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T-T PLOTS OF RADIO SPURS BETWEEN 38, 408 AND 1420 MHz

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Abstract. The T-T plots of the North Polar Spur, the Spur in Aquarius, Taurus and Pegasus, using data at 38, 408 and 1420 MHz of the same resolution of $7^\circ.25 \times 8^\circ.25$, reduced to the case of scaled areas, are presented. The T-T graphs for all spurs have shown clear splitting of branches supporting the reality of quasihysteresis effect. It was shown that this splitting may have astronomical reasons. In an attempt to explain this effect earlier introduced 4V (four vector) model was applied.

1. INTRODUCTION

Since the first radio observations of the sky in the continuum were made several spurs have been noticed. It was found that many spurs can be joined into loops : e.g. the North Polar Spur (NPS) is part of Loop I, the Spur in Aquarius is a part of Loop II. Four major loops are generally recognized and are clearly seen in radio-continuum surveys. In addition, several further radio loop structures were proposed (Milogradov-Turin, 1970, 1972).

The plots of brightness temperature at one frequency against brightness temperature at the other frequency (T-T plots) can provide information about the spectrum of a spur (Turtle et al., 1962). Early T-T graphs were plotted for constant declinations, but later it was done at constant galactic latitudes (e.g. Berkhuijsen, 1971) as a more useful way to investigate Galactic objects. It was already shown by Berkhuijsen (1971) that the latitudinal T-T graphs of the NPS region at 240 and 820 MHz were divided into two branches : one outside the main ridge of the NPS and the other inside it. Such a fork - like structure is called also "quasihysteresis". She has found that the gap between them was real. According to the interpretation of Berkhuijsen (1971) the gap may be due to presence of a smooth extra component, which has a low spectral index and is related to an extended HII region in these lines of sight. The splitting of T-T graphs for frequencies between 10 and 408 MHz for the NPS and several other loops was found by Milogradov-Turin (1982) and shown not to be caused by an HII region (Milogradov-Turin, 1982, 1987). She interpreted it as a presence of four components of radiation (Milogradov-Turin, 1982, 1985, 1987).

2. DATA

The data at 38 MHz were those from the 38 MHz survey of Milogradov-Turin and Smith (1973). Since the spur in Aquarius was laying in the region where comparatively high ionospheric absorption was present, correction for it was applied (Milogradov-Turin and Smith, 1973). The 408 MHz data were got from Haslam and Salter (1983), while the 1420 MHz data were received from Reich (1990), both convolved to the resolution of the 38 MHz survey of $7^{\circ}.25 \times 8^{\circ}.25$ by the authors.

3. T-T PLOTS

In this work T-T graphs were plotted along constant latitudes, every 4°, in regions of four observed spurs : NPS, the Spur in Aquarius, Taurus and Pegasus for all combinations of frequencies. An example is given on Figure 1.

On the majority of graphs the splitting was clearly found (Nikolić, 1994). In those cases when it was less clear, convincing explanations could be found (e.g. uncertain amount of ionospheric absorption, lower quality data etc.). Investigation has shown that sidelobes could not produce this feature (Nikolić, 1994).

4. DISCUSSION

As it was shown by Milogradov-Turin (1982) an inaccuracy in position of the main ridge of a spur could give a fork - like T-T graph. A study was done (Milogradov-Turin, 1982, Nikolić, 1994) showing that no clear dependence of the position of the main ridge of the NPS on frequency exists. This work has shown that the quasihysteresis is a real astronomical effect since it appears in all combinations of three used frequencies on the data corresponding to the scaled aerials measurements.

A possible explanation of the quasihysteresis effect was proposed by Milogradov-Turin (1982, 1985, 1987) by the 4V model. Its basic idea is that the radiation from a spur can be represented by a sum of four vectors. The first component is extragalactic by origin. It has a high spectral index. This component consists of the relict radiation and of the integrated emission from external galaxies (labeled as $\vec{e}$ on Figure 2). The second component, $\vec{d}$, is originating within the Galactic disk and therefore it is assumed to be constant for a given galactic latitude, within a region containing a spur. The spectral index of the disk radiation is less than the spectral index of the extragalactic component. The third component, $\vec{s}$, is related to the spur itself. It has a lower spectral index than the Galactic disc. The fourth component, $\vec{h}$, is originating in the region outside the main ridge of a spur and it has a high spectral index. It is almost isotropic in a layer next to a spur decreasing sharply towards the main ridge. Such a behaviour could be expected from a component originating in a shell of the SNR. An example how the sum of four vectors reproduces a quasihysteresis effect is given in Figure 2.

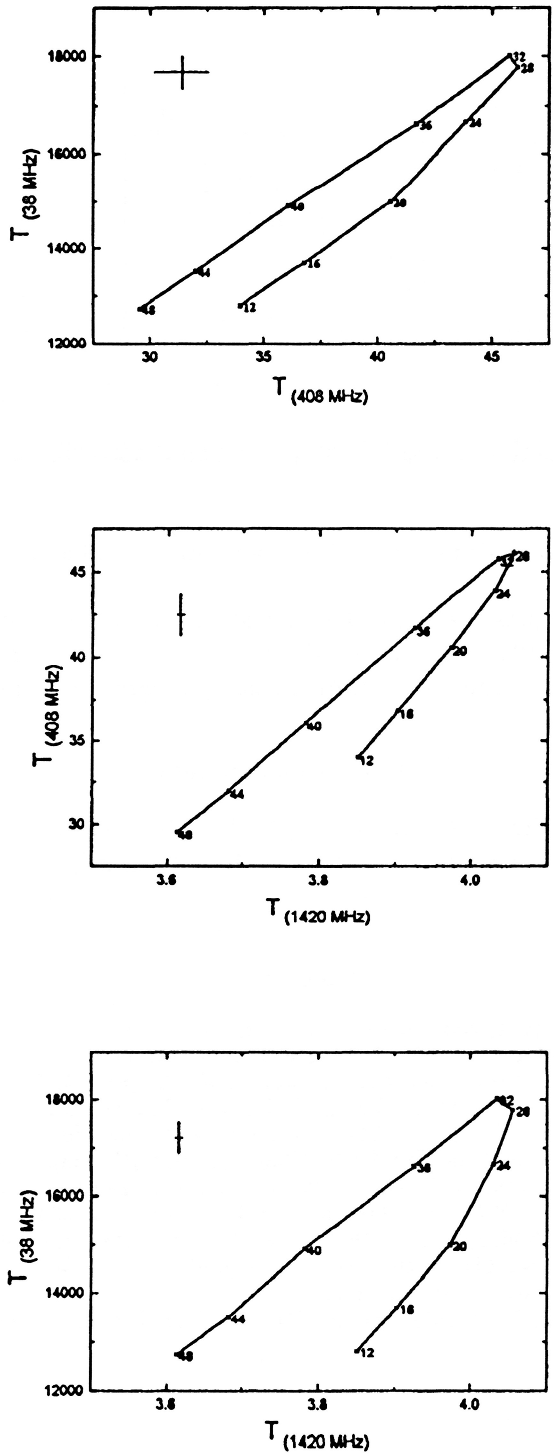

Fig. 1. T-T plots for the NPS on $b = 38°$, for all three combinations of frequencies with typical errors in the upper left corners.

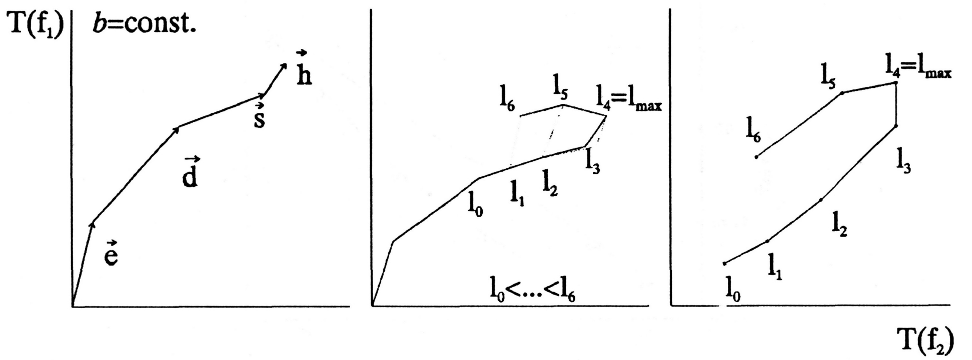

Fig.2. The construction of the T-T plots for a spur according to the 4V model

Fig. 2. The construction of the T-T plots for a spur according to the 4V model.

Existence of the quasihysteresis effect for all spurs has been interpreted by Milogradov-Turin (1982, 1985) as presence of a high spectral component outside the ridge in all spurs. This was named a "curvature rule" (Milogradov-Turin, 1985).

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