SOME CROMLECHS IN NORTH WALES.

I.

IN a recent number of NATURE the Rev. J. Griffith, the acting secretary of the Society for the Astronomical Study of Ancient Stone Monuments in Wales, gave the detailed results of some recent measurements of cromlechs in Anglesey and Carnarvonshire.

FIG. 1.—The May-year Cromlechs at Plas Newydd.

I propose in the present article to refer to some general questions in relation to them.

In the first place, I may point out that it is not a little remarkable that all the cromlechs, which were taken at random—ease of getting at them being the only principle of selection adopted—fell into line; by which I mean that all the directions indicated were the same as those which had already been made out in Cornwall. With regard to the solar alignments, indications were found of observations of the May-year sun (dec. 16° 20′ N. and S.), of both solstices and of the equinox. I have already given curves (*ante*, p. 572) which show how closely the measures fit the computed azimuths in the latitude of Anglesey (53° N.), when the heights of the horizon are taken into account. Two things, however, have to be stated: First the observations were made with a clino-compass only, and many of them in a high wind and snowstorm, which made the measures very uncertain. The next point is one of more general interest. In Cornwall and elsewhere evidence is rapidly accumulating that the solstitial alignments were not made so frequently on the actual place of sunrise as on a point somewhere about a degree south of it for the summer solstice, and north of it for the winter solstice, so that warning of the coming event could be given, and a careful watch kept. It will be seen that the majority of the alignments now in question fulfil these conditions. If we assume that the cromlechs were erected about 1000 B.C., the sun's declination then was N. 23° 50′, according to Stockwell. The only exception is at Presaddfed, at which cromlech only an estimate of the azimuth was possible, as there were no surfaces to measure.

One interesting point connected with this practice of warning is that it explains the azimuth of the Friar's Heel at Stonehenge in relation to the avenue.

Mr. Thomas recently found that the practice was adopted in regard to three or more alignments connected with the Tregaseal circle in Cornwall.

The most massive cromlechs with large quoits supported by tremendous upright stones are connected with the May year; first among these come the double cromlech at Plas Newydd; and reasoning from what one has seen in Cornwall and South Wales of the different methods of building, they are the most ancient structures I have observed in North Wales. On the other hand, the equinoctial cromlechs, supported by horizontal layers or small stones, are the newest.

Photo. by Lady Lockyer.

FIG. 2.—The Equinoctial (? late) Cromlech at Lligwy.

Between these two sets come the solstitial cromlechs. Of them I give three illustrations showing greatly varying types. Of them all Byrn Celli Ddu is the most interesting, as there is a long *allée couverte* or creep-way, which is exceptional in Britain, so far as "cromlechs" go, though many may be still hidden in "long barrows" such as New Grange,

Photo. by Lady Lockyer.

FIG. 3.—Bryn Celli Ddu (Summer Solstice), view looking S.W.

which, so far as I can make out, is oriented to the Winter Solstice. It is fortunate for students that the state of dilapidation of Bryn Celli Ddu just shows the earth of the barrow gone and many of the stones of the creep-way still *in situ.*

Mr. Neil Baynes, who has made a careful study of this monument and the literature connected with it, has been good enough to send me the plan of it, copied from the "Archæologia Cambrensis," in which the orientation is 35° out. He writes:—"The plan *was* made by Lukis, but I do not know who twisted it into the Arch. Cam.—certainly the arrow showing north was not Lukis'.

"The plan shows the creepway parallel with the S.E. stone, which was evidently the first set up, and the subsequent arrangement of the other stones. One can see how the second stone overlapped the first, and so on, until the entrance was reached."

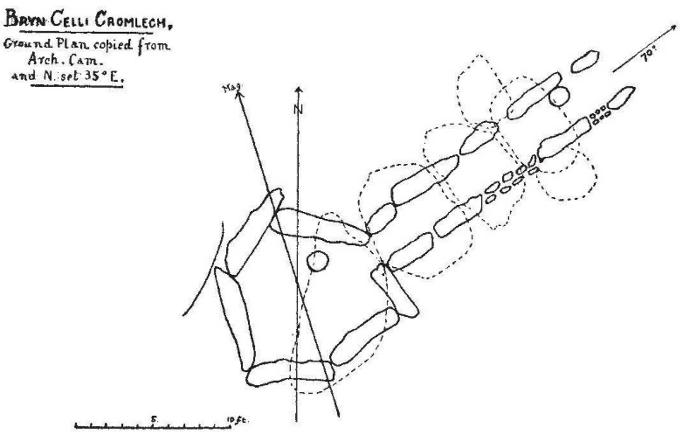

FIG. 4.—Plan of Bryn Celli Ddu, showing the true solstitial alignment of the S.E. stone and the creepway.

There is a feature on this cromlech of great interest. It consists of a cylindrical pillar shown on the plan. There can be no doubt, I think, that it once stood in the fairway of the *allée couverte* for the light to fall upon at the solstice—a kind of echo of the Egyptian ceremonial of the "Manifestion of Ra," the cylindrical stone replacing the statue of the god. Here we have one case out of many which might be named which suggests that what may be called the *furniture* of cromlechs is worthy of a close comparative study.

The cylindrical stone now in question seems to be the counterpart of other stones located in a similar way observed in other cromlechs. Borlase, in his account of New Grange,[1] writes as follows:—

"I am inclined to think . . . that we may accept as true the statement of Molyneux, that a 'slender quarry-stone, 5 or 6 feet long, shaped like a pyramid,' lay along the middle of the cave in the spot in which it is placed in his plan, and that his surmise is probably correct that it once stood upright. My view on this point is strengthened by the fact that a pyramidal pillar, shaped and rounded, was found standing upright within the chamber of the dolmen of Yr Ogof,

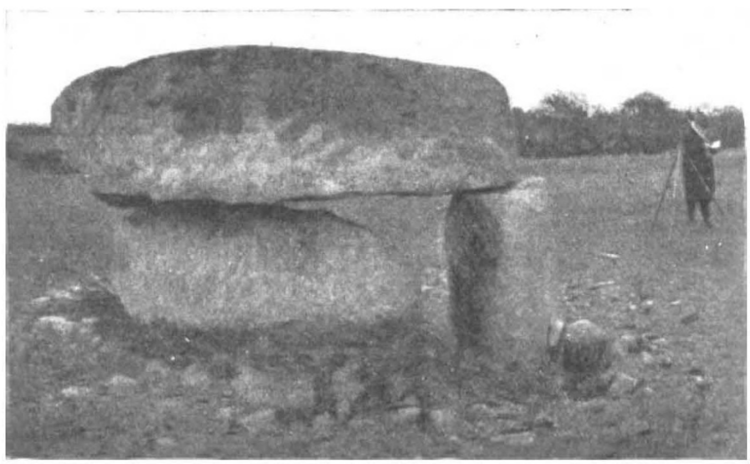

FIG. 5.—Cefn Isaf (Winter Solstice).

in Wales (see Archæol. Camb., 1869, p. 140), which in form closely resembled the pillar-stone called the Bod Fergusa, at Temair. Such a stone could readily have been removed through the passage, and its shape, so suitable for a gate-post or for building purposes, would supply the special motive for its abstraction."

Borlase (p. 450) gives a plan of Yr Ogof showing that that name is a variant of Bryn Celli Ddu. He also states that the plan was made in 1869 by a Captain Lukis, and therefore not by the Rev. W. C. Lukis, to whose accurate work in Cornwall I have on previous occasions directed attention.

In the plan of a "cairn" (L), at Lough Crew, given by Borlase on p. 325, another similar pillar is shown prostrate, but occupying the same position in the cromlech as the cylindrical pillar of Bryn Celli Ddu.

Another similar pillar is also suggested by the plan of the *allée couverte* at Mané Lud given by Borlase on p. 450.

Cefn Isaf—another solstitial cromlech—is to me

[1] "Dolmens of Ireland," p. 355.

very suggestive; it is to be regretted that one of the supporters has gone; with it in position and the quoit removed we have a great similarity to the leading feature in the Aberdeen circles, namely, a recumbent stone between two uprights. The similarity to a cove is also obvious.

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HELIUM.

A LITTLE more than ten years ago this remarkable element was only known to astronomers through the medium of the spectroscope. Now it is not only to be found in all laboratories, but appears to occur in almost all constituents of the earth's crust and in amounts proportional to their radio-activity, except in beryl (Strutt). In some cases it occurs in quantities far from minute, as in certain minerals, particularly cleveite and monazite, where the number of litres of gas obtained is comparable with the number of kilograms of mineral treated. Again, it constitutes more than 5 per cent. of the gases evolved from some mineral springs, as at Maizières, and 1·84 per cent. of the vast supplies of natural gas at Dexter, Kansas, while it occurs everywhere as four parts in a million of the atmosphere (Ramsay). Its mode of occurrence and origin are too complex and still too uncertain to be treated adequately here, but it is apparently not liberated from minerals by grinding alone to an impalpable powder (Moss), and it certainly permeates quartz at temperatures above 220° C., and with a velocity rising with the temperature (Jaquerod and Perrot). Moreover, it appears to be frequently produced in the gradual breaking down of the uranium molecule and the various radio-active transformations of this into radium and other substances.

Helium was first known from its yellow line D_3, and was first detected on the earth by the same characteristic (Ramsay). In nitrogen or hydrogen it appears that a proportion of 10 per cent. can just be detected by its spectrum (Collie and Ramsay). Very shortly it was shown to be a very light, unreactive gas with monatomic molecules. Hence it was taken to be the lightest known member of the argon group. Later determinations have shown that its density cannot differ much from 2·0 (Onnes), and that the value of the ratio of its specific heats is 1·63 (Geiger), which confirms the earlier results.

The very simple character and small mass of the molecule are evident in all its properties; thus its refractivity $(n-1)$ is found to be very small, but various observers differ as to whether there is dispersion in the visible spectrum or not. Recent results give values of $3{\cdot}478\times10^{-5}+7{\cdot}6\times10^{-16}/\lambda^2$ (Burton), and $3{\cdot}47\times10^{-5}+8{\cdot}2\times10^{-16}/\lambda^2$ (Cuthbertson and Metcalfe), in excellent agreement for a value about one-quarter of that of hydrogen and with considerable dispersion. Measurements on the conductivity for heat $K=f\eta C_v$ show that it is greater than for other gases, and appear to indicate that f has its theoretical value of 2·5. They are, however, complicated by the uncertainty as to the value of η, the viscosity. The viscosity with reference to air is given as 0.96 (Rayleigh). The diffusion of helium through a porous plug is faster than the simple theory would indicate (Ramsay and Collie), and this, together with the want of conformity in effusion results, may be partially due to its very low inversion temperature (Donnan).

The same characters are obtained under the influence of electric stimulus; thus ionic velocities of 6·31 cm./sec. for negative and 5·09 for positive α rays (Frank and Pohl) are larger values than those found for any gas but hydrogen. In the vacuum tube the dark space exhibits several distinct maxima showing long free paths (Aston).

The Zeeman effect is extremely simple and regular, the lines breaking up into normal triplets with dispersions $(d\lambda/\lambda^2)$ proportional to the fields up to 12,000 c.g.s. (Lohmann). Confirmatory observations with measurements of e/m give values of this for D_3 $(\lambda=5876)$ of $11{\cdot}3\times10^6$ across and $12{\cdot}3\times10^6$ parallel to the field, somewhat higher values being found for two other strong lines, $\lambda=6678$ in the red and $\lambda=5016$ in the blue-green (Grey and Stewart).

Gaseous helium has a small negative magnetic susceptibility of 0·00175, less than argon (Tänzler), while its dielectric cohesion is the lowest known. All monatomic gases have low values, argon being 39 where hydrogen is 205, but helium is 18·3, so that 0·005 per cent. of the diatomic gas can be clearly detected (Bouty).

It would seem as if this property might be a certain and easily applied method of checking the freedom of helium from hydrogen. Other methods of testing its purity are determinations of density and spectrum analysis. The former is extremely accurate when great precautions are taken, but does not easily give an accuracy of more than 0·05 per cent.; however, with the spectroscope it seems that 0·008 per cent. or less of hydrogen can be seen (Onnes).

It is, however, in its character of the most perfect known gas that helium has the most obvious usefulness, and this in two directions. At all temperatures below 100° C. a constant-volume helium thermometer is the most convenient and accurate known because the corrections are very small and regular. Determinations of the mean pressure coefficient from 0°·0 C. to 100°·0 C. gave values of 0·00366241 and 0·00366270 for a normal thermometer (760 mm. at 0°·0 C., Travers and others). These values, when corrected and re-calculated to the international scale (1000 mm. at 0°·0 C.), appear as 0·0036616 and 0·0036613, the former of which agrees exactly with a direct determination at this pressure (Onnes). To obtain these corrections use has been made of isotherms observed at 0°·0 C., 20°·0 C., and 100° C., and the corrections of the helium thermometer to the absolute scale are deduced from isotherms at the values given. They are −0°·006 at −103°·57 C., +0°·002 at −182°·75 C., and +0°·01 at −216°·56 C., while in later measurements of the boiling point +0°·2 is assumed at −268°·6 C. = 4°·5 K., if absolute zero = −273°·10 C. (Onnes). The isotherms indicate that there is no minimum until about −253° C., so that the Boyle point, where $(d(pv)/dp)_t=0$, appears to lie at about this temperature, and hence the Joule-Kelvin inversion temperature, for small pressure differences, will lie at about twice this, or 40° K. The isotherm for −258°·82 exhibits a distinct minimum at about 10 atmospheres, as can be seen by plotting the following values for pv against p; $p=0$, $pv=0{\cdot}05222$; $p=40{\cdot}012$, $pv=0{\cdot}06150$; $p=46{\cdot}222$, $pv=0{\cdot}06559$; $p=53{\cdot}326$, $pv=0{\cdot}07063$; $p=58{\cdot}797$, $pv=0{\cdot}07531$.

The value of the critical temperature, which had been variously given from 8° K. (Dewar) to 2° K. (Olszewski), and about 1° K. (Onnes and Keesom), was settled by these isotherms as not greater than 5°·3 K., and later observations of the liquid fixed it as little above 5° K. with a correspondingly low critical pressure of 2·3 atmospheres (Onnes). Liquid helium boiling normally at 4°·5 K. is very mobile, with an extremely small apparent surface tension and a density of 0·15, and is only eleven times denser than the vapour above it (Onnes).

In mixtures of helium and hydrogen the gaseous helium sinks in the liquid hydrogen at about 40 atmospheres (Onnes), which opens up a wide field of