between τ about 1 and 0·1. Careful observation and analysis of the spectra of faculae might reveal more about that almost unexplored problem.

A deeper understanding of flares can probably be obtained only in connexion with the *magneto-hydrodynamics of supersonic turbulence* in plasms. Radio and cosmic-ray astronomy shows that in such plasms electric fields and corpuscular radiations with a wide range of energies are quite important. The production of cosmic rays on the Sun, e.g., requires fields of at least 0·1 volt cm.$^{-1}$, that is 100 times stronger than those mentioned under 2.

11. SUMMING UP

By M. G. J. MINNAERT

Since the available time is rather short, I shall only give a very brief summary in the form of a diagram, which may be a basis for discussion.

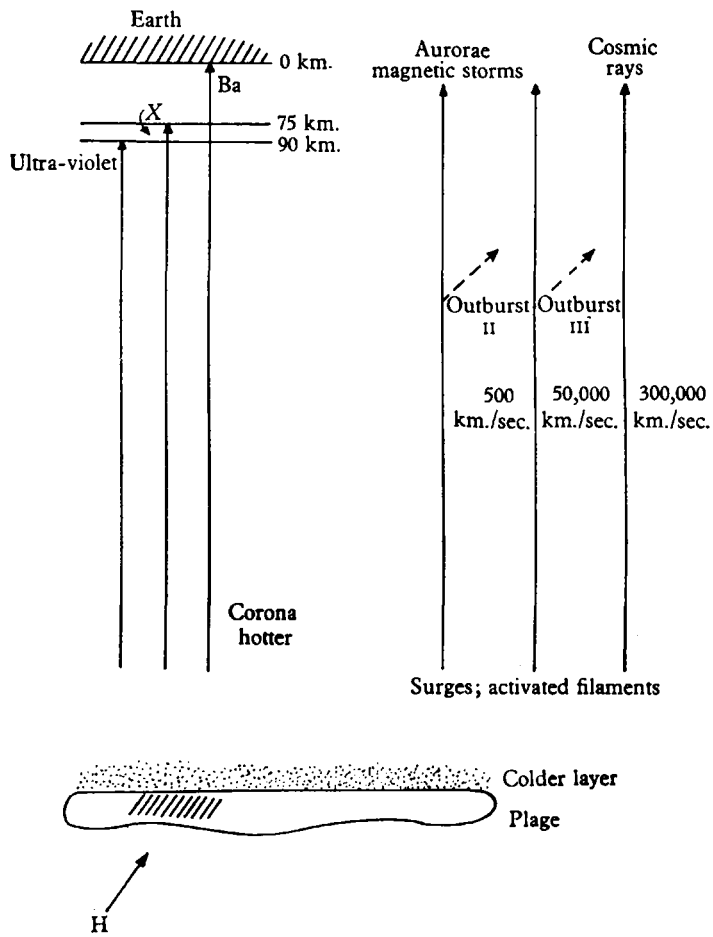

Fig. 6

Before a flare appears, there is already a special, perturbed temperature distribution over a certain solar area, which we call a plage. The apparition of a flare is due to the influence of a special disturbance, which might be a local magnetic field H coming from inside the Sun. Apparently this produces electric currents, which then are amplified by the mechanism of Dr Unsöld till high temperatures are reached, accompanied by influences on the surroundings and by emission of radiation and corpuscules.

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The mechanism of the ejection itself has been described by Dr Kiepenheuer. The observations demonstrate that the following emissions take place, either from the flare or from neighbouring regions:

1. Ultra-violet and X-radiation, producing the ionospheric disturbances, some in layers at about 90 km. and others about 75 km.
2. Corpuscules with a speed of the order of 500–1000 km./sec., producing the magnetic storms and the aurorae.
3. Corpuscules with a speed of 50,000 km./sec., of which no special terrestrial effects are observed.
4. Cosmic radiation.

During the passage of the corpuscules through the chromosphere and corona, electromagnetic radio-waves are generated, which at each height have the frequency of the corresponding plasma oscillation and appear in the order of increasing wave-lengths. Associated with the passage of the 500 km. corpuscules are outbursts of type II; associated with the 50,000 km. corpuscules are outbursts of type III.

It remains to investigate in how far these streams find their origin in the following individual objects:

(*a*) Surges, which are found to ascend and to descend along the same path, either when they are observed at the limb with the polarizing filter or when they are seen projected against the solar disk by their Doppler effects;

(*b*) Already existing quiescent prominences, which are activated and ejected by the influence of the flare, and which often reappear at the same place.

In both cases it seems as if a part of the material was ejected while another part is falling back.

There is a difference of opinion concerning the origin of the cosmic rays. Wild assumes that they are the 50,000 km. corpuscules, subsequently accelerated. Alfvén thinks that they are formed in the corona by magneto-hydrodynamic shock waves, proceeding from the flare.

DISCUSSION

H. ALFVÉN: I do not think that Wild's type III bursts with velocities of 50,000 km./sec. are associated with cosmic rays, as implied in other speakers' remarks.

M. MINNAERT: Then we add a third characteristic emission of corpuscules with almost the velocity of light.

M. N. SAHA: If we ascribe to protons the velocity of about 60,000 km./sec. the energy of the protons would be of the order of a million electron-volts.

12. CONTRIBUTION TO THE DISCUSSION

By K. O. KIEPENHEUER

A flare is only part of a group of related phenomena, which all originate in *one* primary cause. This cause is obviously of magnetic nature and might be understood in terms of a magnetic disturbance rising from sub-photospheric layers into the chromosphere. According to our knowledge the following individual features have to be included:

Flares.
Activation of existing filaments.
Ejection of surges.
Line excitation in the chromosphere and the corona.
Emission of corpuscules with velocities from 3×10^7 to 6×10^9 cm./sec.
Outbursts.
Emission of cosmic ray bursts.