tion, 1913), is that in practice the energy changes do not take place by scattered radiation alone, but also by corpuscular radiation and characteristic or fluorescent radiation. It does not seem permissible to consider scattered radiation by itself. The genesis of radiation must involve the mutual play of both corpuscular radiation and waves. When X-rays fall on a body some of the incident energy reappears as scattered radiation, some as corpuscular radiation, and some as characteristic radiation. Consequently Planck's original oscillators formed an artificial body which has no counterpart in reality. He was, of course, aware of this, for on p. 133 he states that "it does not matter whether such a body exists anywhere in Nature, it is only necessary that its existence and properties should be compatible with the laws of electrodynamics and thermodynamics."

As a result of the difficulties associated with the form of the theory described in the book referred to above Planck made an important modification of his hypothesis ("Eine veränderte Formulierung der Quantenhypothese," *Preuss. Akad. Wiss. Berlin, Ber.* 34, pp. 918–23, 1914). This paper assumes that radiation and absorption take place continuously, and that the quantum action is not between the oscillators and the radiation, but takes place between the oscillators and the free particles (molecules, ions, and electrons), which exchange energy by impacts with the oscillators. The laws of classical electrodynamics then hold good for every interchange between the oscillators and free radiation. At the same time the radiating substance becomes more like its counterpart in Nature, and the feeling of artificiality which the former theory produced is removed. Also the difficulty connected with the use of Hertz's expression for calculating the density of the radiation disappears.

(To be continued.)

The Extent of the Recent Drought.

THE recent prolonged drought in the British Isles has directed attention to an interesting aspect of meteorological science. It is natural to inquire how far the drought has been confined to our immediate neighbourhood, or how far it has been general. With the exception of Hildebrandsson's pioneer work on action centres, no systematic research dealing with the extent to which drought has affected considerable areas of the earth's surface at one time has yet been carried out. A basis for detailed study of this character will be provided by the "Réseau Mondial," published by the Meteorological Office, five annual volumes of which have now been issued. This publication gives pressure, temperature, and rainfall for about 400 stations distributed over the globe, the month being taken as a unit. In the present article it is proposed to make a preliminary survey, so far as material is already available, of the world's weather this year, particularly during the months May, June, and July. As no system of telegraphic reporting from "Réseau Mondial" stations has yet been established, we have to rely in making such a survey on the most recent monthly, weekly, or daily weather reports obtainable from the various countries, and, largely, upon general newspaper reports.

Table I. shows the percentage of normal rainfall which has fallen in various parts of the British Isles since the beginning of the year :—

TABLE I.—*Percentage of Normal Rainfall.*

1921.	England and Wales.	Scotland.	Ireland.	British Isles.
January	146	168	119	145
February	15	39	51	34
March ...	101	170	129	133
April ...	59	61	46	56
May ...	79	108	90	91
June ...	17	40	24	26
July ...	Probably below 50	Rather above 100	Above 100	About 100

Table II. gives the percentage of normal rainfall for the various districts into which the British Isles are subdivided :—

TABLE II.—*Percentage of Normal Rainfall by Districts.*

	Scotland, North.	Scotland, East.	England, North-east.	England, East.	Midland Counties.	England, South-east.	Scotland, West.	England, North-west.	England, South-west.	Ireland, North.	Ireland, South.	English Channel.
January	164	162	144	107	128	118	165	174	123	132	99	95
February	64	26	16	26	15	21	37	14	9	38	60	15
March...	160	109	45	53	73	62	176	124	92	127	114	67
April ...	61	51	69	87	57	63	56	62	43	51	30	53
May ...	117	89	86	59	70	71	100	83	89	89	83	73
June ...	46	41	27	20	18	6	30	15	13	17	10	36
Average percentage February to June :—	90	63	49	49	47	45	80	60	49	64	59	49

It should be noted that Tables I. and II. are not based on identical stations.

Table I. shows that January was a month of excess rainfall in all regions. Previous to this we have to go back to July, 1920, to find another month with rainfall above normal for the whole British Isles, the percentages for August to December, 1920, varying between 68 and 96. It is evident from the table that the drought has been much more conspicuous in England and Wales than in Scotland and Ireland, where it has not been so remarkable. This is well shown in the map (Fig. 1), which has been prepared by the British Rainfall Organization. The area of greatest drought is the southern and eastern midlands, the amount of rainfall increasing outwards from this centre, particularly to the north and west. February, April, and June were the months of greatest deficiency. March, which appears to be normal (101 per cent.), was a month of drought in most places in the eastern and midland counties, but wet in the west and north-west.

The year 1887 was the driest one of the nineteenth century in the British Isles. The year 1893 was also very dry. A comparison of the mean values for twenty-five stations in England and Wales, during the months of drought, with the normal for 1881–1915 shows that the present year (February to July) has the least rainfall—49 per cent.—while 1887 (February to July) had 57 per cent., and 1893 (March to August) 65 per cent. If considered, however, from the point of view of frequency of absolute or partial drought periods at individual places, the present year was surpassed by both 1893 and 1911. Although we have had prolonged spells of hot weather, the maximum shade temperatures of 1911 have not been

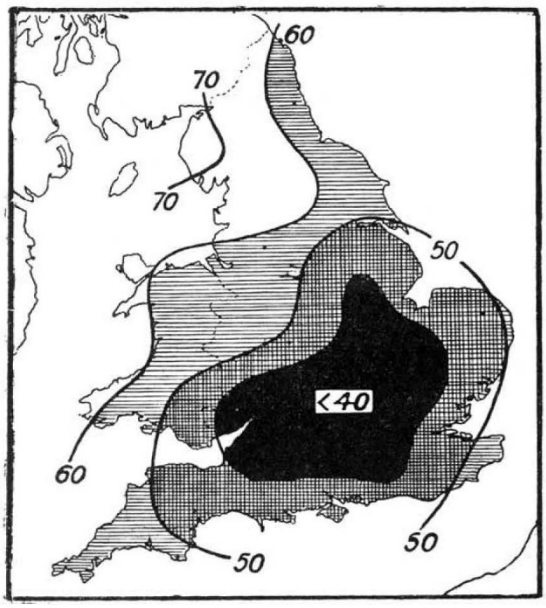

FIG. 1.—Rainfall, February–July, 1921. Per cent. of average, 1881–1015.

equalled. Woodland and moorland fires have been extensive and frequent, especially in Surrey.

In France the winter and spring were unusually mild and dry. Drought was severe in March and June, and persisted with only temporary breaks to the end of July. Paris rainfall, January 1 to July 15, was 104 mm., the normal being 236 mm. In Central and Southern France violent rainstorms occurred in July. Forest fires have been very numerous in Northern France and Belgium.

The winter was abnormally dry in Switzerland, with comparatively little snow. Early in January the Rhine and Rhone had shrunk to half their ordinary volume, and the general lack of water caused great restriction of electrical services. The winter is stated to be the driest for ninety years. Similar conditions were maintained throughout the spring, and June was so hot and dry that rivers were 6 ft. below normal, and the snow-line on the mountains receded more than 300 ft. On July 28 a shade temperature of more than 100° F., the highest since 1870, was recorded at Geneva.

In Norway, Denmark, and Germany forest and moorland fires were frequent in July after a spell of hot, dry weather. Central Europe generally does not, however, appear to have had the same degree of drought as North-western Europe. There was no rainfall deficiency in Germany in April to June, and temperatures, on the whole, were not unusually high, but drier conditions established themselves in July. In April Austrian temperatures were below normal, and rainfall, on the whole, above, in some cases two or three times the normal. In May, however, rainfall was deficient, and mean temperatures up to 7° F. above normal were experienced. Rainfall was also below normal at Budapest in April.

In Russia the drought has been very severe and prolonged, particularly in the south and south-east districts. Crops have consequently failed almost universally, so that a famine of unparalleled magnitude is threatened.

There is no information yet available from the bulk of the Asiatic continent. Winter snowfall in Baluchistan and the hills of the Punjab and North-west Frontier regions was the smallest for many years, but that in North-east Persia was normal. The monsoon broke rather late in India (June 22), but in spite of a lack of rainfall in the Bombay Presidency early in July, afterwards relieved by a week's rain, Indian rainfall has been quite satisfactory in general. Heavy rainfall, associated with a gale in the Mediterranean, caused a sudden rise of the Tigris in April; later on a period of intense heat set in in Irak and the Persian Gulf region. This is the hottest weather experienced since the British landing in 1914, and a shade temperature of 128·9° F. is stated to have been reached on July 16. If confirmed, this will constitute one of the highest shade temperatures ever recorded. Normal weather prevailed in Japan in April, but heavy rain and floods occurred in certain regions in June. Rainfall at Hong-Kong between January 1 and April 30 was 217 mm., the normal being 295 mm.; the temperature was not exceptional in April.

In Algeria, April and May were cloudy, with rainfall above the normal, and rather low temperature. The Nile was below its usual level up to June, and the Blue Nile was also low in May, owing to the lateness of the rainfall in the Abyssinian mountains. In June a rainfall unprecedented for the season occurred in Lower Egypt, a fall of 22 mm. being recorded at Ezbekia. During thirty-five years measurable rain has fallen only on one occasion in June, and it barely exceeded 1 mm. Apart from this, Egyptian temperature and rainfall were not remarkable during April to June, being somewhat above normal in some parts, and below it in others. At Dar-es-Salaam the total rainfall of April and May was 25 per cent. above normal.

There has been much hot weather in Canada, and rainfall, while by no means absent, has been deficient in many parts during the last three months. It is stated that there has been no such

long period of intense hot weather in the history of the province of Ontario, and the same applies to the whole of Eastern Canada, where shade temperatures ranging from 95° F. to more than 100° F. have been reported. The heat has caused much interruption of work, and destructive forest fires have been numerous. The harvest will be an early one, but, on the whole, is nearly up to the average.

New York suffered from several hot spells in June and July, an unusual feature being the accompaniment of exceptionally high humidity, which intensified their effect. In the latter month the whole of the middle section of the country eastward of the Rockies experienced great heat. There does not seem to have been any general deficiency of rain. Further south the cotton-growing districts had an excess of rainfall in July, and the crop will be very poor unless fine, dry weather supervenes.

Little information is available from Central and South America, but British Honduras had rainfall and temperature below normal in April, rainfall above, and temperature below, normal in May, and drought at the beginning of June. Peru has been suffering from drought sufficient to reduce the maize crop to half its usual value.

In Southern and Western Australia temperature was above normal during last summer in that continent. A shade maximum of 108° F. was registered at Perth on January 21, the highest on record for that city, and at Adelaide on more than one occasion the thermometer was 2° higher. Sydney temperatures were, however, below the normal. There was a spell of dry weather in Victoria, South Australia, and New South Wales in April, but rain fell in May. Early in June there was heavy rain in many parts of Queensland and New South Wales, and in July heavy gales and rainstorms swept the country from Sydney northward to Queensland, and were followed by disastrous floods in the coastal rivers. Later the weather in New South Wales and Victoria was the coldest experienced for a quarter of a century, and snow fell in districts where it has never been seen before. South Australia, up to June at any rate, had experienced a dry and unusually mild winter.

The open winter in the Arctic regions has caused an abnormal number of icebergs to be scattered over a large area of the North Atlantic Ocean, and conditions are worse for ships than they have been for many years.

To summarise, so far as information goes at present, the drought has been mainly European, chiefly in North-west Europe and Russia. Canada has had extremely hot weather, but without a serious deficiency of rain. The season in Australia has been abnormal, and there are indications of abnormal conditions in other widely separated regions, notably Irak and Peru. The only region of special excess of rain in the northern hemisphere appears to have been the Southern United States.

The Disaster to the Airship R38.

THE suddenness of the catastrophe and the terrible death roll have directed the attention of the whole world to some aspects of airship construction. With the airship Britain and America have lost many valuable lives and a great amount of personal knowledge irreplaceable at short notice. A tribute to the bravery of the crew can be given with all sincerity, for some at least were aware of the fact that the airship was a great experiment, and on some important points designed without sufficiently exact knowledge of the conditions to be met. Not that anyone anticipated a collapse so complete and immediate as that which occurred, when the first warning was too late to enable experienced members of the crew to use the parachutes provided.

There have been less severe accidents to British airships in the past, but the cumulative effect had been to give some confidence in their ability to take appreciable damage without total failure. By taking the simple precaution of flying into the wind on the outward part of a trial flight, an airship when partly disabled has hitherto been able to return to its base quickly and safely. No parallel to the estimate of five seconds from first warning to fracture of the hull appears to exist.

It is too early to draw final deductions from the accident, for the evidence is incomplete, and the consequential failures are certain to mask, if not wholly to hide, the source of initial weakness. It may be gathered from the reported statements of eye-witnesses on the ground and survivors from the airship that the most probable element of failure was some weak member of the hull structure. The explosion, whether of petrol vapour and air or escaped hydrogen and air, followed the failure of girders amidships. It has been suggested that the breaking stress might have been imposed by a rapid application of the rudder in an endeavour to produce the equivalent of a gust of wind from the side. Whether this be true or not, it is probable that no one was able to estimate the forces which would result from the manœuvre. Airship design as known to us has been a matter of experience and guessing, and not of calculation founded on scientific knowledge. Policy, first dictated by the Admiralty and more recently by the Air Ministry, has never given any effective opportunity for the accumulation of the scientific knowledge on which alone rapid advance in construction could safely proceed.

In the early days of rigid airships the breaking of naval airship No. 1 at Barrow was followed by