

Radio polarisation measurements of meteor trail echoes with BRAMS

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Abstract

BRAMS, the Belgian RADio Meteor Stations, is a network of radio receiving stations using forward scattering techniques to detect and characterize meteoroids. One of the receiving stations located in Uccle is sensitive to all kind of polarisation. We present the preliminary radio polarisation measurements of meteor trail echoes and discuss how these data can be used to retrieve physical information about the meteor trail (e.g. ionisation).

1. Description of BRAMS

BRAMS (Belgian RADio Meteor Stations) is a network of ~20 radio receiving stations located in Belgium with the aim of detecting and studying meteors with forward scattering techniques. The transmitter is a dedicated beacon located in Dourbes in the south-west of Belgium. It emits vertically a right-handed circularly polarised sinusoidal wave, at a frequency of 49.97 MHz and with a power of 150 watts. The main objectives of the project are to compute meteoroid flux rates and trajectories. Most receiving stations are using a 3 element Yagi antenna and are therefore only sensitive to one polarisation. The station located in Uccle has also a crossed 3 element Yagi antenna and therefore allows measurements of all kind of polarisations.

2. Principle of the polarisation measurement

The principle is illustrated on Figure 1. The two receivers are synchronized with an external 10 MHz reference. Signals from the two receivers and the PPS

from a GPS clock are sampled simultaneously by an ADC then stored on a PC as binary files. Sampling frequency is 5512 Hz. We then carry out a FFT of the sampled signals to obtain spectrograms (see example in Figure 2) where meteor echoes can easily be distinguished from « spurious » echoes such as reflections on planes. Several calibration tests will be discussed (determination of the relative gain of the two systems – antenna+receiver – for orthogonal polarisations, accurate determination of the phase shift between the two systems, calculation of the error bars associated with the measurement of the Stokes parameters, ...)

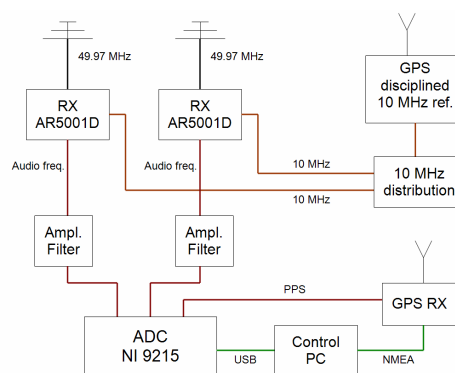


Figure 1: Illustration of the radio polarisation measurement principle.

3. Examples of radio polarisation measurements of meteor trail echoes

Figure 2 shows examples of spectrograms (5 minutes) obtained for both polarisations. Stokes parameters U,Q,V + polarised signal I_p + profile $I(t)$ are shown for 2 different types of meteor echoes, namely underdense echoes (short echoes produced by low ionisation meteor trails) and overdense echoes (long echoes produced by high ionisation meteor trails). The corresponding echoes in the spectrograms are circled in yellow.

4. Discussion

The examples in Figure 2 illustrate that the polarisation of the meteor echo can vary from nearly linear to nearly circular. We will discuss how these

measurements can be used to obtain valuable information about the meteor trail such as the ionisation at the reflection point. These data will also be compared with theoretical predictions such as those developed in Jones & Jones (1990) using full wave calculations for oblique scatter of radio waves on meteor trails.

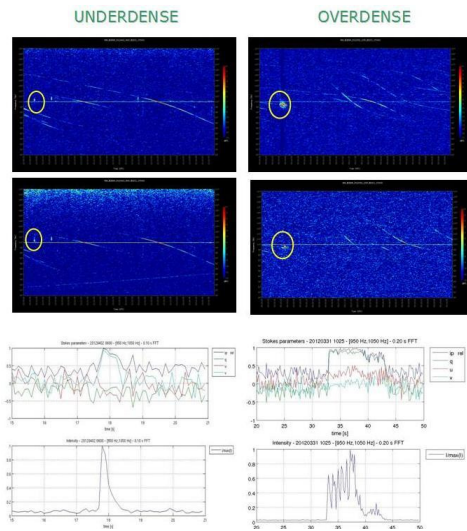


Figure 2 : Two examples of radio polarisation measurements of meteor trail echoes. From top to bottom : spectrograms of the 2 signals, Stokes parameters Q,U,V, polarised signal I_p and profile $I(t)$ of an underdense meteor (left) and an overdense meteor (right).

References

[1] Jones W. & Jones J. : Oblique scattering of radio waves from meteor trains, Planet. Space Sci. 38, 55-66, 1990.