THE STRUCTURE AND EVOLUTION OF CORONAL HOLES

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Abstract. When observed at soft X-ray wavelengths coronal holes are seen as open features, devoid of X-ray emission and bounded by apparently divergent coronal loop structures. Inspection of the topology of the photospheric magnetic fields associated with these features suggests that holes are formed when the remnants of active region fields, emerging in both hemispheres over a period of several solar rotations, combine to form a large area of essentially unipolar field. Remnants of opposite polarity fields surround these features resulting in a divergent magnetic configuration at the hole boundaries. Holes are seen to form and evolve while the large scale divergent field pattern is reinforced and to close when large scale remnants occur which disrupt the general field pattern. Two types of holes are observed in the early Skylab observations. The first are elongated features which are aligned approximately north-south extending from one solar pole to a polar filament channel in the opposite hemisphere. The polar holes and somewhat lower latitude holes appear to lie in unipolar areas which are completely confined by opposite polarity fields.

Studies of the rotation properties of an elongated hole, which extended from the north pole to a latitude of approximately 20°S, showed it to rotate with a synodic rate of $(13.25 \pm 0.03) - (0.4 \pm 0.1 \sin^2 \phi$ deg day^{-1}. Possible explanations for the almost rigid rotational characteristics of this feature are discussed.

1. Introduction

Soft X-ray observations of the quiet corona reveal the presence of features which are devoid of emission and are bounded by apparently diverging large scale loop structures giving them a characteristically open appearance (Vaiana *et al.*, 1973a). These open features, which are also seen as areas of reduced electron density in K-coronameter data (Altschuler *et al.*, 1972) and metric radio scans (Dulk and Sheridan, 1974) and reduced emission in certain extreme ultraviolet (EUV) lines, (Munro and Withbroe, 1972; Neupert and Pizzo, 1974) and in the D_3(5876 Å) line and 10830 Å line of He I (Harvey *et al.*, 1974) have been given the name 'coronal holes'.

High resolution observations of the coronal structures associated with these holes were first obtained by the AS&E group in sounding rocket flights on March 7 and November 24, 1970 (Krieger *et al.*, 1973). In the former case a hole located near the south west limb could be traced into the outer corona in comparisons made between the soft X-ray images and white light eclipse observations (Van Speybroeck *et al.*, 1970). Analysis of the physical characteristics of the hole seen on November 24 showed it to have a reduced emission scale height which was about half that of other coronal

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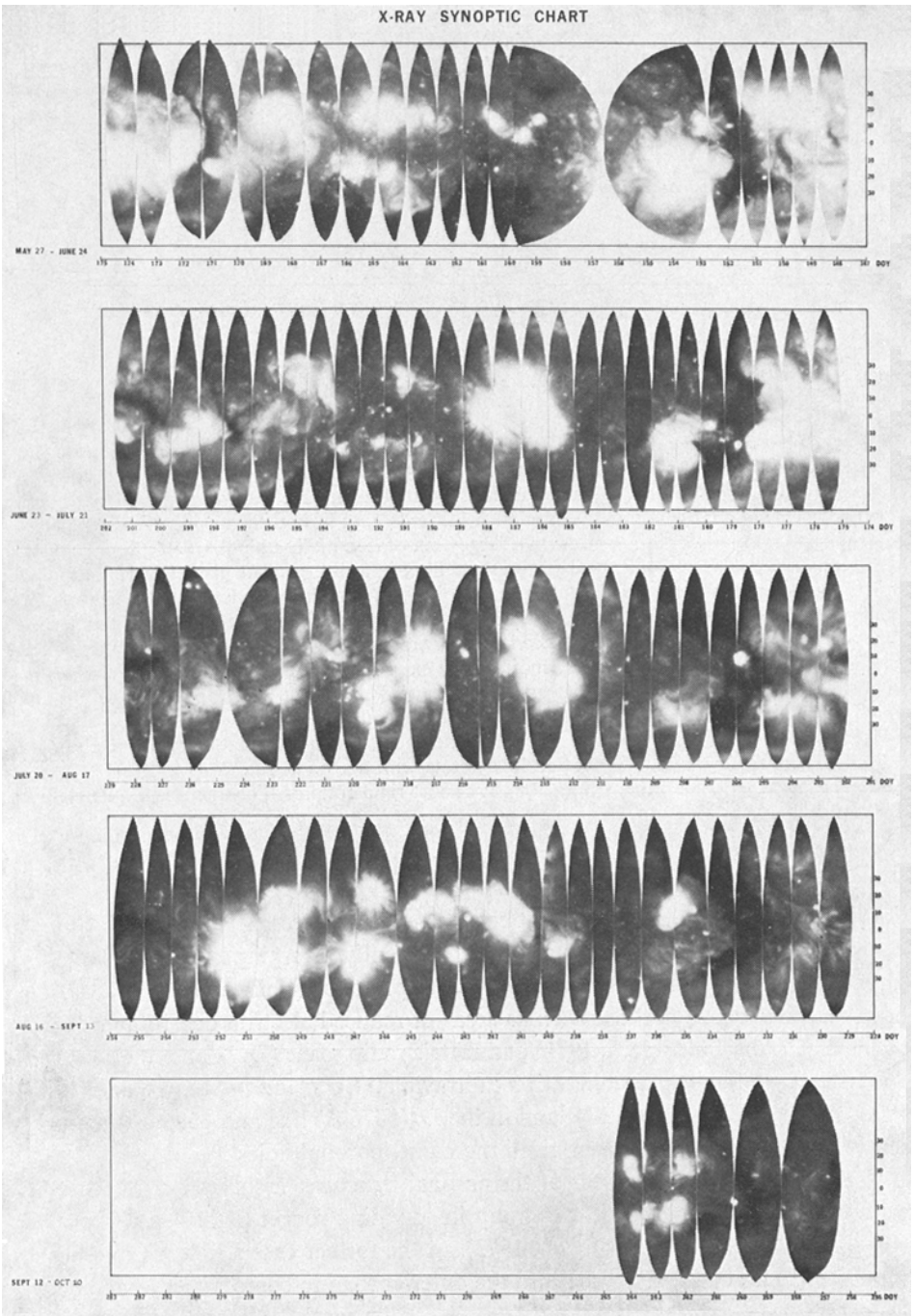

Fig. 1. A synoptic presentation of data obtained by the AS&E X-ray spectrographic telescope experiment during the first two Skylab missions. The chart is formed from segments taken from the central portion of X-ray photographs obtained at approximately 24 h intervals. The width of the segments is proportional to the time interval between selected frames and is typically 13.3° in longitude. Wider swaths correspond to periods in which data gaps occur.