POLARIZATION OF HERRINGBONE STRUCTURE IN TYPE II BURSTS

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1. INTRODUCTION

Herringbone Type II bursts were first described by Roberts (1959). These bursts are distinguished by their unusual structure - rib-like features (herringbones) extending on either side of a Type II backbone.

A high degree of circular polarization (up to 70%) has been observed in herringbone structure of some Type II bursts (Stewart, 1966). The Culgoora spectropolarimeter (Suzuki and Sheridan, 1977) has made the study of this subject much easier because the sense and degree of polarization can be obtained over a wide range of frequency by a simple inspection of the colour record. Figure 1 shows some examples of records of Type II bursts with herringbone structure from the spectro-polarimeter (in colour) and radio-spectrograph (black and white).

Here we report the observed polarization characteristics of 16 events during 1977/78 (supplemented by results obtained from radio-heliograph observations of six earlier events).

2. POLARIZATION OF THE HERRINGBONES

The sense of circular polarization of the herringbones does not change within each group, nor between fundamental and harmonic components. However, there are occasions when two or more herringbone groups occur in one event, and then the sense of polarization is not always the same between these groups. We have not yet been able to check whether dissimilar groups occur in different regions of the corona.

In most cases the harmonic component herringbones are more diffuse than their fundamental counterparts and in extreme cases the harmonics appear to be completely diffused. Furthermore, continuum associated with the start of a Type IV burst sometimes occurs in the frequency range of the harmonic component (see Fig. 1). Consequently it is some-times very difficult to identify the harmonic component and to determine

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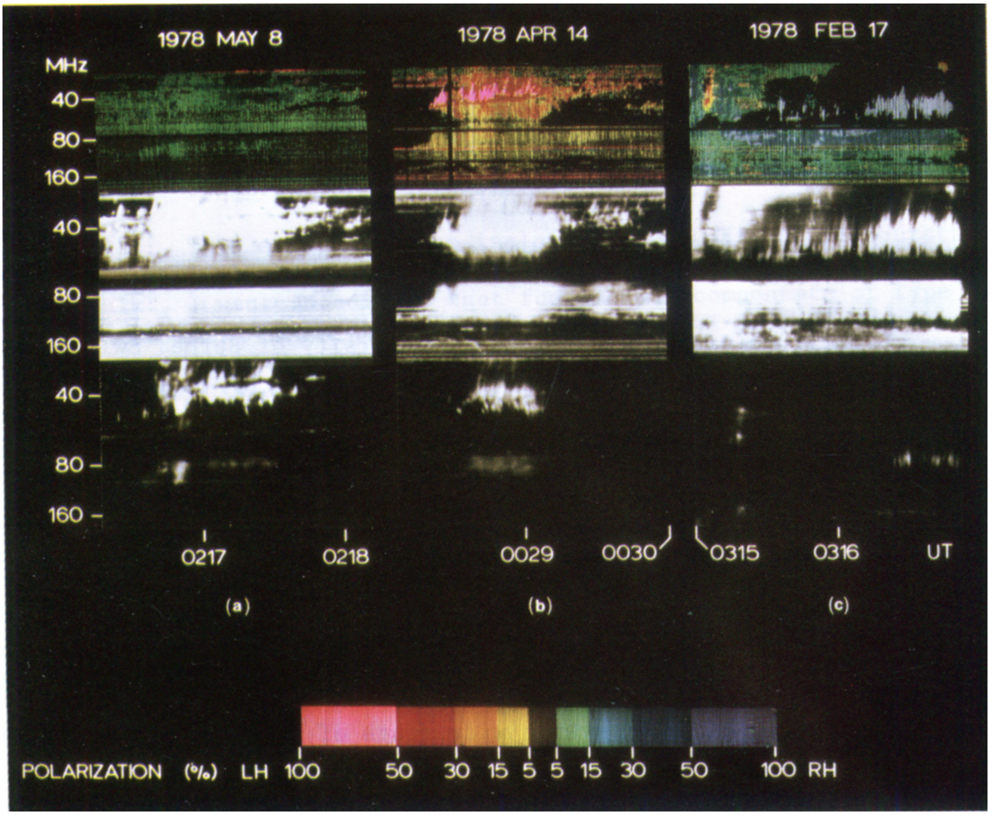

Fig. 1 - Examples of the records of Type II bursts with herringbone structure.
Top (colour): Spectropolarimeter record
Middle (black-and-white): Radio-spectrograph record (normal gain)
Bottom (black and white): Radio-spectrograph record (low gain)

its polarization. As we have excluded doubtful cases, the number of samples of harmonic herringbones is small. There is also a possibility that some herringbone groups with weak polarization have been unintentionally excluded, because it is sometimes difficult to see the weakly polarized bursts against a background of continuum.

Figure 2 shows the polarization of the fundamental component herringbones. An average polarization value for each herringbone group was used. When a mixture of two polarization values was observed in a single group, each value was given an appropriate weight (e.g. 0.75 and 0.25). It will be seen that generally a slightly higher degree of polarization (perhaps not statistically significant) is observed in the forward-drifting herringbones (those projecting from the backbone towards lower frequencies) than in the reverse-drifting ones (those projecting towards higher frequencies).

Figure 3 shows the comparison of the degree of polarization

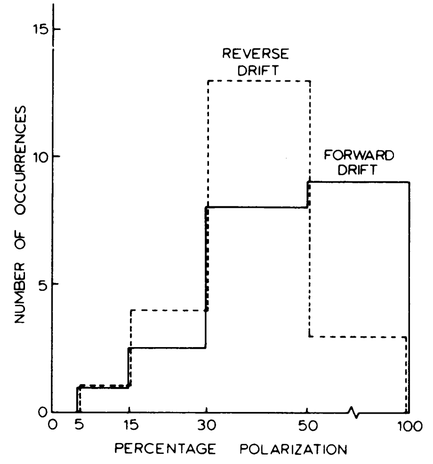

Fig. 2 - Degree of polarization of forward-drifting and reverse-drifting herringbones of fundamental Type II bursts.

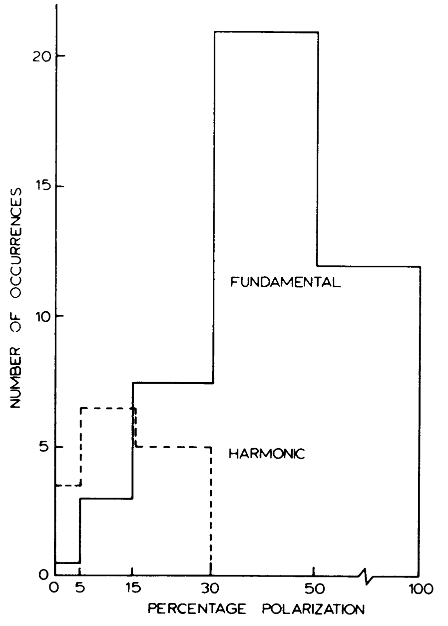

Fig. 3 - Degree of polarization of the fundamental and harmonic herringbone structures.

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between the fundamental component and harmonic component herringbones. The results for forward-drifting and reverse-drifting bursts are combined in this figure.

The distributions for the F and H herringbones of Figure 3 are rather similar to those for the F and H components of the Type III bursts with F/H structure, such as those reported by Suzuki and Sheridan (1977) or Sheridan et al. (1980). For the fundamental component however it appears that low polarization is less frequent in the herringbones than in the Type III bursts. (This may, in part, be attributed to the possible exclusion of the low-polarization herringbones mentioned above, but this effect is believed to be quite small.)

For only a few cases were we able to measure the polarization of the F and H component herringbones in the same group, and we can only say at this stage of our analysis that the ratio of the degree of polarization of the fundamental to that of the harmonic is ~3. This again is in reasonable agreement with Type III bursts.

We have not shown histograms for right-hand and left-hand circular polarizations separately because the distribution does not appear to depend significantly on the sense of polarization.

3. POLARIZATION OF THE BACKBONES

Usually the backbones in the herringbone structures are, like ordinary Type II bursts without herringbones, weakly polarized ($\leqslant$20%). In some cases however the backbone appears to be masked by more highly polarized herringbone features. The sense of polarization of the backbone is always the same as that of the herringbone. In a few events (e.g. Fig. 1a) the backbone appears to be completely missing.

4. DISCUSSION

The similarity of the polarization characteristics of herringbone structures and those of the F/H Type III bursts supports the theory that they are generated by similar mechanisms.

Wild et al. (1963) have proposed that the herringbones are produced by fast streams of energetic electrons escaping, along (more or less) radially directed magnetic field lines, ahead of the shock front where the Type II burst is generated in the case of forward-drift component and behind this front for the reverse-drift component.

The observed low degree of polarization of the backbone portion of herringbone Type II bursts supports this theory, because we would expect to find highly disordered magnetic fields (due to strong m.h.d. turbulence) near the shock front. Further out, where the herringbones are generated, the turbulence and the consequent magnetic field

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disorder would be less developed and hence the herringbones should be more polarized than the backbone Type II burst. In some cases the backbone seems to be completely missing. This might again be caused by strong turbulence preventing the escape of the radiation (especially that of the fundamental).

We hope to use the Culgoora radioheliograph source position measurements to test this hypothesis; if this model is correct one would expect to find the herringbone sources displaced from the Type II backbone source.

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DISCUSSION

Slottje: Contrary to your remark we see on the high resolution Dwingeloo radiospectrograph that the fine structure (herringbone and other) is in harmonic type II bursts as sharp or sharper than that in the concurrent fundamental type II burst.

Stewart: Highly polarized herringbones in fundamental type II bursts appear much sharper than the (more weakly polarized) herringbones in second harmonic type II bursts. The result is very fishy.

Slottje: Do you observe herringbone structure also with splitband bursts and if so is the herringbone similar in both splitband components?

Stewart: Some type II bursts with herringbones have a missing backbone. This could represent a split band burst. However, the split bands (if they exist) are obscured by the herringbone features.

Benz: Do you see a harmonic counterpart to every herringbone at the fundamental frequency and vice versa?

Stewart: Yes, that's the way we thought.