until they strike an object, when they solidify on contact. Thus bodies exposed to mist or fog at low temperatures become covered with a coating of light fluffy ice to which we give the name of 'rime'. In certain conditions of thin mist hoar frost and rime may both be formed at the same time.

G. C. SIMPSON.

Meteorological Office,
Adastral House, Kingsway,
London, W.C.2.

Empirical Factors in Weather Forecasting.

THE Meteorological Office always welcomes friendly and constructive criticism, and therefore it gives me much pleasure to reply to the points raised by Mr. Wilfred Trotter in his letter published in NATURE of Oct. 19. Mr. Trotter's main indictment is that modern British forecasts prepared on synoptic charts take too much account of the pressure systems shown on those charts and too little of that general tendency for persistence of weather which sometimes seems to cause fine weather to continue for a long unbroken spell with little regard to the pressure distribution. It would be idle to deny that there may be some truth in this charge, but perhaps I may point out some of the difficulties with which the forecaster is faced. Let us take as an example a case which was fairly common during last summer, when a trough of low pressure over Ireland, stretching down from an Icelandic depression, is moving eastward across the British Isles and probably already giving some rain in Ireland. The question to be answered is, Will this rain spread to the south and south-east of England? The forecaster knows from his experience that in normal circumstances it will generally do so. In the particular type of weather which we are discussing he also knows that the past month or past few months have been abnormally dry. There are these two conflicting elements to be balanced. If he leaves out rain and it comes, he fails in what to many people is the most important factor of his forecast. He decides that he cannot take this risk with no better grounds for the omission than the somewhat nebulous one that the summer has so far happened to be abnormally dry. He therefore indicates the probability of some rain; when he comes to the office the next day and reviews the situation, he may wish that he had taken the risk and left out the reference to rain. It is easy to be wise after the event. It must be remembered that, even in a dry summer like the past, there have been days when troughs of low pressure have given rain in the south of England, so that if the forecaster had omitted to mention it on every occasion, he would in some cases have been wrong, and badly wrong.

There is a further point. The Meteorological Office has to forecast for the whole of the British Isles, and it frequently happens that drought in one part of the country coincides with excessive rain in another part. We have been taken to task already this summer for not making enough mention of heavy rains which fell in the West Highlands of Scotland. The forecaster, therefore, who is looking at the whole of the country may not have the dryness of the season impressed upon him quite so strongly as members of the public who see the weather in their own locality only, and from the nature of the case take little account of that in other areas. We have been aware of this tendency to forecast rain more frequently than the event proves to be necessary in dry spells for many years, and if we have failed to benefit by experience, this is due more to the difficulty which I have tried to indicate above than to ignorance of the facts. The cure will be found in more science, not less. When we really understand the workings of the atmosphere and have enough upper air observations to tell us what is happening at the time, we shall know that the particular trough which is approaching cannot bring rain; but that time has not arrived yet.

One further criticism is made by Mr. Trotter, and that is with regard to the forecasting of summer thunderstorms, his charge being that too little account is taken of the time of year and that thunderstorms are forecast as confidently in the latter part of August, or even in September, as in the middle of July when the thunderstorm season is at its height. The forecasting of thunderstorms is perhaps the branch into which more scientific method has been introduced than into any other branch of forecasting, and much account is now taken of whether the upper air conditions, as shown by aeroplane ascents, are stable or unstable. Nevertheless, these observations are not always available when required, and then the older methods of forecasting by pressure distribution and surface temperature have to be used exclusively.

I have not statistics available to show whether Mr. Trotter is right in thinking that the trustworthiness of the forecasts of thunder declines steadily throughout August. The average number of days of thunder at Kew Observatory in August is equal to that in July, and higher than in any other month of the year, though the September figures show a sharp drop. Recent criticisms of our forecasts have suggested that we forecast thunder too often throughout the whole summer, and I believe that this is largely due to the fact that any individual observer is concerned only with the thunder in his immediate vicinity, whereas our forecasts cover a whole district. If a thunderstorm is likely in any part of that district, we do not feel justified in omitting it from the forecast. The number of days in an average summer when thunder is reported at a few isolated places but by no means generally over a district, is very considerable.

J. S. DINES.

Meteorological Office,
Adastral House, Kingsway,
London, W.C.2, Oct. 25.

The Motion of a Lorentz Electron as a Wave Phenomenon.

I HAVE been able to express the equation representing the uniform motion of the surface of a Lorentz electron in a form which strongly suggests that the 'parcel' or particle aspect of the phenomenon may be associated with the interference of two waves. Thus, if (x, y, z) are Cartesian co-ordinates relative to a material observer and t is his proper time, the motion of the electron's surface is represented by

$$\frac{(lx + my + nz - c\beta t)^2}{1 - \beta^2} + (\lambda x + \mu y + \nu z)^2 + (Lx + My + Nz)^2 = a^2,$$

where (l, m, n) are the direction cosines of the velocity $c\beta$ and a is the rest radius. On account of relations of the types

$$l^2 + \lambda^2 + L^2 = 1,$$
$$lm + \lambda\mu + LM = 0,$$

this is reducible to

$$\phi(x, y, z, t) = a^2, \quad . \quad . \quad . \quad (1)$$

where

$$\phi(x, y, z, t) \equiv \psi(x, y, z, t) + \frac{1}{m_0{}^2c^2}\{W(x, y, z, t)\}^2, \quad (2)$$

$$\psi(x, y, z, t) \equiv x^2 + y^2 + z^2 - c^2t^2, \quad . \quad . \quad (3)$$

$$W(x, y, z, t) \equiv \frac{m_0 c\beta}{\sqrt{1 - \beta^2}}\left(lx + my + nz - \frac{ct}{\beta}\right) \quad . \quad (4)$$

(m_0 is the rest mass of the electron). The function ψ