for any instant whatever. From the orbital velocity it is easy to deduce the length of the semi-axis major of the orbit, and the parallax is equal to the semi-axis major in seconds of arc, divided by the length of the same when expressed in astronomical units. The sum of the masses follows from the ordinary application of Kepler's third law. Dr. See lays special stress upon the importance of these investigations being taken up practically, as they will furnish us with "an absolute parallax exact to the highest degree," and will also enable us to apply a rigorous test of the universality of the law of gravitation. It is known already, from micrometrical measures, that Kepler's second law holds good for binary stars, and therefore that the force is central; but it remains to be shown that the principal star is in the focus of the real ellipse.

THE SOLAR PARALLAX.—Among the various methods suggested as suitable for the determination of the solar parallax, that afforded by the parallactic inequality in the motion of the moon deservedly takes a high place. The reason is that in this particular term the parallax of the sun is multiplied by a coefficient which increases the quantity to be determined in the approximate ratio of 1 : 15, so that an error of a tenth of a second in the inequality would not produce an error of one-hundredth in the parallax sought. But in deriving the solar parallax it is necessarily assumed, that the relation between these quantities is accurately given by theory. Unfortunately there has been a discrepancy between the coefficients derived by Hansen and Delaunay, and the accepted explanation has not been the correct one. In order to ensure identity between Hansen and Delaunay it was necessary to suppose than an error existed in the highest term computed by Delaunay, and that the deviation of the remaining terms from the general character of the series did not exist. Recent work by Mr. Hill and Prof. Brown has, however, confirmed the accuracy of Delaunay's theory so far as this particular term is concerned, though it leaves a general doubt on the legitimacy of neglecting the higher terms in some of the series in other parts of the theory. Prof. Newcomb points out (*Astronom. Jour.* No. 356) that this more recent discussion of Messrs. Hill and Brown demands an increase on the theoretical value of Hansen, on which he had previously relied, of 0″·30, and consequently a diminution in the solar parallax of 0″·021 giving the corrected value of $\pi = 8''{\cdot}773$.

THE EPPING FOREST MUSEUM AT CHINGFORD.

THE opening of this museum, which we announced in our last week's issue as having been fixed for Saturday, November 2, was in every respect an interesting ceremony, and marks a period in the history of the Essex Field Club, of which this active society may well feel proud. Two or three years after the foundation of the Club in 1880, an informal meeting was held at the residence of Mr. E. N. Buxton, with a view to starting such a local collection, but the Conservators at that time had not long been in charge of the Forest, and they did not see their way to giving house-room for the museum in the old lodge known as "Queen Elizabeth's." The founders of the Club, however, have never lost sight of the desirability of having such a collection in the Forest district, and in February 1894, a special meeting of local residents and others was convened, and a local sub-committee formed for the purpose of forwarding the scheme. A subscription list was opened, and a sufficient sum raised to warrant another application to the Conservators for the use of Queen Elizabeth's Lodge. This was granted, and the Banqueting Room, which from time immemorial has been unoccupied and devoid of fittings, has now undergone transformation into a museum, which was declared open to the public as a part of Saturday's proceedings. The arrangement of the collections, illustrating the natural history, geology, archæology, and topography of the Forest, has been entirely carried out by Mr. William Cole, the Hon. Secretary of the Club, aided by his brothers and a few zealous workers who gave their co-operation, notably Messrs. W. Crouch, I. Chalkley Gould, A. Greenhill, and others. On Saturday afternoon a very representative gathering of scientific men took place at Chingford, to assist at the opening ceremony. The members and guests, comprising among the former Sir William Flower, Mr. Edward North Buxton, Profs. R. Meldola and G. S. Boulger, Mr. J. E. Harting, &c., and among the latter a large number of the Epping Forest Committee of the Corporation of London, were received by the President of the Club, Mr. David Howard, in a room adjoining the museum. After a few introductory remarks by the President, Sir William Flower addressed the meeting on the general subject of local museums and the advantages to be derived from their establishment. Mr. Deputy Halse, the Chairman of the Epping Forest Committee, then expressed, on behalf of the Corporation, the satisfaction which they all felt in being associated with the Essex Field Club in the movement, and declared that from Monday, the 4th, the collections would be available for public inspection. The party then proceeded to view the museum, and great satisfaction was expressed at the large amount of material which had been brought together in a comparatively short time and with very modest financial means. Mr. Greenhill's collection of flint implements from the valley of the Lea, Mr. T. Hay Wilson's set of drift rock materials from the local glacial gravels, Mr. Crouch's shells of the Dengey Hundred, the cabinets of Forest flowering plants, fungi and insects, and the interesting set of relics found during the Club's explorations of the Forest earthworks, were all much admired. A pamphlet by Mr. Chalkley Gould, being one of a proposed series of museum handbooks, was distributed at the meeting. The author in this pamphlet gives a description of the Romano-British station at Chigwell in illustration of the specimens which he has contributed to the museum. After the inspection the party assembled for tea at the Royal Forest Hotel, some eighty or ninety members and visitors being present. At a meeting of the Club, held after tea, the President moved a vote of thanks to Mr. William Cole and his coadjutors for the large amount of work which they had voluntarily done on behalf of the museum. This was warmly seconded by the Rev. A. F. Russell, the rector of Chingford, who is chairman of the local sub-committee. Mr. Cole having acknowledged the vote of thanks, Mr. A. Smith Woodward (of the British Museum) then gave a short address, in the course of which he pointed out the essential requirements that the museum should fulfil in order to be of real use, and commented most favourably upon the arrangement of the collections, their contents, and their mode of display. Sir William Flower expressed his concurrence with Mr. Woodward's remarks, and made some further observations and suggestions, especially dwelling upon the importance of taking steps to insure the permanence of the museum when those who had laboured so well for its foundation were no longer able to carry on the work. In the course of his remarks he paid a high tribute to the general work of the Essex Field Club, of which he had been an honorary member almost from the time of its foundation. Prof. Meldola, in proposing a vote of thanks to Mr. Deputy Halse, pointed out that the element of permanence to which Sir William Flower had alluded was most likely to accrue from their association with the Epping Forest Committee. This vote having been seconded by Mr. E. N. Buxton, and replied to by Mr. Halse, Mr. Harting made some remarks on the danger of encouraging promiscuous "collecting" by schoolboys, and the proceedings terminated. Favoured by an exceptionally brilliant autumnal afternoon, the meeting was a distinct success, and must have given great satisfaction to its promoters. The museum is necessarily small, but a good beginning has been made, and the time may be looked forward to when increased accommodation will be required. The feature which most strongly commends it to students of natural science, and lovers of the Forest generally, is the purely local character of the collections. No more appropriate use of Queen Elizabeth's Lodge could possibly have been made, and the Corporation of London have done wisely in allowing the Essex Field Club to found an institution which, however small and unpretentious, is, even as at present appointed, a distinct boon to all frequenters of the Epping Forest district.

CONCENTRATION OF GOLD ORES.[1]

WHEN gold mining is a new industry in any country, the methods of extraction are often somewhat rough and ready. With great quantities of rich ore waiting for treatment or easily obtainable, the mill-man is usually intent on obtaining the greatest possible quantity of bullion in a short time, rather than on establishing a good system of reduction, which in the

[1] "Report on the Loss of Gold in the Reduction of Auriferous Veinstone in Victoria." By Henry Rosales. (Issued by the Department of Mines, Melbourne, 1895.)

long run would extract the maximum percentage of gold per ton at the minimum cost. It matters little to him how much gold runs off in the tailings into the nearest stream, so long as enough is extracted to pay expenses and yield a handsome profit. When, however, the industry becomes firmly established, the aspect of affairs is changed. The richer mines can afford to spend something in endeavouring to improve their practice; the poorer ones have their very existence threatened by the loss of 30 or 40 per cent. of the gold, which has been raised from a great depth, only to be left on the dumping ground.

This stage has long been reached in the older gold fields of Australia, such as those in Victoria, where the industry has always been carefully nursed by the Government. One of the latest proofs of the solicitude of the Victorian Department of Mines is the issue of this report of Mr. Rosales, the veteran expert on concentration, who gained a Government prize for an essay on the subject as long ago as the year 1861. The report deals with the concentration of tailings from the stamp battery, and although it is specially applicable to Victoria, nevertheless it contains much information and many suggestions which deserve careful study by metallurgists in all parts of the world, and may be particularly valuable to the workers in South Africa.

In Victoria, as in many other countries, the majority of the gold ores found are "free-milling," yielding a fair percentage of their gold when amalgamated with mercury. The usual method of treatment is to crush the ore in a stamp-battery, a little mercury being added in the mortars, and to pass the pulp over amalgamated copper plates, by which most of the free gold is retained. The "battery sands," still containing a little free gold and a varying percentage of auriferous sulphides of the heavy metals, are then treated by various machines, such as canvas tables, vanners, percussion tables, blanket and wooden strakes, and revolving buddles, with a view to separate the heavy particles in which the gold is contained from the lighter worthless gangue. The concentrates are treated by grinding to impalpable pulp with mercury in iron pans, by chlorination or by smelting, according to the nature of the sulphides and to the other conditions.

The tailings from the orthodox concentrating machines would be allowed to run to waste if it were not that, on almost every mine in Victoria, they are compelled to run the gauntlet of the simple contrivances of a few Chinamen, who pay tribute to the mine-owner for the privilege of taking his leavings, and who extract enough gold to provide themselves with a living. Nevertheless it was stated in 1889, on the very high authority of the late Government analyst, Mr. J. Cosmo Newbery, that the tailings of the quartz-mining districts, even after passing the Chinese tables, contained in general from two to two and a half dwts. of gold per ton—some 15 per cent. of the amount originally contained in the ore. The gold thus lost is estimated as being of the value of over £350,000 in the year 1894, and a similar state of things is unfortunately only too prevalent in other countries.

Experts are agreed that it is the methods of concentration which are chiefly answerable for the continuance of this unsatisfactory state of things, not so much because the machines now at the disposal of the metallurgist are defective, as that in many cases they are set to do work for which they are inappropriate, although capable of dealing effectively with certain classes of material. In particular, the neglect on the part of metallurgists to classify the crushed ore according to size has been fatal to good concentration in a countless number of cases, and this mistake has not yet been generally rectified.

Let us suppose that a gold ore has been crushed so as to pass through a screen equivalent to a wire-sieve with thirty holes to the linear inch. The particles of ore are of all sizes, ranging from those which can just pass through the screen down to perfectly impalpable powder. From 20 to 50 per cent. would easily pass through a 100-mesh sieve, and a part of the ore, the "slimes," is so finely divided that it settles in still water with great difficulty. In spite of this, the whole mass, without any classification, is perhaps, after treatment with blankets, hurried over some one type of concentrator favoured by the manager, and the tailings allowed to escape without further treatment.

For example, a percussion table with "end-blow" is used, and the coarser particles of pyrites are readily separated from the remainder of the ore by its action. It usually happens, however, that the valuable sulphides, being softer than the quartz and other constituents of the gangue, are in the main more finely pulverised than the latter, so that the slimes are the richest parts of the ore, and these, under the circumstances, will almost all escape. Thus at the Johnson's Reef Mine, Eaglehurst, it was found that the "slimes," though constituting only 3 per cent. of the pulp, contained 21 per cent. of the gold, while 44 per cent. of the pulp, which was retained on a 60-mesh sieve, consisted mainly of quartz grains, and was absolutely worthless.

Or, in the alternative, the battery sands may be sent directly to some travelling belt table, such as the Frue vanner—a machine capable of doing splendid work in saving rich slimes—with the result that the coarser particles, valueless in themselves, interfere with its efficiency. Mr. Rosales cites the case of a mine at Ballarat, where the costly Frue vanners, which had been set to treat unclassified battery sands, were discarded in favour of the cheaper percussion tables, the fact being that neither concentrator could be expected to save the pyrites properly, the vanner being no more fit to treat coarse material than the percussion table is adapted to concentrate slimes. It would have been better to use the two machines successively on the same material, although even then, in the absence of classification, losses could not have been prevented.

Mr. Rosales has not been content to criticise, but has added a sketch of a complete system of concentration, which, with modifications, would be applicable to almost every gold ore likely to be met with. The keynote of the system is classification, and he can hardly be accused of laying too much stress on it, seeing that it has been neglected more generally than any other consideration in the past. He favours hydraulic classifiers (inverted pyramidal or pointed boxes of various forms) for separating the slimes from the sand; but, on the other hand, he considers that the division of the sand itself into two or three classes, according to the size of the grains, is best effected by revolving screens or trommels.

This view will undoubtedly be called in question. It is rare that a finer screen than one containing twenty holes to the linear inch is fitted to these machines, and although 60-mesh screens have been employed, the smallness of the capacity of trommels supplied with such fine sieves, and the great cost of repairs caused by their rapid wear, seem to render it unlikely that they will ever come into wide use. In revolving screens the effective surface operating at any one time is only a few inches wide, and, if they were fitted with 100-mesh sieves, it is to be feared that continuous clogging would reduce their capacity almost to the proverbial teaspoonful. There seems no adequate reason why the cheap, handy, rapidly-acting pointed boxes should be passed over, and if Mr. Rosales would press these, instead of the trommels, on Australian mill-men, he would perhaps find a more ready acceptance of his suggestions. It is true that when pointed boxes are used, the particles of ore in each class are "equivalents" (*i.e.* those falling at an equal rate in water), and not equal in size, particles of high density being left mixed with somewhat larger ones of lower density, but the classification is usually sufficient for the purpose.

For the rest, Mr. Rosales seems to lay more stress on efficiency than on cheapness. When, as in his complete system, nearly twenty different machines, without counting duplicates, are at work, each with a different purpose, in removing the auriferous sulphides from one kind of ore, the loss of gold may be reduced to little or nothing, but it is evident that the extra amount saved is not all clear gain. An additional percentage of gold may often be obtained at a loss, even by an automatic machine if it is costly to buy and to keep in repair.

No sudden drastic changes, however, are proposed by Mr. Rosales. The losses of gold in Victoria and elsewhere are undoubted, and until it has been shown that they cannot be profitably reduced, no shirking of the matter is admissible. Tests on each mine by sieving and assaying in the laboratory (which, alas! too often is non-existent) can alone show in what direction the practice may be improved, and, if proper attention were paid to the slimes only, many gold mines would have a much brighter outlook than at present.

In conclusion, a word may be said in protest against the unscientific and misleading Australian (and English) method of reporting assays of gold ores. The actual weight of gold extracted from the sample of ore is seldom recorded, and the probable error is quite undiscoverable. An observed weighing of 0·001 grain may be reported as 15 grains per ton, or may appear as two, three, or more times this amount. In every case the unit in the report is much smaller than that used for the observation. What analytical chemist would be guilty of such practices in his other work?

T. K. ROSE.