Abstract. The source positions of solar radio bursts of spectral types I, III(U) and III(J) and V observed by
the Culgoora radioheliograph are found to lie almost radially above soft X-ray loops on pictures taken by
the S-056 telescope aboard Skylab. The radio source positions and the X-ray loops occur near magnetic
loops on computed potential field maps. However, the magnetic induction required to explain the radio
observations is much greater than the computed potential field value at that height. Dense current-
carrying magnetic flux tubes emanating from active regions on the Sun and extending to \( \approx 1.5 R_\odot \) above
the photosphere provide a satisfactory model for the radio bursts.

1. Introduction

The characteristics of certain metre wavelength bursts suggest that they arise on
magnetic field loops which extend to \( \approx 1.5 R_\odot \) above the photosphere. For example,
bipolar source structure in type I bursts at 80 MHz suggests that the fast electrons
exciting the radiation are trapped in closed magnetic fields above a bipolar sunspot
group (Kai, 1970). The characteristic 'inverted U' spectrum and also the tangential
source displacements (Labrum and Stewart, 1970) and reversals in the sense of
circular polarization between the leading and trailing arms of the U burst (Sheridan et
al., 1973) suggest that the fast electron stream producing the emission is guided away
from the flare region along a high magnetic loop.

From the observed heights of type I and type III bursts at the solar limb it appears
that the density in the source regions is 8 to 10 times higher than that in the ambient
corona (Stewart, 1976). For normal type III bursts it is believed that the electron
stream propagates along a coronal streamer, where it is known from white light
observations that the electron density is enhanced (Newkirk, 1961). Type I, III(U),
III(J) and V bursts probably do not arise in such 'open' structures. For them a density
enhancement implies the presence in the corona of dense curved magnetic flux tubes.
At lower heights in the corona (\( \leq 0.1 R_\odot \)) soft X-ray pictures show many discrete
loops interconnecting active regions on the solar disk. These loops are the most direct
evidence to date for dense magnetic flux tubes in the lower corona. To test our
hypothesis that dense flux tubes also exist at the heights of radio bursts, we have
compared the source regions of bursts observed by the Culgoora heliograph during
the first week of September 1973 with soft X-ray pictures taken by the S-056
telescope aboard Skylab. It will be demonstrated below that type III(U), III(J) and V
bursts tend to occur above extended X-ray loops. Such behaviour suggests that the
fast electron streams giving rise to the radio bursts are guided away from the flare region along dense magnetic flux tubes situated above the X-ray loops. Similarly it will be shown that type I bursts often occur above active region X-ray loops and also occasionally above extended X-ray loops.

2. Soft X-ray Loops

A series of soft X-ray pictures taken by the S-056 telescope aboard Skylab is shown in Figure 1. The exposure times for these pictures were chosen to highlight the fainter extended X-ray loops interconnecting active regions. In Figures 1c, e, g and h in particular one can see examples of these extended X-ray loops which appear to interconnect active regions both in the same hemisphere and also on either side of the equator. The dark areas on these photographs are nests of bright, closely spaced loops above active regions and are necessarily over-exposed. These active region

Fig. 1. Selected soft X-ray pictures for 1973 September 1 to 6; exposure times 95 s, passband 8–22 Å. Note the faint X-ray loops interconnecting dark active regions. Exposure times were chosen to highlight the fainter loops and hence bright nests of loops above active regions are over-exposed. The date is given below each picture as day/month/year. Pictures were taken by the Aerospace/Marshall Space Flight Center Telescope S-056 aboard Skylab.