THE OCCURRENCE AND POSSIBLE MEANING OF THE 'NIMBUS'

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There are few observations of cases in which a nimbus has developed around a solar flare of major importance. Speculations have been made about the nature of this obscuring cloud. We shall give here some consequences of the assumption that we have to do with scattering by a cloud of electrons, ejected together with the protons during the formation of the flare.

Since the electron receives radiation from a solid angle 2π, half the scattering cross-section should be taken, that is $\frac{1}{2} \times 0{\cdot}66 \times 10^{-24}$ cm^{-1}.

If we start from a darkening in a nimbus of 3% (Houtgast, 1962), we get $\frac{1}{2} \times 0{\cdot}66 \times 10^{-24} N_{\text{tot.}} = 0{\cdot}03$, which yields for $N_{\text{tot.}} = 10^{23}$.

For a height of the cloud, assumed equal to its cross radius, of about 100000 km = 10^{10} cm, $\bar{n}_e = 10^{13}$ per cm^3.

For comparison: in a prominence $n = 10^{10}$–10^{11} cm^{-3}, at the base of the chromosphere the total number of particles is 10^{16} cm^{-3}, for a height of 1000 km it is 10^{13} cm^{-3}.

Since the scattering of electrons holds for all wavelengths, the observation in continuous light is to be preferred for avoiding the influence of chromospheric structure as seen in Hα and other lines.

The gas of protons and electrons in a nimbus would cause a series of absorptions due to free-free and bound-free transitions. Of these the Balmer continuum is the most important. It can compete with electron scattering for T_e of the order of 10000° and $n = 10^{10}$–10^{11} cm^{-3}, increasing with n. So it would be interesting to observe a nimbus in a wavelength region below the Balmer discontinuity, say at λ 3600 Å.

Other explanations of the nimbus phenomenon are not excluded, but we wish to stress the need for observations which could give more information. I should very much like to receive available, unpublished, and future observational data.

References

Houtgast, J. (1962) *Bull. astr. Inst. Netherl.*, **17**, 56.
(1963) in *The Solar Corona, Symposium No. 16 of I.A.U.*, Ed. by John W. Evans, p. 231.

DISCUSSION

Kiepenheuer: The question of whether the nimbus effect could be explained by electron scattering had been discussed already at the Cloudcroft Symposium (J.W. Evans, *Proc. IAU Symposium No. 16:*

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The Solar Corona, New York 1963, p. 233). The main difficulty involved seems to me the very large total number of electrons and consequently ions required to produce the observed effect, which is of the order of 10^{43} electrons respectively ions. It is equivalent to about 10^5 times the electron respectively ion number of a well-developed prominence or of a flare surge. I can not quite see, how such a large amount of material can be injected without observable effects.

Severny: The picture shows the nimbus for a flare just at the limb and it gives an idea about the maximal height of the layer producing the 'nimbus'. The height of the layer responsible for nimbus cannot be larger than 10^4 km ($= 10^9$ cm).

De Jager: Since the nimbus is a Hα phenomenon, its explanation should be looked for in the Hα-source function. If it were due to electron scattering it should as well be visible in the continuous radiation.

Beckers: If the nimbus were due to electron scattering I would expect it to be bright when seen on the disk in the centre of Hα. This because of the large thermal motions of the electrons which cause Doppler shifts of about 10 Å r.m.s. for the incident radiation at a temperature of 10000 °K. So the electrons see radiation coming from the continuum near the Hα line causing a strong increase in brightness (factor 5). Another factor to take into account is the solar limb darkening causing the electron cloud to go into emission near the limb for wavelengths where the limb darkening is large. At Hα this may only be a small effect, however.

Švestka: An electron density of 10^{13} cm^{-3} exists only in narrow filaments of the flare, the volume of which is much smaller than you have considered. I also suspect very strongly that with the number of free electrons you give, we should have to observe continuous emission behind the Balmer limit, which never has been the case. And as for the limb event shown by Professor Severny, we should observe some emission hill on the limb, since the light scattered by the electrons to all directions must become visible on the limb. But we do not observe anything like that.

Houtgast: The foregoing remarks are very much to the point and are welcome reasonings regarding the nimbus problem. Once more they stress the need for a quantitative treatment, as well theoretically as from the observational side.

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