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Study on the association of solar gyroresonance emission sources with brightness temperature intensification at 17 GHz

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Remarkable works done in the last decades by many authors on the solar gyroresonance mechanism have illuminated the way to establish the relationship between this form of emission and magnetic fields in the solar atmosphere and to know the magnetic nature of the middle and upper layers of the active regions. Despite all these advances, solar physics still needs a direct means (without magnetograms) of identifying the sources of gyroresonance emission.
In search of a solution to this problem, we used solar images at 17 GHz synthesized by the Nobeyama Radioheliograph (NoRH) to map the likely sources of gyroresonance.
To achieve this result, we first hypothesized that gyroresonance and bremsstrahlung mechanisms can generate a large brightness temperature intensification due to the close relationship such mechanisms have with magnetic fields and because of the role of the magnetic field in controlling the brightness of the solar atmosphere in the radiofrequency range.
To test this hypothesis regarding the gyroresonance process, we selected 8 large active regions (ARs) among the HMI magnetograms generated by the Solar Dynamics Observatory (SDO) corresponding to the 1st half of the 24th solar cycle. We then analyzed each AR through its magnetogram and its image at 17 GHz. Aiming to verify, in these radio maps, whether there is a correspondence between brightness bumps and parameters associated with gyroresonance emission, we constructed three categories of brightness maps for each active region, respectively presenting the field of: brightness temperature in BT maps, brightness temperature gradient in BTG maps, and brightness temperature gradient to brightness temperature ratio in BTG/BT maps. Such parameters are the characteristic circular polarization, whose modulus is greater than 30%, and characteristic magnetic field strengths, associated with the gyroresonance radiation at 17 GHz for 3rd and 4th harmonics. Such a step also aimed to verify which of these categories would best map the putative sources of gyroresonance emission.
On these maps, we then plotted the contours of the characteristic parameters.
For each AR, we also obtained the degree of correlation between its brightness variables and the characteristic polarization. We then observed that the contours of characteristic magnetic field strengths are predominantly enveloped by the area of the brightness bumps, while the contours of the characteristic polarization fit well to such areas, being better fitted to the relative bumps (in the BTG/BT maps). In the statistical analysis, we observe that for each active region, there is a predominance of strong correlations between the brightness variables and the modulus of the characteristic polarization. Such correlation tends to be highest for the brightness temperature. For each brightness variable, the highest correlations tend to occur for the predominant

polarization direction of the active region.

The data, therefore, indicate a high probability that the gyroresonance emission mechanism was at least one of the important causes of the radio bumps produced in the observed active regions.