Non-thermal Continuum emissions observed from the Cluster constellation: statistical studies

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Non-Thermal Continuum (NTC) radiation is an electromagnetic wave of weak intensity (about 80. 10^{-7} V_{rms}. $Hz^{-1/2}$) which can last several hours. This radiation has been observed by several satellites in all regions of the magnetosphere and in the solar wind. Missions as Voyager and Ulysses had shown that NTC exists in the environment of all the magnetized planets. These observations make NTC a classical astronomical phenomenon scientists have to understand.

Observations of terrestrial NTC radiations can be classified in two classes. A first class corresponds to wave frequencies below plasma frequencies in the magnetosheath: the radiation bounces at the magnetopause and is trapped in the magnetospheric cavity. This class of NTC is often observed in frequency-time spectrograms as a smooth intensity level covering a wide frequency band. A second class corresponds to frequencies above the magnetosheath plasma frequencies, the radiation escaping in the interplanetary medium. In the corresponding spectrogram, the NTC radiation exhibits narrow band elements. It is generally believed that these two forms have the same origin, and are generated by the conversion of an electrostatic wave into an electromagnetic one. Numerous observations show that a strong density gradient is needed [1]. This condition imposes that the mode conversion has to take place at the plasmapause or at the magnetopause. Observations show that it occurs at the plasmapause rather than at the magnetopause and preferentially in the morning side, between 2 and 4 Earth radii [2]. Furthermore, it has been argued that NTC sources are located at the magnetic equator [1].

The Cluster mission, which has been launched during the summer 2000, is a constellation of four identical satellites. The tetrahedral disposition of the satellites allows a spatio-temporal study of the structures they crosses. The polar orbit explores a range of key regions of the magnetosphere. The Whisper instrument measures the electric field intensity and frequency in the 2-80 kHz range, giving access to the observation of NTC emissions in each of those key regions: solar wind, magnetosheath, cusp, tail, inner magnetosphere [3]. On the other hand, Whisper observes intense electrostatic waves at the plasmapause, in the equatorial plane as well as off the magnetic equator. We believe that these emissions may be primary sources of NTC radiation.

In this paper, we first present and discuss a statistical study of the electrostatic emissions thought to be potential NTC sources. In a second part, we present and discuss a statistical study of the characteristics of NTC radiation as observed by Whisper:

- Signatures in frequency–time spectrograms on each spacecraft. We show for example that each type of signature has a given occurrence and is related to a given region of the magnetosphere.
- Directivity properties. Cases of a high modulation index has been found for each type of frequency-time signature.
- Spatio-temporal extension of the radiation beam, from compared signatures. This part of the study will form a starting point to test generation mechanisms.

Sample references

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