HALLEY'S COMET.

BY DR. ALEXANDER W. ROBERTS.

Already in the pages of this magazine reference has been made to the approach of Halley's comet, the most important astronomical event of the years 1909 and 1910. Every seventy-five or seventy-six years this remarkable body completes its far-stretching and extremely elliptical orbit round the sun.

When the comet sweeps round the sun at its nearest approach, or perihelion, it passes within the earth's orbit; while at its farthest reach, or aphelion, it lies outside the confines of the solar system. Thus during the greater part of its long journey, for at least seventy-three years out of the seventy-five, or seventy-six, it is invisible in even the most powerful telescopes. It is then describing that portion of its path which lies outside the orbit of Jupiter. When, however, it is within the orbit of this planet, it is near enough to our earth to be visible in our evening or morning skies.

At first, on its sunward flight, it is discernible only as a faint telescopic object, but each day witnesses its increase in brightness, till at length it is visible to the naked eye, is, indeed, conspicuous enough to compel the gaze of even the indifferent beholder. As a rule it is easily seen by the unaided eye for some months.

After passing its brightest phase—which it will do this cycle in the first week in June, 1910—it rapidly decreases in brightness and is soon lost to view in even the largest telescopes.

It was last seen at the Cape Observatory in May, 1836, passing after that date into the far distances from which it came. But although it vanished from the sight of men, its onward track through space was known with as great accuracy, relatively, as sailors know the way of a ship over the trackless deep. And thus every lap of its vast orbit, over three thousand million miles distant, at its widest reach, from our earth, has been mapped out with the utmost care, and with assurance. Unseen for seventy-three years, it is yet as surely seen by those who make this branch of astronomy their care as if it shone brightly and continuously in our midnight sky. The invisible bonds of law have it in their inexorable hold, and from out the confines of that unbreakable leash it can never, never pass.

In the accompanying figure are given positions of the comet at various dates along the 1835-1910 cycle.

We have already said that the comet was last seen in May, 1836. It was then moving swiftly away from the sun, midway between the orbits of Mars and Jupiter. In the early days of 1837 it crossed the orbit of Jupiter. Jupiter himself was not very far away when the comet passed under his line of march. Slowing now down considerably, the year 1838 is well advanced before the region of Saturn's sway is reached. In six more years Halley's comet is as far distant as Uranus, and in twenty more years it is out beyond the farthest planet. And now, like a great, stately ship wearing in midocean, the comet slowly sweeps round in its orbit. Its long outward flight is spent, and the conquering homeward pull draws it sunward again. The year 1872 marked the comet's farthest distance, its aphelion; after this date its return journey begins.

At the opening of this century it was again within the orbit of Uranus. By the end of 1907 it had reached Saturn's orbit; and early this year it swept within the orbit of Jupiter.

On the first of June this year it was five hundred million miles distant from us, but rushing in at an ever-increasing speed. In June its velocity of approach was a million miles a day.

It will come nearest to our earth the first week of June, 1910, being then only twenty million miles distant from us—a hand-breadth in astronomical reckoning.

After this date it will move swiftly away from the earth, becoming daily more faint, till in the early days of 1911 it will disappear into the night, not to emerge again till the year 1985, when the most of those who read this article will have ceased to care about comets.

No small emulation is being witnessed between those observatories endowed with large telescopes, as to which one will be the first to pick up the returning voyager from far-distant shores. It is expected that this will be done in August or September of this year. The comet will then be a faint, nebulous star not far from Orion. But with regard to this matter of search, it may be said that it has already begun, chiefly by means of photography; it being thought that this auxiliary to science might make visible fainter objects than the eye can see.

In July of this year the comet held its course in the morning constellations, and was then badly placed for northern observers. It is so well placed, however, for southern observers that there is a hope that some observatory south of the line may have the good fortune to pick up the comet before the lengthening nights will enable northern observatories, armed with huge telescopes, readily to pick it up in the northern autumn. From September, 1909, to March, 1910, the comet will be well situated for observers all over the world, being then high up in the midnight sky.

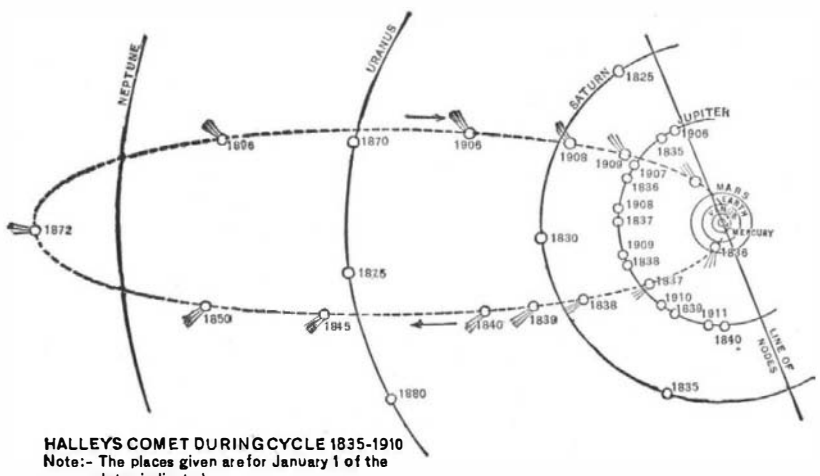
By the month of April, 1910, it will have passed right round to the evening sky, and toward the end of the month it will be lost in the rays of the sun. During May it is, for a brief time, a morning star; but in June it has again stolen round to the west, and should, in that month, be an object of conspicuous brightness in the evening sky of southern latitudes. It will remain an evening star till October of that year, when once more it will pass behind the sun, and then will appear as a morning star. By this time, however, it will be rapidly decreasing in brightness and will soon be lost to view.

There are few more interesting chapters in the history of astronomical research than that which tells the tale of the tracing back through the long centuries of this remarkable comet. Chiefly through the devoted labors of a group of classical and Oriental scholars, we can trace back the appearances of Halley's comet through twenty centuries, surely a long enough period to give it a distinction among comets.

Some of these appearances are of unique interest. On the Bayeux tapestry there is a famous picture of the comet which appeared in 1066 and which William the Conqueror regarded as a herald of victory for his arms. Hind proved that this fateful star was none other than Halley's comet.

Then, again, there are many references in classical literature to the appearance of various "fearful stars," some of which can be claimed as returns of Halley's comet.

It is a marvel that the deductive minds of many of the ancient philosophers did not see a connection



HALLEYS COMET DURING CYCLE 1835-1910
Note:- The places given are for January 1 of the dates indicated.

—as they did in eclipses—between regularly recurring phenomena. Possibly the fear which these supposed messengers of doom raised in the hearts of all, learned or unlearned, may have led the ancients to leave comets alone.

It is to Edmund Halley, the contemporary and friend of Newton, that we are indebted for lifting comets from the region of superstition to the calmer sphere of pure geometry. At Newton's request he undertook a thorough investigation of their movements, and into the laws which controlled these movements. The 1682 comet especially held his attention. His keen mind soon traced a connection between similar appearances separated by seventy-six years, and on working out the orbit of the comet, which will now forever be inseparably connected with his name, he boldly declared that it would again appear in 1758. It was seen for the first time on December 25th of that year by an amateur astronomer in Saxony.

Thus for ever the mystery which had gathered round comets was dispelled.

There are one or two very interesting questions connected with the return of this comet. Of these one is the constitution of these bodies. The usually accepted view is that they are composed of myriads of meteors at a very high temperature. But this does not explain their appearance thoroughly. It is indeed rather an imperfect explanation of the tail.

Then, do comets grow fainter each return? The belief prevails that they do. A comparison of the forthcoming appearance of Halley's comet in 1910 with the magnificent drawings made by Sir John Herschel of the 1835 appearance should do much to settle this question.

It is said that there are planets exterior to Neptune. Dr. See, of Mare Island Observatory, has even given them a local habitation and a name. If there are extra-Neptunian planets, then they should make their presence felt by perturbations of such comets as pass out beyond the orbit of Neptune. We have already referred to the near approach of Jupiter to Halley's comet in 1838. This approach would have the effect of pulling the comet back in its orbit, and thus by decreasing its centrifugal force bring it back more quickly again to the sun. Every planet circling round the sun tugs at the comet more or less, now hastening, now retarding its journey. Because of such "interferences" its path round the sun is a sinuous curve; and sometimes because of hindrances by the way, it takes seventy-seven years to return, while at other times it is incontinently pushed onward and its round is seventy-five years.

Thus if there are planets beyond Neptune they will make their presence felt in disturbing the comet as it passes its aphelion goal.

Enough has been said to indicate how much interest attaches to the appearance of this comet in 1910, and how eagerly its coming is being watched and waited for.

Status of the Birkeland-Eyde Nitrogen Reducing System.

It may be of interest to present some of the leading points regarding the present state of the nitrate industry in Norway, using the Birkeland and Eyde electric arc furnace. In this process, the gases coming from the furnace are rapidly cooled so as to prevent a decomposition due to the heat. In this way the yield is increased. Since 1905, when the first plant was started at Nottoden, Mr. Birkeland has been making researches with a new tubular furnace. On the other hand, the Baden Aniline and Soda Works, of Ludwigshafen, which is associated with the Norwegian enterprise, is also studying a new type of tubular arc furnace, but without the use of a magnetic field for blowing the arc. It appears to give satisfaction, and will soon be used experimentally in Norway. The question of fixing the nitrous vapors industrially has given rise to many researches. At Nottoden, the processes are kept secret as much as possible, however. The gas coming from the furnace is taken to oxidizing towers, where they remain for a certain time, and in this part the nitric oxide is finally transformed to nitrogen peroxide. The latter is passed into large granite towers of 35 square yards section and 60 feet height, and the gas is acted upon by a water spray. Nitric acid of 25 per cent strength is thus formed, and this can be used for preparing the nitrate of lime, which is used as a fertilizer. There remains 20 per cent of nitrogen peroxide in the gas coming from the towers, and it is passed into wood towers resembling the former and is there acted upon by the alkaline solution such as carbonate of soda or lime water. After this treatment the gases do not contain more than 3 to 5 per cent of the peroxide. The preceding products allow of obtaining nitrate of lime by neutralizing the nitric acid by roughly broken limestone, and the bath is evaporated by the waste heat of the furnace. The nitrate of lime for chemical purposes is delivered in blocks, while for agricultural purposes it is crushed and sifted. On the other hand, the treatment in the towers by the carbonate of soda solution yields nitrite and nitrate of soda. The pure nitric acid coming from nitrogen in this way gives rise to products which are of value for pyrotechnics, as it is found that the impurities in the industrial products often cause changes in the material and these give rise to accidents. The present acid is almost entirely pure and so is well adapted for this purpose. As to the value of Norwegian nitrate for fertilizing, H. De Felitzen finds that for oats the yield per acre is greatly increased. Without fertilizer we have the figure 4.2; with natural Chile nitrate it is 6.1, and with Norway nitrate it reaches 7.1. It is probable that 200,000 tons of Norway nitrate will be produced in 1913 and 125,000 tons in 1911.

Grinding Cement.

Fineness of grain is greatly to be desired, both in finished cement and in the raw materials of which it is made. In the new Pfeiffer cement machine the process of grinding is kept separate from the expulsion of the meal, or product of grinding. The last-named operation is effected by means of a fanning mill of peculiar construction which, without employing any sieves, delivers a product of very fine grain. The machine requires much less power than the ordinary machine, so that a very fine cement can be produced more cheaply than common cement is produced by the usual methods.

It is gratifying to learn that the application of block signaling on the railways of the United States is increasing, although not very rapidly. The last report of the Interstate Commerce Commission shows that the total length of road operated under the block system at the beginning of the year was 59,548 miles, a net increase over the previous year of 879. The small increase is attributed to the financial depression.