Letters to the Editor.

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The Mass-spectrum of Copper.

THE number of elements of which the isotopic nature has been determined is now large enough to give considerable weight to statistical relations. Among elements of odd atomic number two definite empirical rules stand out. The first is that none of them consists of more than two isotopes. This has no exception so far. The second is that the more abundant of the two constituents, or both, will be of odd atomic weight. The only exception to this is the element nitrogen; moreover, the only even isotopes at all are the weaker constituents of lithium and boron. That both of these rules should be violated by copper having the three isotopes 62, 64, 66, announced recently by Prof. Dempster, seemed therefore excessively improbable.

I have now been able to obtain the mass-spectrum of copper by employing cuprous chloride in the accelerated anode ray method used with the mass-spectrograph. The lines are faint, but their evidence is conclusive since they appear at the expected positions 63 and 65 and have the intensity ratio, about 2.5 to 1, predicted from the chemical atomic weight 63.57. The positions of the lines could be determined with great accuracy by comparison with the line 56 due to iron derived from the anode container. No deviation from the whole number rule was observed.

With regard to Prof. Dempster's results (NATURE, July 7, p. 7), it is very suggestive that the intensity and grouping of the lines he ascribes to copper agree exactly with those of the strong isotopes of zinc. It seems possible, therefore, that they are due to the presence of traces of that element either in the copper or more probably, together with the rubidium he mentions, in the furnace material.

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Cavendish Laboratory, Cambridge, July 25.

Polar Temperatures and Coal Measures.

FOR some years I have held a view of the possible origin of some at least of the coal measures of the polar regions that is not found in the ordinary geological text-books. After discussing it with a dozen friends who are geologists, and some of them specialists in glacial geology, I have concluded—somewhat to my surprise—that the theory is new. A short statement of the theory may therefore be desirable.

It is generally considered that certain plants are not limited in their geographic range, by no matter how intense a cold in winter, if only they have an adequately hot summer. Apparently this hot summer may be very short and still the plants prosper. Notable examples are the black spruce of northern Canada and similar trees in the northern part of the Old World.

In the western hemisphere I have examined specimens of coal from 79° north latitude. So far as the material could be identified it was coniferous. In other deposits almost equally far north I have found gum and pine cones.

The northern limit of conifers in North America at present is between 68° and 69° north latitude. That this limit is determined not by intensity of cold in winter, but by lack of heat in summer, is shown by the luxuriance of the black spruce and several other trees in the mountain valleys of the Yukon, where the minimum temperatures in winter are from 10° to 20° lower than at the northern limit of trees. This northern limit is therefore determined by the proximity of the Arctic waters chilled by floating ice, which lower the summer temperature.

The United States Weather Bureau frequently reports temperatures above 90° in the shade, observed under standard weather bureau conditions, at Fort Yukon in Alaska, just north of the Arctic circle. The Bureau occasionally reports 95° F., and has reported even 100° F. The Canadian Weather Bureau reports nothing above 88° F., but that is because its northern stations are strung out at intervals along the northward flowing Mackenzie River. On two journeys down this river (1906 and 1908), and from common report as well as from weather bureau observations, I know that there is on most occasions a wind blowing with almost the steadiness of a trade up the Mackenzie valley from the Polar Ocean. Explorers who have been in the Canadian Arctic, away from the Mackenzie wind-trough, have observed temperatures much higher than those recorded by the Weather Bureau.

We have, then, observational confirmation of the theory, according to which the polar regions receive about as much heat for five weeks in summer as does the equator.

Most observers reporting climate from the polar regions have done so from locations on shipboard or on a sea-coast, where the downpour of the summer sun's heat has been neutralised by the chill of the ocean stored up through a long and cold winter. It is true that the ground in the Arctic is frozen, and that the temperature of the earth 40 or 50 ft. down has been found to be about +10° F., whereas the ocean 50 ft. down would have a temperature about +29° F. Soil and even rock are, however, poor conductors of heat, and the ground chill is imprisoned, while the ocean chill is freely liberated. Furthermore, the great heat of summer produces on most land surfaces a mat of vegetation, which is an even poorer conductor of heat than the earth itself. This is why a thermometer 6 ft. above a damp meadow in the arctic regions of Alaska, protected from the sun's rays in the usual weather bureau way, is able to record temperatures ranging from 60° F. to 100° F. almost every day for a period of several weeks in midsummer.

Consider now what the weather conditions in the Arctic Regions would be if, instead of the present ocean ranging in depth from one to three miles, we had an extensive low land—say a continent as low and as flat as Australia, with the North Pole near the centre of it. Better still, assume that the low land of northern Siberia, with physical characteristics such as it now has, were to extend to and beyond the North Pole, including a large part of the Canadian Archipelago, or even joining up with North America itself. Remembering that the sun delivers about as much heat in the Polar Regions as in the Tropics in midsummer, and also the observation that frozen ground has little effect upon the temperature of the air above it, then according to recorded midsummer lowland temperatures at present in the Polar Regions, we should have at the North Pole July heat of so-called "tropical" intensity, and conditions all over the Arctic suitable for dense forests of black spruce and other trees and shrubs, without calling upon any further alteration in environment—such as different chemical composition of the atmosphere.