10 JANUARY 1984
TUESDAY MORNING
Session 17: Solar Irradiance
0830-1200 (Student Union Ballroom)

Invited Talk
17.01 Theoretical MHD Structure of Stellar Atmospheres and Close Observations of the Sun. E. N. PARKER, E. Chicago. The stellar atmosphere is the area where miniscule forms of free energy overwhelm the tenuous gas and produce the suprathermal activity that is now recognized as a part of every "normal" star. The activity is sufficiently bizarre, from the point of view of traditional physics, that observation spearheads the inquiry. As it turns out, the key to most active phenomena involves a combination of large and small scale effects, which can be observed only in the nearest star. One of the most outlandish aspects of the activity is the fibril state of the magnetic field, appearing as a reduction of the total energy of the system, and the clustering of fibrils to form sunspots, in response to subsurface convective patterns, with bipolar magnetic regions rising from two distinct levels in the convective zone. The activity complexes, made up of sequential emergence of bipolar active regions, look like thermal relaxation oscillations caused by the blocking of heat transport by the intense axial azimuthal fields in the deep convective zone. The failure of magnetic fields to possess a static equilibrium appears to be one of the principal causes of the heating of the active coronal regions to produce X-rays, as a consequence of the convective mushing of the footpoints of the magnetic fibrils. The generation of Alfven waves in both active and quiet regions eludes observations so far, with a question as to how the waves would be dissipated if present. The observed fading of magnetic regions, without any sign of the departing flux, shows that the observations are still missing some of the essentials. Hence firm answers to these questions require the highest spectral and spatial resolutions from IR to UV in rapid time sequences.

17.02 Observed Energy Balance of Active Region 18511, August 1982. G. A. Cheung, A. D. Hapgood, J. K. Lawrence, SRO/SUOR, and J. C. Shetland, NMU. The irradiance fluctuation of B560 18511 has been observed from its appearance on 3 August until its disappearance on 16 August 1982. Observations have been obtained with a linear diode array and the ESP using the 28 cm vacuum telescope and spectrophotograph. The observations have been analyzed so as to obtain a net and a sunspot irradiance fluctuation separately. The peak irradiance deficit of the sunspot only is ~830 parts per million (ppm) of the quiet solar disk. We estimate that the effect of scattered light roughly cancels the bolometric correction, within about 10% of the result. We have integrated the observed irradiance fluctuation over the cosine of the heliocentric angle, to obtain an estimate of the flux deficit of the region for this 2 week period. The flux deficit of the sunspots is ~22% while the net flux deficit is ~85 relative to the quiet sun. The difference is due to facular emission, which amounts to about 65% of the sunspot flux deficit. This percentage could run as high as 80%. Data for the July, September, and October transits are being analyzed to obtain the energy balance for this region. This research has been partly supported by NSF grant no. AST-8121863.

17.04 Solar irradiance, g-modes, and convection. C. L. WOLFF, Goddard Space Center. Wilson’s spectrum of solar irradiance data before spacecraft implantation shows 5 peaks longer than 16 days which are the same (± 12) as periods arising from the rotation of the lowest harmonic g-mode oscillations. This supports the idea that g-modes are the fundamental cause of changes in irradiance while sunspots and faculae are merely consequences of this more general phenomenon. As further support from the literature, Foukal and Vernazza (1979) found that extremes in irradiance tend to occur one day before extremes in sunspot or facula development. Also, large scale brightening and large scale flow is cited which is consistent with the model.

17.05 Comment on the Solar Irradiance Calculations of Hoyt and Eddy, K. H. SCHATTEN, NASA/GSFC. A flaw in the Hoyt and Eddy irradiance model is found. The flaw is basically the result of the fact that:
\[
\Delta S = \sum \frac{\Delta I}{F} = \sum \frac{\Delta I}{N} + \sum \frac{\Delta I}{F} - \sum \frac{\Delta I}{N}
\]

The discrepancy between the product of two averages of a set of numbers and the average value of their product can be considerable when the values vary significantly. In other facular emission models, the solar output is enhanced by using the equation:
\[
\Delta S = \sum \frac{\Delta I}{F} (C_F - 1) A_F,
\]
where \(\Delta S\) is the irradiance change associated with a facular area, \(F\) is the photospheric limb darkening, \(C_F\) is a projection factor, \(C_F\) is facular contrast, and \(A_F\) is facular area. Instead of summing up the products of these terms, Hoyt and Eddy use the expression, \(\Delta S = 0.03 \ f\), where 0.03 is the average contrast and \(f\) is the facular area, based upon sunspot areas. Hoyt and Eddy make the above mistake when they undervalue facular emission by 1) using an average contrast of 0.03 despite the contrast difference increasing from 0.03 near the sun's center to 0.4 near the solar limb, and 2) approximating the facular areas as equal to 1.33 times the areas of those sunspots located at distances greater than 65% of the radius of the solar disk.

17.06 Variations of Total Solar Irradiance During Rapid Sunspot Growth. B.S. HODSON, UCSD, R. JONES, GSFC/POD, P. McINNISH, NASA/GSFC. Periods of sunspot growth correspond in the conventional view to the eruption of magnetic flux tubes driven upwards by the buoyant force. This motion releases potential energy. We assess this energy for a period of especially rapid sunspot growth in April, 1980, and compare it with the time variation of the total solar irradiance as observed by the ACRIM instrument on board the Solar Maximum Mission. The buoyant energy, according to a simple estimate, greatly exceeds the energy deficit represented by the reduced luminosity of the spot. We find no evidence for appreciable conversion (> 1%) of this energy into luminosity during the growth phase of the spots.