

## SHORT COMMUNICATIONS

### GRANULATION NEAR THE EXTREME SOLAR LIMB\*

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Rösch (1957) found that on good photographs the photospheric granulation remains visible to within less than 10 sec of arc from the limb, and sometimes to less than 5 sec. Recently, however, these results have been contradicted by Edmonds (1960) who, on the basis of an examination of photographs obtained in "Project Stratoscope" (Schwarzschild 1959), finds that the granulation disappears almost completely at  $\theta=75^\circ$  (33 sec from the limb). Poor focus obliterates the last vestiges of the pattern closer to the limb; nevertheless, Edmonds concludes that the granulation disappears completely at  $\theta=78^\circ$  (21 sec from the limb). Since a determination of the distance from the limb at which the granulation disappears provides an estimate of the height of the top of the convection zone (Plaskett 1955; de Jager 1959), it is important to resolve this contradiction.

An examination of photographs taken with the 5-in. photoheliograph described by Loughhead and Burgess (1958) shows that the granulation remains visible very close to the limb, thus confirming Rösch's results. Plate 1 shows overlapping regions of the Sun in the neighbourhood of the west limb: both enlargements were made from the same original negative, using intermediate negatives of slightly different densities in order partially to compensate for limb darkening. The white line on Plate 1 (*b*) indicates the position of the actual limb, derived from the original negative. Apart from the much brighter *facular* granules, a number of granules can be seen less than 10 sec from the limb; in fact, one rather bright granule can be seen only 4 sec from the limb. Even in regions where individual granules are hard to distinguish, the photograph gives the impression of a low contrast, foreshortened picture of the ordinary 1-2 sec granulation. No granules are visible on the original negative in the last 4 sec to the limb; this region does not appear in Plate 1 (*b*).‡ However, observations of even higher resolution would be required to detect any possible continuation of the granulation so close to the limb.§

These results have been confirmed by other good limb photographs taken during the past three years.

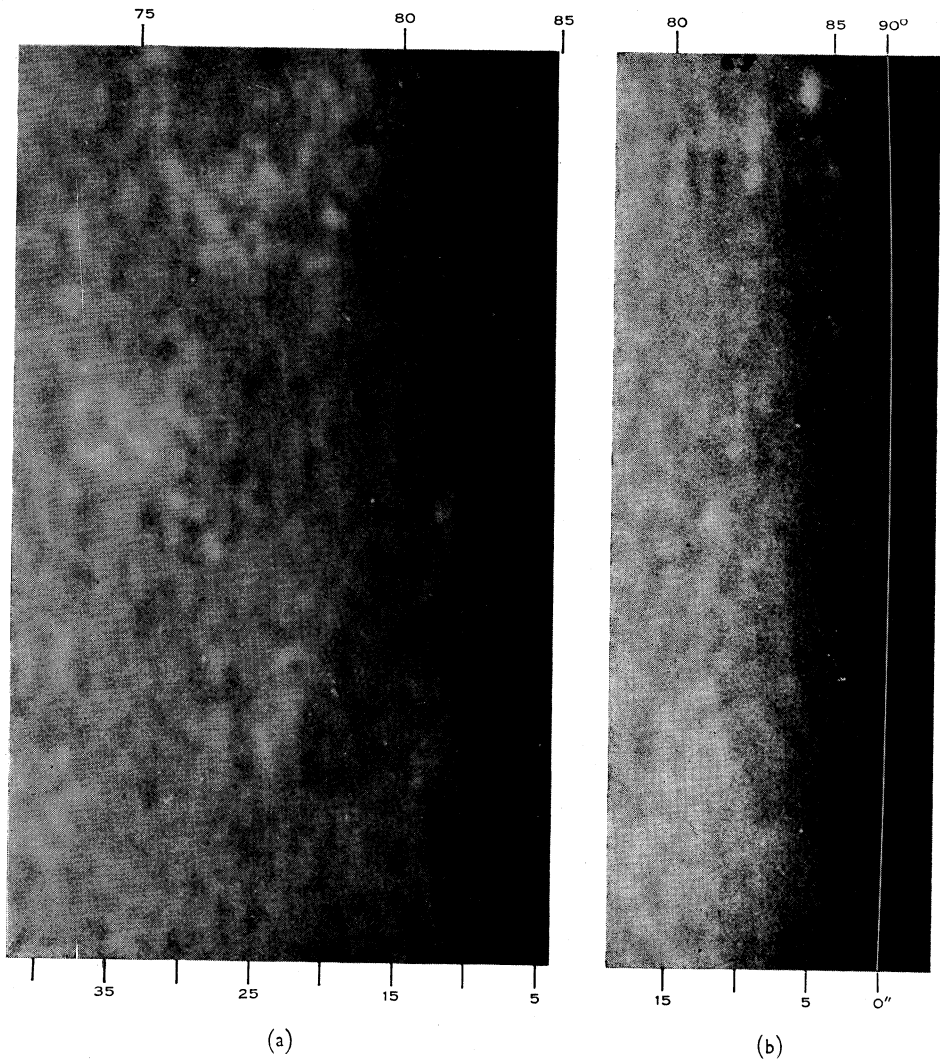
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‡ Plate 1 was obtained with the aid of a "seeing monitor" (Bray, Loughhead, and Norton 1959), which is now used to trigger automatically the photoheliograph shutters when the seeing signal falls to some predetermined, acceptable value.

§ On the other hand, we have often obtained photographs showing individual *facular* granules only 1-2 sec from the limb.

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West limb photographed on February 27, 1959, at 11<sup>h</sup> 44<sup>m</sup> E.A.S.T. Both prints were made from the same original negative. The white line indicates the position of the actual limb, derived from the negative. The upper scale gives the value of  $\theta$ , the angle between the line-of-sight and the normal to the photosphere at the point of observation; the lower scale gives the distance from the limb in seconds of arc.



Edmonds states not only that the granulation vanishes some considerable distance from the limb but that it is replaced by a *larger-scale* pattern of brightness fluctuations with sizes in the range 2–5 sec. Its most prominent features are dark areas, which begin to appear at  $\theta=60^\circ$  and are still easily seen out to  $\theta=86^\circ$  (2 sec from the limb). We have occasionally observed a similar pattern on our own limb photographs and had previously made an independent assessment of its reality based on an examination of photographs selected from 23 limb films obtained during the last three years. However, we concluded that the effect is spurious for the following reasons:

- (1) The effect is best seen on *mediocre* photographs, taken at times of only fair seeing. For example, it is particularly prominent on photographs affected by a type of seeing sometimes encountered which tends to shear the detail by 1 or 2 sec of arc—thus destroying the fine detail but leaving coarser structures more or less unaltered. On all good photographs individual granules can still be distinguished close to the limb; the dark areas no longer seem to dominate the pattern and merely form part of the network of intergranular material.
- (2) The value of  $\theta$  at which the effect first becomes prominent varies from photograph to photograph.

The effect may be partly due to the fact that on photographs affected by poor definition due to seeing or other causes the ordinary granulation is smeared out, whereas the larger of the dark areas between the granules (which are characteristic features of the ordinary granulation—cf. Bray and Loughhead 1958, Plate 1) remain visible. Near the limb the crowding together of these areas due to foreshortening accentuates the impression of a coarse structure of dark areas on a grey background.

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