Are Coronal Holes M-regions?

GENTLEMEN,—

Whilst reading the tribute to C. W. Allen by Stibbs\(^1\) on the occasion of Allen’s retirement it occurred to me that not only did Allen\(^2\) anticipate the existence of the solar wind but also that the properties he ascribed to ‘M’ regions are just those now attributed to features known as “coronal holes”.

Recent observations of the spatial distribution of the extreme ultraviolet emission from the Sun, made from satellites\(^3\) and rockets\(^4\) have shown the existence of large areas on the Sun where the EUV emission is markedly reduced. These areas are known as “coronal holes” because of their lower-than-average electron density and temperature. It has been proposed by several writers\(^5,6\) that these regions are the origin of the high-velocity streams in the solar wind which cause solar–terrestrial effects with periodicities of about 27 days. However, the similarity between the properties ascribed to coronal holes and the M-regions has not to my knowledge been discussed, nor has Allen’s contribution been recently acknowledged.

Allen’s important conclusions, drawn from observations of recurrent magnetic storm disturbances between 1906 and 1942, were that, unlike great magnetic storms, M-regions were not associated with sunspot groups. He concluded that they avoided areas within 40° of sunspot groups and were more frequent than normal just outside this area. He thought it likely that the cause of an M disturbance was “an emission coming practically from the whole of the Sun’s surface and constrained to move in streams by forces in the Sun’s atmosphere”. He deduced that the flight time from the Sun to the Earth of the particles causing the storms was three days. In a later analysis Saemundsson\(^8\) supported Allen’s main conclusions and pointed out the need for a radial magnetic field above M-regions. These are just the properties of the solar wind streams now being associated with coronal holes.

Allen tentatively identified M-regions with streamers and although this may prove not to be the case the controversy between identifying the solar wind streams with coronal holes or coronal streamers still continues, as witnessed by lively discussion at the recent IAU Symposium 57.

However, it seems likely that, thirty years later, Allen’s M-regions can be identified with the newly-discovered “coronal holes”.

I am, Gentlemen,
Yours faithfully,

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References

(2) C. W. Allen, M.N., 104, 13, 1944.