ANCIENT BUDDHIST POTTERY.

AN IMPORTANT DISCOVERY IN BURMA.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

THROUGHOUT the whole of Burma there are sites of ancient civilization awaiting excavation; and in view of the importance of the relics there unearthed, and their bearing upon our knowledge of the early inhabitants of the East, the investigations are being carried out methodically and with unremitting care and skill by the British government. There is a special official department for this field of operations, and at the present time several surveys are at work in those areas from which the most important finds are anticipated. Next to Egypt, India, including Burma, is of exceptional interest in tracing the earliest civilization and its extension through the East; and dealing as it does with a race totally different from that which radiated from Egypt throughout Africa, western Asia, and southern Europe—a race distinctly dissimilar in type, characteristics, religion, and mythology—the scientific unraveling of the secrets of these long-since forgotten townships, villages, and sepulchers is of far-reaching importance to the world at large. Moreover, they tend to shed further light concerning the mysteries of the remarkable Eastern god Buddha and the numerous mystical sacred rites and ceremonies incidental to the worship of this deity.

One of the most important branches of the Archæ-

out with double rows of square reliefs executed in terra cotta, and each of which depicted a particular scene in the life of Buddha during his many transmigrations. According to the tenets of the Buddhist doctrine, every adherent before attaining that enlightenment possessed by the deity must pass through an almost illimitable sequence of existences, and through which even Gautama, who was to become the Buddha, himself had to pass before reaching final emancipation. The outcome of this mythology was that in the very earliest days of the religion, the devotees set to work collecting stories of their leader's doings in successive existences, some of which he passed in the shape of various birds and animals. With each existence is associated some particular story, derived from the extensive folk lore of the country, but attributed to Buddha himself. These stories must have been impressed into the service of the religion at a very early date, but it was the southern Buddhists especially who developed them, and in their scriptures we find more than five hundred such stories, the whole collection being known as the "Jataka" or "Birth Book."

Several illustrations of these stories have been brought to light at other pagodas, but they were of

iconography of the eleventh century. Two of these plaques are illustrated, with descriptions.

It is pleasing to note that the British government has placed the excavation and conservation of these relics in competent hands. A rule is that in restorations no additions must be made. However strong may be the presumption as to the appearance of a piece of work in its original state, the efforts of the restorers are confined to working with the pieces actually found, no modern additions being added.

JOULE AND THE MECHANICAL EQUIVALENT OF HEAT.

By PROF. FLORIAN CAJORI.

JOULE was the son of a wealthy brewer. In 1830 he saw the first trains which traveled between Liverpool and Manchester. One of the happy circumstances of his boyhood life was his connection with John Dalton and Dalton's laboratory containing effective home apparatus. His association with Dalton gave direction to his constructive genius. Joule's father fixed up a room for a chemical laboratory. Before the boy was of age he began experimentation in chemistry and electricity.

The king's counselor is asked by his master to explain the nature of the Service of Truth. He cannot answer the question, but obtains the solution from a seven-year-old prodigy.

On the right a man and his wife are living as hermits. Their son, bringing them a jar of water on a deer's back, is accidentally killed by a hunter who aims at the deer.

ANCIENT BUDDHIST POTTERY DISCOVERED IN BURMA.

ological Survey is that at Mandalay in the Burmese province. This district is particularly rich in Buddha monuments, and the government is preserving all the most noteworthy buildings and relics, some of which are of inestimable value, affording excellent examples of native architecture and decoration during successive eras. The district which has so far proved the most remunerative field of research from an antiquarian point of view is Pagan. In this district there are in all about five thousand pagodas in various stages of decay, some of the most ancient of which have yielded valuable relics. The most noteworthy of these shrines is that known locally as the "Petleikpaya," meaning "the Pagoda of the Curling Leaf," the conservation of which the Indian government is now carrying out. When the authorities determined to investigate the heap of debris beneath which the pagoda is half buried, the fact that the rubbish might yield such important results as have been achieved, was not anticipated. The sum of the researches points to the fact that it evidently dates from the period of Anawrata—approximately 1066 A. D.; but later search has revealed the significant fact that the present building in reality stands upon another similar and older structure, thereby confirming the supposition formerly entertained, that these Buddhist buildings existed in Burma prior to the reign of Anawrata, and that that monarch did not introduce Buddhism into the country, as is generally maintained, but rather developed the religion.

While engaged in removing the debris surrounding the pagoda, the excavators came across the remains of a vaulted corridor, the most prominent feature of which was the decoration of the walls both inside and

inferior workmanship. In the plaques unearthed at Petleikpaya, however, the workmanship is excellent; and they are in a remarkable stage of preservation. The figures are finely modeled, being sharply cut and as clear as when they were drawn from the kiln, the hieroglyphics are clearly and deeply cut, so as to be easily decipherable. In the accompanying illustrations two of these plaques are shown. An interesting point concerning these terra-cotta illustrations is that to each is attached a number alongside the legend, so that the particular story depicted may be easily found in the Birth Book.

In the first—Sambhava-jāt, 518—Sucirata, counselor of the King of Kuru, is asked by his master to explain the nature of the Service of Truth. Sucirata confesses his inability to solve the question, and procures its solution from Sambhava, the seven-year-old son of Vidhūra, chaplain to the King of Benares. In the second plaque—Sāma-Jāt, 543—the incident depicted represents on the right Dukūla and his wife Parikā, who are living as anchorites in the Himalaya region. They are blind, and their material wants are attended to by their son Suvannasāma. On the left appears Piliyakka, King of Benares, who while shooting at a deer carrying a pot of water for Suvannasāma, kills the latter.

Though the particular and varied stories illustrated are carried out in the conventional manner of the time, and consequently have a somewhat stereotyped appearance, the individuality of the artist is apparent throughout, so that they comprise specimens of the art of the period of a valuable order. At the same time they constitute reliable records, and extend definite incontrovertible records of the orthodox Buddhist

After laborious tests he succeeded in showing that the heat developed by the union of two chemical elements effected in a battery is the same as that developed by combustion, and that the heat has a definite equivalent in the electromotive force between these elements. He studied the relations between electrical, chemical, and mechanical effects, and was led to the great discovery of the mechanical equivalent of heat.

In a paper read before the British Association in 1843 he gave the number as 460 kilogrammeters. This was only a year after Mayer had published his first paper. Friends who recognized the physicist in the young brewer persuaded him to become a candidate for the professorship of natural philosophy at St. Andrews, Scotland, but his slight personal deformity was an objection in the eyes of one of the electors and he did not receive the appointment.

The early papers of Joule attracted little attention. His facts were so novel, so apparently heterodox, and the language in which they were conveyed so unfamiliar, that the older physicists permitted them to remain without due consideration. Faraday was then busy with his experimental researches. Graham was studying the diffusion of gases. Wheatstone, Whewell, Herschel, Forbes, Airy, were engrossed with problems of their own. Those who were first to applaud Joule a few years later were still pupils. William Thomson and Gabriel Stokes were at Cambridge; Rankine, a youth of 22, was studying engineering; Tait was a boy at school; Clerk Maxwell had just acquired the nickname of "Dafty" at Edinburgh Academy. In 1844 a paper of Joule, "On the Changes of Temperature produced by the Rarefaction and Condensation of Air,"

was rejected for publication by the Royal Society, but was printed in the Philosophical Magazine the year following.

In April, 1847, Joule gave a popular lecture in Manchester, delivering the first full and clear exposition in England of the universal conservation of that principle now called energy.

The local press would at first have nothing to do with it. One paper refused to give even a notice of it. The Manchester Courier, after long debate, published the address in full. In June, 1847, the subject

was presented before the British Association meeting at Oxford. The chairman suggested that the author be brief. No discussion was invited. In a moment the section would have passed on to other matters without giving the new ideas any consideration, if a young man had not risen from his seat and by his intelligent observations created a lively interest in the new theory. The young man was William Thomson, now better known as Lord Kelvin. The result was that the paper caused a great sensation. Joule had attracted the attention of scientific men. After the meeting

Joule and Thomson met and discussed the subject further and the latter obtained ideas he had never had before.

Joule experimented on the mechanical equivalent of heat for about forty years. By magneto-electric currents he got in 1843 the value of 460 kilogrammeters as the equivalent of the large French calorie. By the friction of water in tubes he obtained 424.9; by the compression of air, in 1845, 443.8; by the friction of water he obtained, in 1845, 488.3; in 1847, 428.9; in 1850, 423; in 1878, 423.—Popular Science Monthly.

THE NEXT APPARITION OF HALLEY'S COMET.*

AN IMPORTANT ASTRONOMICAL EVENT.

BY H. C. WILSON

THE great comet known as Halley's has a period which has varied from 79 to 74½ years in the last seven centuries, owing to the disturbing effect of the planets Jupiter and Saturn upon its orbit. Its path around the sun is very elongated; at perihelion the

Concerning the comets of 1066 and 1145 Messrs. Cowell and Crommelin add this remark: "Though the computations for the revolutions 1066-1145, 1145-1222, are still incomplete, enough has been done to make it extremely probable that Hind's identification is cor-

1531 and 1607 it does not appear to have been so conspicuous, the tail being recorded as only 7 deg. long. At the latter of these two apparitions Kepler described the comet as a star of the first magnitude, but so trifling was the tail that it was at first doubted whether it had any. Again in 1682 the comet attracted little attention except among astronomers; the tail was observed as 12 to 16 deg. long. This apparent waning of the comet led astronomers to fear that in 1759, its first predicted return, it might be so faint as not to be visible at all. However, the predictions of its course were so accurate that it was found, with the aid of small telescopes, by two observers three months before reaching perihelion. The tail did not become visible until after perihelion and when it should have been brightest was seen against bright twilight and so was not conspicuous, but in the southern hemisphere where the circumstances were more favorable it was visible to the naked eye and its length on one date was estimated at 47 deg. In 1835 it was visible to the naked eye during the whole of October, with a tail from 20 to 30 deg. long. The question now naturally arises, will the next return, in 1910, be under favorable or unfavorable circumstances? Shall we expect to see a great, magnificent comet as in 1456, or a comparatively insignificant object as in 1607, or will it be an ordinary big comet as in 1835? In order to aid in answering this question I have collected together the elements of the comet's orbit at the different apparitions which have been observed and have drawn the diagram which appears as the frontispiece of this number of Popular Astronomy (May, 1908).

HALLEY'S COMET AND THE PLANETS IN 1910.

comet is nearer than Venus to the sun, while at aphelion it is farther off than Neptune, being then thirty-five times as far as the earth from the sun. The comet has been observed at each of its apparitions certainly as far back as the year 1222 A. D., and it is extremely probable that the identification of the great comets of 1145 and 1066 with Halley's comet is correct. Back of these the identifications are more or less vague, although two, those of the years 451 and 760 A. D., are fairly certain.

The French astronomer Pontécoulant carried the calculation of the perturbations of this comet back to 1531, and recently Messrs. Cowell and Crommelin of the Royal Observatory at Greenwich have extended the calculations back to 1222, and are now working on the revolutions 1066-1145 and 1145-1222. The result of these computations has been to prove that Hind's conjecture as to the identity of the comet of 1301 with Halley's is correct, but that his similar identification of the comet 1223 is erroneous, the perihelion of Halley's comet occurring in September, 1222, instead of July, 1223. "There was, however, a much more remarkable comet which appeared at the exact epoch of the calculation, and examination shows that the greater part of the statements made concerning it by contemporary writers are quite consistent with its being Halley's, so that the identity is placed beyond a reasonable doubt."

rect in each case, though his elements of the apparition of 1066 clearly need modification. They differ more widely from the present elements than perturbations will account for. However, the positions are so vaguely recorded that large alterations in them are possible."

We have thus one great comet whose history has been traced back over eight centuries, and in that time it has come to perihelion eleven times and has not failed of being seen and recorded at a single apparition. It has at each return been visible to the naked eye and several times has been a splendid object, creating great interest and even terror among the people who saw it. The tail of the comet has varied very much in appearance at the different apparitions, owing to the different angles at which it was seen and the different background of dark sky or bright twilight against which it was projected. In 1066 it was a "famous object which created universal dread throughout Europe. In England it was looked upon as a presage of the success of the Norman invasion." In 1145, according to the Chinese records, on May 14 it had a tail 10 deg. long. In 1222 it is recorded that in the months of August and September a fine star of the first magnitude, with a large tail, appeared. According to the Chinese the tail was 30 cubits long and the comet remained in sight for two months. In 1301 and 1378 it was visible for six weeks. In 1456 it occupied a space nearly 70 deg. in length, and spread terror throughout Europe, being visible for a month. In

APPROXIMATE ELEMENTS OF HALLEY'S COMET REDUCED TO THE EQUINOX OF 1910.

Perihelion passage.	Angle from ascending node to perihelion.	Longitude of ascending node.	Inclination of orbit to ecliptic.	Perihelion distance.	Period years.
	Degrees.	Degrees.	Degrees.		
451 July	3...	108.5	53.3	16	0.60 ...
760 June	11...	107.5	52.5	17	0.60 ...
1066 Apr.	1...	...	...	...	...
1145 Apr.	29...	...	...	...	79.1
1222 Sept.	15...	105.6	51.6	16.5	0.67 77.4
1301 Oct.	22...	...	...	...	79.1
1378 Nov.	8...	107.77	54.67	17.9	0.584 77.0
1456 June	8...	104.82	50.08	17.62	0.581 77.7
1531 Aug.	25...	104.30	50.77	17.00	0.579 75.2
1607 Oct.	27...	107.25	52.66	17.14	0.585 76.2
1682 Sept.	14...	109.26	54.35	17.76	0.583 74.9
1759 Mar.	12...	110.65	55.92	17.62	0.585 76.5
1835 Nov.	16...	110.64	56.19	17.76	0.586 76.7
1910 May	10...	111.54	57.18	17.78	0.59 74.5

Motion retrograde.

The diagram was prepared by the aid of ephemerides of the comet computed by Mr. F. E. Seagrave of Providence, R. I., and the elements differ slightly from those given in the last line of the table, but not enough to affect the shape of the diagram appreciably. Mr. Seagrave adopts May 10 for the date when the comet will be at perihelion. The computations of Messrs. Cowell and Crommelin point to an earlier date, probably about April 8 for perihelion passage. Comparing this with the dates in the table we see that this coincides very closely with that for the apparition in 1066 when the comet was a famous object.

According to the table, if we accept the records of 451 and 760 as being genuine records of Halley's comet, it has been at perihelion in all the months of the year except January, February, May, and December. The great displays appear to have been when the perihelion passage occurred in April, June, July, and November. The reasons for this will be plain to one who studies the diagram. The dotted curved line represents that portion of the comet's orbit which lies

* Popular Astronomy.