III. Active Regions

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During the past three years arguments related to the AR physics can be found in the proceedings of the following meetings : Chromospheric Diagnostics and Modelling, NSO Sacramento Peak, 1984 (I) ; The Hydromagnetics of the Sun, Noordwijkerout, ESA, 1984 (II) ; Solar and Stellar Physics, Titisee, 1987 (III). Many aspects concerning the high activity levels of AR's can also be found in the proceedings of large number of meetings organized on solar flares. Microwave mapping is reported in Section VII. Some results are also reported in Section II.

A. STRUCTURE EVOLUTION AND ENERGY BALANCE OF SOLAR ACTIVE REGIONS.

Schroeter (1984) critized the interpretation of the 13.1-day periodicity in the solar global oscillation measurements as to be a direct evidence for fast rotating solar core. He suggests that the rotation of AR's, occurring predominantly in long lived active longitudes 180 degrees apart, can simulate an AR-weighted Doppler signal in good agreement with the global oscillation measurements.

New measurements of the contrast of solar faculae have been reported by Libbrecht and Kuhn (1984, 1985). A decrease in temperature gradient above optical depth =1 at 0.5μ, from quiet sun to faculae, was observed by Foukal and Duvall (1985). These observations are respectively in qualitative agreement with contrast computations, made by Chapman and Gingell (1984) for a "hot wall" type model, and with the hot wall model of Deinzer et al. (1984a,b). Lawrence et al. (1985) determined that, for visible wavelengths, the facular luminosity excess is about 0.5 of the sunspot luminosity deficit for one AR transit on the solar disk (Aug. 1982). On the other hand Chapman and Meyer (1986) found that, for five AR's transits, the sunspot energy deficit can be roughly balanced by the facular energy excess. Near the disk center a very low net average excess intensity, for active regions, was measured by Hirayama et al. (1985). Pap (1985) investigated the differences of the characteristics of the correlation between the variations of the solar constant and active and old sunspot area. The very important problem of the energy balance between sunspots and faculae in AR's seems not to be solved.

Schrijver et al. (1985) studied UV and X-ray emission of AR's of various sizes and in various stages of evolution in order to clarify many aspects of the stellar outer atmospheres observations. Areas at chromospheric levels are larger than areas at TR levels ; near the edge the TR seems to be much thinner than well inside the AR. The average line intensities show a small spread (factor of 2 in chromospheric lines, factor of 4 in coronal ones). Brightenings greater than a factor of 2 in the Si- IV line intensity have been observed by Hayes and Shine (1987) in a number of AR's. Their emission time profiles, density increase profiles and slight redshifts (in some cases) suggest them that these UV bursts might be due to energy release mechanisms similar to flares but on a smaller scale. In some cases a secondary gradual brightening is observed after the main impulsive burst and the authors suppose that it could be the analog of the flare thermal phase. Impulsive EUV bursts from a small growing AR are observed by Withbroe et al. (1985), morphologically similar to those observed in the coronal bright points. This fact bring them to the conclusion that the impulsive heating (probably due to rapid release of magnetic energy) is also an important heating source for the upper chromosphere and lower coronal layers in small bipolar AR's. The emergence of magnetic flux from lower levels might be the triggering mechanism.

Simultaneous and cospatial FTS measurements of the CO bands and Ca-II/K central line intensities in AR's by Ayres et al. (1985) show an "anomalous" behaviour because the line core brightness temperature of the strongest CO features are lower in the plage areas than the minimum temperature of the solar atmosphere empirical models. The authors then confirm their previous hypothesis, that the solar outer atmosphere might be thermally bifurcated. However this conclusion led to some controversies, since this bifurcated model seems inconsistent with the Ca-II, far IR and UV observations (some more details could be found in the Commission 12 report).

B. EMERGING FLUX REGIONS (EFM)

Excellent observing material enables Brants (1985a,b), and Brants and Steenbeek (1985) to outline more precise ideas on the physical behaviour of an EFR. Roundish darkened patches within the intergranular lanes (protopores) may precede the birth of a pore. A fast growing pore coincides with the area of a downflow of 1.5 Km/sec. The majority of the pores grow in area and darken ; they tend to coalesce to form a spot, particularly near the leading and following edges of the EFR, where strong velocity shears are also observed. Magnetic flux is found over most of the EFR area, with values ranging between 100 and 1700 G outside pores. The complicated behaviour and interacting signatures, regarding the birth of AR's, are nicely reviewed by Zwaan (1985). From the analysis of all the EFR's found in the BBSO material during 1978 Liggett and Zirin (1985) derived that the rate of flux emergence is 10 times higher in AR's than in quiet regions.

From the comparison of C IV Dopplergrams and Hα images Athay et al. (1986a, b) infer that magnetic shears are a common property of AR's. Even if magnetic shears are often associated with flaring activity, they seem not to be a totally sufficient condition to produce flares.

Topka et al. (1986) considered the small scale changes occurring in magnetic flux elements and they derived no evidence for migration or diffusion when magnetic cancellation occurs. The comparison of the SMM-UVSP spectroheliograms and the distributions of vertical electric current density , calculated from vector magnetographic measurements, enable de Loach et al. (1984) and Haisch et al. (1986) to claim that, in spite of some determined correlations, the expected scaling relations between simple ohmic heating and radiative losses cannot be established.

C. VELOCITY FIELDS AND FLOWS

The analysis of AR's loop flow as derived from SMM observations has been reviewed by Poletto and Kopp (1984). Lites et al. (1985) showed that He-I 10830 A line Doppler shifts maps indicate persistent flow pattern in AR's upper chromosphere near the limb. These features are very similar to those already observed in the TR C-IV Dopplergrams. Time series of two-dimensional maps of V and B have been statistically analyzed by Berton (1986). The improvement of the existing methods for the determination of the V and B vector maps from time sequence of AR observations and the ambiguity of the various solutions are also discussed by Berton (1987). C-IV spectroheliograms and Dopplergrams enable Kopp et al. (1985) to derive empirical velocity and EM profiles all along AR limb loops. They compare these parameters with the theoretical values obtained from three different simple models (steady-state loop with siphon flow, steady downflow in both loop legs, not steady downflow) and conclude that none of these is capable to reproduce the observed parameters behaviour. Improved quality observations seem to be needed to provide reliable constraints for developing more realistic models of cool loop dynamics.

D. LOOP STRUCTURES

As loops are believed to trace out the magnetic lines of force connected with the AR, notable efforts have been given to study this type of structures.

In their long series of papers on high resolution observations of the solar chromosphere Bray and Loughhead (1985, 1986), Loughead and Bray (1984, 1985) carefully determined many parameters of AR Hα coronal loops. The loop material rises along one leg with an increasing upward velocity (despite the retarding effect of the gravity). In the other leg the material descends under the effect of a retarding force since it does not attain the free fall velocity. All the derived velocities are supersonic (Mach numbers in the range 1.5 - 5.). True widths are of the order of 0.7 - 0.8 arcsec, with a central axis contrast of the order of 0.8 and longitudinal Hα optical depth ranging from 0.06 to 1.3. Detailed analysis of the variations of the thermodynamic parameters (Ne, Te, P etc.) along the loop axis exhibit a wavelike nature, with an apparent wavelength of the order of 50000 - 60000 Km. Cram (1986) examined the consistency between the values of the Hα source function derived from the cloud model interpretation of the measured Hα contrast of coronal loops and the values calculated with NLTE. A generally satisfactory agreement is found.

EUV spectra of AR loop structures have been studied by Doyle et al. (1986). Physical parameters derived from low temperature lines (< 10^5 K) seem to be inconsistent with the values inferred from scaling laws based on static loop models. Only the assumption that the Te and EM values, obtained from Mg-X data, remain constant up to 5.10^6K allow a better agreement between the derived parameters and the model ones. Narain and Kumar (1985) contributed to the study of the heating and cooling mechanisms in AR loops.

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