift of one or two million dollars, if given to Harvard for astronomical purposes, could be best expended. The cooperative scheme of work suggested is one which would certainly accelerate progress, and the results attained would be such that enlightened donors could see and appreciate them.

There would be no attempt to interfere with independent work; in fact, the scheme aims at promoting such work and providing for the publication of the results. The Carnegie Institution was established with the same objects, and has already provided the means for carrying on important inquiries in various branches of science. Prof. Pickering's plan is worthy of the broad views associated with Harvard College Observatory, and we trust that means will be forthcoming to carry it into effect. We reprint part of the circular in which the plan is put forward.

The following outline of a plan will show how a sum of fifty to one hundred thousand dollars annually could be advantageously expended for astronomy by this observatory. A board of advisers, consisting of several of the leading astronomers of the country, would be appointed which would meet once a year, or at first oftener, to consider how the available income could be best expended in order to receive the greatest scientific return.

This board would consist partly of the directors of observatories who could expend portions of the income themselves, and partly of older astronomers who, having retired from active work, could decide without prejudice how the income could be expended to the best advantage by others. They would have authority to add temporarily to their number astronomers who might be invited to participate in any special work, and who could thus take part in their discussions on equal terms. All expenses of this board would be paid from the income, and except for clerk hire these would be almost the only executive expenses. A circular letter would be sent to all astronomers, inviting application for aid and suggestions for methods of expending the income. If possible, close relations would be established with the trustees of all the research funds which could be used for astronomical purposes, to increase efficiency and avoid duplication of work. The most important duty of the board of advisers would be to consider each year what departments of astronomy were being neglected, and to secure the needed observations, or if necessary undertake them themselves, or see that they were made at Harvard. As every astronomer is inclined to undertake the work which attracts him most, especially interesting investigations are likely to be duplicated unnecessarily, while laborious or unattractive investigations are neglected. This is particularly objectionable, since in astronomy, a science of observation and not of experiment, an opportunity once missed can in many cases never be recovered. As an example of needless duplication, fifty observatories agreed to observe the planet Eros during its opposition in 1900, but, so far

as known, only two or three have made the reductions needed to render their observations of any value. When a plan was decided on, it would be discussed by the entire board, and it is obvious that their combined experience would render serious mistakes less probable than when all depends on the judgment of a single individual, as is now the case. They could find the best man for a given research, and give him the best possible facilities for carrying it on. They could undertake larger and more difficult researches than a single observatory could attempt. It would be the power of many, instead of one, and of large, instead of restricted, resources. The opportunity offered to such a board of advisers, having control of the principal instruments of the country and a large sum of money available to set at work any particular corps of astronomers, ought to secure results far beyond those attainable at any existing observatory. All the advantages of a trust would be secured, with none of its objections. No one could object to a trust in wheat, for example, if its only object was to increase the quality and quantity of the crop, and to furnish it to consumers at the lowest rates, also to aid those not members of the trust in every possible way. In the present case, these conditions would be enforced by a body of men entirely unprejudiced, the Corporation of Harvard College. It is universally admitted that in the industrial arts there is a great advantage in cooperation, and in carrying on work on a very large scale. The same remarks apply to scientific investigation, with the added advantage that the supply and demand are indefinitely great, so that the market can never be glutted.

Apart from the advantages to astronomy of such a plan as is here outlined, it is believed that it would serve as a valuable example to the other sciences, and the moral effect of promoting uniformity of purpose, and friendly aid to one another by astronomers of all countries, would encourage other donors. An incidental advantage of this plan is that it could be tried on a small scale, as for a single year, and the donor could thus see what results were likely to follow if he made the plan permanent.

Of course, every effort would be made to establish the closest relations with astronomers in general, as the object of the institution could not be attained if the work done was not regarded as advancing astronomical research in the best way. Much might be accomplished through existing societies and periodicals. Another matter of especial importance is that when an astronomer is aided who is qualified to carry on a work in the best way, no restrictions should be made on the appropriation which would in any way interfere with his obtaining the best results.

It will be noticed that this plan differs from those governing existing funds for research in being active and not passive. While the trustees of other funds wait for applications, and then consider what appropriations can be made, it would be the aim of the advisers of this fund to learn what astronomers desired aid, what instruments now unused were available for work, and what valuable material remained unpublished and consequently useless for lack of means. Its special object would be to determine the needs of astronomers, to find what subjects were being neglected, especially those the usefulness of which would be lost by delay, and, if possible, to take the necessary steps to secure their execution. Much might be done with existing funds, and it is believed that the trustees of such funds would, in many cases, welcome the means of expending the available income to the best advantage. The opportunities for good work are far in excess of the present means for supplying them. Even the great resources of the Carnegie Institution will be able to respond to only a portion of the excellent applications made to it for aid.

It is most important that unnecessary delays should be avoided. It often happens that an astronomer could undertake a piece of work at once, perhaps during a summer vacation, while after a delay of several months he might be unable to carry it out, or might have lost many of the details then fresh in his mind. This is still more important with large pieces of work. A delay of several years may render a mature astronomer incapable of completing a work, which if undertaken at once, he could carry out with his greatest vigour and skill.

These remarks apply with equal force to the present plan of work. The Harvard Observatory has now the appliances, both intellectual and physical, for undertaking large pieces of work. Several of the leading astronomers of the country are in sympathy with such a plan for cooperation, so that the important methods of organising and initiating a system could be devised at the present time under very favourable conditions which may not prevail a few years hence, although the plan once started could easily be carried on by others. It therefore seems wise to make a beginning, however small, hoping to show results that will lead to an early fulfilment of the entire plan.

The undersigned, therefore, invites the astronomers of this and other countries to send to him applications for aid. A brief statement of the case in form for publication should be made, generally not exceeding two hundred words in length, with an estimate of the cost, and any additional necessary details. If publication is not desired, it should be stated.

The undersigned will then use his best efforts to secure the execution of such of these plans as commend themselves to him, reserving the right to omit all others. If the list of applications received seems worthy of it, he will publish and distribute it to possible donors, and will endeavour to secure its publication elsewhere. He will also bring such applications as commend themselves to him to the attention of the officers in charge of the following research funds, with which he is officially connected :—

Rumford Fund of the American Academy. Principal, 52,000 dollars. Income available to aid American investigators in light and heat.

Elizabeth Thompson Science Fund. Principal, 26,000 dollars. Income available for investigators of all countries in all departments of science. Appropriations seldom exceed 300 dollars.

Henry Draper Fund of the National Academy. Principal, 6000 dollars. Accumulated income April 15, 1902, 1515·99 dollars. Available for investigations in astronomical physics, by citizens of the United States.

Advancement of Astronomical Science Fund of the Harvard College Observatory. Principal, 70,000 dollars, of which 10,000 dollars is now available as stated above. Income may be used for astronomers of any country.

When we consider the great sums at the disposal of the trustees of the Carnegie Institution, and the large unexpended balances of the various research funds of the National Academy, it is not probable that any really worthy investigation requiring only a few hundred dollars for its execution need fail for want of such a sum.

There is another direction in which the writer believes that a great astronomical return could be obtained for a reasonable expenditure of money, some of which is already available. There are, in the United States, many telescopes of large size, which are now in use during only a small portion of every clear night. It is believed that in many cases advanced students in astronomy would be glad to undertake systematic observations with such instruments for a salary equivalent to a fellowship. They would thus be enabled to continue their studies, and at the same time make valuable additions to our knowledge of astronomy.

Larger investigations may be carried on by the Carnegie Institution or by private gift. For such investigations the undersigned offers assistance to prospective donors, *if they desire it*. He will in that case secure for them the opinions of the leading astronomers of the country regarding any proposed investigation. A wealthy man, when making a large investment in an industrial enterprise with which he was not familiar, would always obtain the opinion of an expert, for which he would often pay a large sum. How much more important is it in a subject like astronomy, with which he is likely to be still less familiar, that he should learn the views, which would be given freely and without charge, of the principal experts in the country who have devoted their entire lives to the consideration of these subjects.

In brief, it is proposed to establish an institution in connection with the Harvard Observatory the aim of which should be to advance astronomy as much as possible by making appropriations under the combined advice of the leading astronomers of the country. Much attention would be paid to neglected subjects, especially to those which cannot be

provided for by later observations, to secure for persons properly qualified the use of powerful telescopes now idle and therefore useless, and, in general, to secure for the person best qualified for any given research the best possible means of carrying it on. It would provide means for co-operation, and would aim at the advancement of astronomy, regardless of country or any personal considerations. The cost of this plan, if fully carried out, would be less than that of a first-class observatory, and it could be fairly tried for a short time at a moderate expense. For success, it must be wholly unselfish and this condition permanently secured, the investments must be safe, and the net income large. It is believed that no guardian would more surely fulfil these conditions than the Corporation of Harvard College.

EDWARD C. PICKERING.

THE ROYAL VISIT TO GLASGOW.

THE laying of the memorial stone of the new buildings for the Glasgow and West of Scotland Technical College by His Majesty King Edward on Thursday, May 14, is a gratifying indication of the importance now attached to an efficient system of technical education. The ceremony at the College was the first item on the programme of the Royal visit to the city, and, except as regards the weather, which was more lavish of the April shower than the May sunshine, was most successfully carried out. An hour before the arrival of the King and Queen upwards of 4000 guests had assembled on the site of the new buildings, and their Majesties, on stepping on to the royal platform, received a most loyal welcome. Lord Balfour of Burleigh, the minister in attendance on the King, introduced to His Majesty Mr. W. R. Copland, the chairman of the Governors of the College, and Mr. D. Barclay, the architect of the new buildings, and the laying of the memorial stone was immediately proceeded with. In thanking His Majesty, Mr. Copland recalled the fact that, so long ago as 1881, on the laying of the memorial stone of the Central Technical College of the City and Guilds of London, His Majesty was pleased to recognise the importance of educating persons destined to take part in the productive industries of the kingdom, and referred to the training of the intelligence of the industrial community as the great factor in retaining the position of Britain as a manufacturing nation. The King, in reply, expressed the great pleasure it had given him to lay the memorial stone; he had long recognised the importance of the work done by institutions of this kind, and hoped the building now to be erected would realise to the full the expectations of the governors.

In the course of the day their Majesties visited the University, the foundation stone of which they had laid on October 8, 1868. The Very Rev. R. H. Story, D.D., Principal and Vice-Chancellor of the University, the professors, lecturers and demonstrators, and a large body of graduates were assembled in front of the magnificent building on Gilmorehill, and in the name of the University the principal presented an address to His Majesty. In the address it was noted that, except on two occasions, in 1849 and in 1888, when Queen Victoria visited Glasgow, no Sovereign of Great Britain had seen this University since King James VI. visited it on his return to his ancient kingdom after succeeding to the throne of England. In his reply the King expressed his great gratification at having an opportunity, accompanied by the Queen, of renewing his acquaintance with the ancient University; he was deeply interested in the allusions to the visits of his predecessor King James VI. and of his august and beloved mother, Queen Victoria; he recalled with satisfaction his own share in laying the foundation stone of the noble building, and he earnestly desired that this and other universities as schools of higher learning might grow and prosper, and so advance the material progress of his people.

After His Majesty had replied to the address, the Deans of Faculties were presented to him by Lord Balfour.

The constitution under which the Glasgow and West of Scotland Technical College is now working dates from 1886, but the institution itself had its origin in Anderson's College, which was founded in 1796 under the will of John Anderson, M.A., F.R.S., professor of natural philosophy in the University of Glasgow, and is thus certainly the oldest institution of the kind in Great Britain, and probably in the world. Prof. Anderson was in many respects a remarkable man. The idiosyncrasies of his character brought him into frequent conflict with his colleagues in the University, but it is more pleasant to record that he seems to have been deeply impressed with the importance to the industries of the city of awakening in masters and workmen an intelligent interest in the scientific aspects of their trade. He made frequent visits to the local workshops, and took great pains to make himself familiar with local industries. It is well known that when James Watt had difficulties put in his way by the incorporation of hammermen of Glasgow he was appointed mathematical instrument maker to the University, and it was Anderson with whom he was most closely associated in this post. In furtherance of his aims Prof. Anderson inaugurated classes in the University designed to attract employers and workmen as well as the ordinary university students, and these he carried on until his death in 1796. At the present day, when technical education has assumed such a prominent position in the public mind, it is but fair to recall with gratitude the work of the man who may be justly named its pioneer.

On his death Prof. Anderson bequeathed all his means "to the public, for the good of mankind and the improvement of science, in an institution to be denominated 'Anderson's University.'" He directed that the management of the institution was to be vested in the Board of Trustees constituted under his will, and this Board continued in existence until 1886, when the institution was incorporated in the Glasgow and West of Scotland Technical College.

The first chair created was that of chemistry and natural philosophy, and was occupied by Dr. Thomas Garnett until 1799, when he was called to fill the first professorship in the Royal Institution. His successor in Glasgow was Dr. George Birkbeck, who formed a special class for "the gratuitous instruction of the operatives of Glasgow in mechanical and chemical philosophy," in the belief that "men should be taught the principles of the arts they practise." This class, which was named "the Mechanics' Class," separated in 1823 from Anderson's College and took the title of "Mechanics' Institution," the first of the many mechanics' institutions that marked the movement for the scientific education of artisans. In 1881 the Glasgow Mechanics' Institution changed its title to that of "The College of Science and Arts," and continued to maintain a separate existence until it was merged with the parent institution in the present Technical College.

The names of many eminent men are associated with Anderson's College. Among its professors were Dr. Andrew Ure, author of "The Dictionary of Arts and Manufactures"; Dr. Thomas Graham, afterwards Master of the Mint, for whom the honour is claimed of establishing the first laboratory for public instruction in chemistry in Great Britain; Dr. Thorpe, the present Director of the Government Laboratories; Dr. W. Dittmar; and Dr. G. Carey Foster, the present Principal of University College, London. Among its students were Dr. Livingstone; Lord Playfair; Dr. James Young, the founder of the Scottish oil industry; and Sir J. H. Gilbert, of Rothamsted. Lord Kelvin and his brother, Prof. James Thomson, were students of the Mechanics' Institution.

In 1886, by an Order of Her late Majesty, Queen Victoria, in Council, Anderson's College, the College of Science and Arts, the "Young" Chair of Technical Chemistry—founded