CHAPTER 1

INTRODUCTION

The first phenomena associated with the active regions of the solar surface that were observed were the sunspots. They were observed with the unaided eye by the Chinese about 28 B.C. and with the first telescope by Galileo in 1611. Since then they have been followed quite regularly but the interest has been much more in their statistical properties than their physical properties. The Wilson effect in sunspots was discovered by Alexander Wilson in 1769. BRAY and LOUGHHEAD (1964) found that its explanation lies in the higher transparency of the spot material compared with the photosphere. Then there were the discoveries of sunspot periodicity by Heinrich Schwabe, and of latitude drift by Carrington which was investigated in more detail by Gustav Spörer and is now known as "Spörer's law".

It is generally believed today that all the solar phenomena in an active region, the most intense of which are sunspots, bright faculae, flares, surges, active filaments, prominences, and radio bursts, are concentrated in places where the magnetic field is compact, reaching a maximum flux of about 10^{21} maxwells as suggested by BABCOCK and BABCOCK (1955). The time schedule of an active region was given by KIEPENHEUER (1966). Though the spot phenomenon is only a short episode (1 - 2 solar rotations) in the long life of an active region (about 10 solar rotations), it plays a very important role in the active region. The more detailed study of its morphology, its structures and its formation will lead to an understanding of the formation of an active region on the solar surface.

High resolution observation of sunspots has begun very recently in the programme of a few observatories. The morphology of individual spots was studies with high resolution (about 1 sec of arc) by BRAY and LOUGHHEAD (1964). The Evershed effect in the penumbra was investigated by many authors. The observations of this effect have been interpreted in terms of a horizontal outflow in the photospheric layer and a horizontal inflow in the chromosphere.

The formation of sunspots has been discussed quite often. Early theories of the origin of sunspots sought to explain the darkness of a spot in terms of the adiabatic cooling of gas moving upwards in a region of stable radiation equilibrium. Modern views accept that it originates from the presence of internal magnetic fields. BABCOCK (1961) developed a theory of the 22 - year solar magnetic cycle by which a number of solar phenomena that are dependent on the field can be explained. An active region is formed by the rising of a submerged flux rope to the surface. The cooling of the active region which causes the appearance of a spot was proved by DE JAGER (1964). This inhibition of convection is caused by the reflection of convective energy flux near the critical level in the convective layer, which would normally reach the photosphere where there is no magnetic field.

The morphology of the magnetic field of individual sunspots is not yet known exactly. The investigations have to depend on the observation of the Zeeman effect in specially selected Fraunhofer lines in the sunspot spectrum. The study was started in 1908 at Mount Wilson Observatory by G.E. Hale who proposed the classical picture of the magnetic field in an individual regular spot. The results of modern observations contradict the classical picture. BRAY and LOUGHHEAD (1962) assumed that the greatest magnetic field is in the core, located near one end of the umbra, with the field lines emanating from it and returning to other parts of the umbra rather than to neighbouring spots or the photosphere. This new model of the field configuration in the umbra is consistent with the modern magnetic observations, but it cannot be proved until the high resolution magnetic observations are obtained.

Chapter 2 describes the instruments used in observations at the Bangkok Observatory. The camera is a 150 mm-Zeiss Coude' refractor. In chapter 3, sunspot data taken with the 150 mm-Zeiss Coude' refractor are reduced. In chapter 4 the development of two sunspot groups which appeared on the east limb on 20 November 1967 are studied in the light of Babcock's theory on the formation of sunspot groups. The chromospheric structure around a sunspot is studied in chapter 5 from the H α-filtergrams taken with the domeless Coude' refractor at the Capri Observatory, on 16 August 1967. In chapter 6 a model of the magnetic field in a sunspot is discussed in the light of the photospheric and chromospheric studies of active regions.

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