# Use of Sonification For analysis and Detection of Plasma Bubbles at 21 MHz

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Abstract

This research explores sonification as a useful tool for space science data exploration. Our interest lies in basic scientific analysis of plasmas of the ionosphere, of interplanetary space and of the interstellar medium. These plasmas all contain irregularities. Propagation of electromagnetic waves, like optical or radio waves, through a medium with random fluctuations in refractive index results in amplitude and phase fluctuations (Scheuer 1968). These variations may be displayed via sonification, using changes in sounds to represent the data variations. This is particularly useful extending science to the visually-impaired. The xSonify Java-based tool was developed to explore sonification techniques and its value for general science analysis and also assistive technology.

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## Introduction

Data sonification is a tool with potential for studying complex sets of scientific data. Sonification provides the researcher with the ability to perceive variations and trends that are invisible to some data analysis techniques. Sonification offers the capability of seeing and listening to one or multiple data sets.

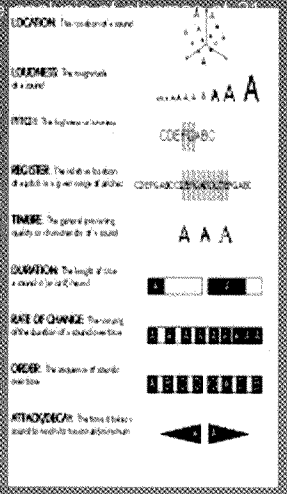
The simplest approach to get an acoustic representation of radio-astronomy data is to use audification, the direct playback of the raw time series as air pressure variations. Sonification is the representation of data by using (mainly non-speech) sound. It is the auditory analogue to data visualization. Auditory displays extend (or in some cases replace) visual displays, and basically make use of the highly-developed human listening skills for detecting patterns and regularities. One sonification is presented in this poster *spectral mapping sonification* which offers a quite direct inspection of the recorded data. This poster describes the sonification techniques applied to the [illegible] MHz.

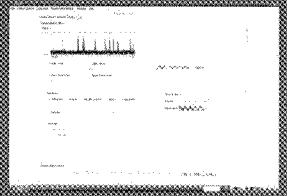
## xSonify

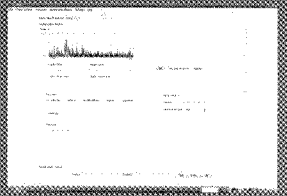
The program provides the opportunity to display numerical data as sound with the help of three different kind of sound attributes: pitch, the volume and the rhythm of sound.

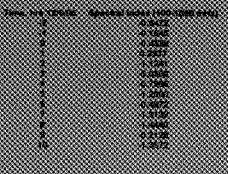
The user can also assign different Sonification modi or different instruments to each dataset.

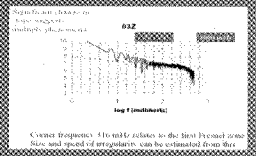
Sonification provides also a chance for blind scientists to work with data and needs speech support. Xsonify provides the user optionally with its own speech support software – independent from commercial

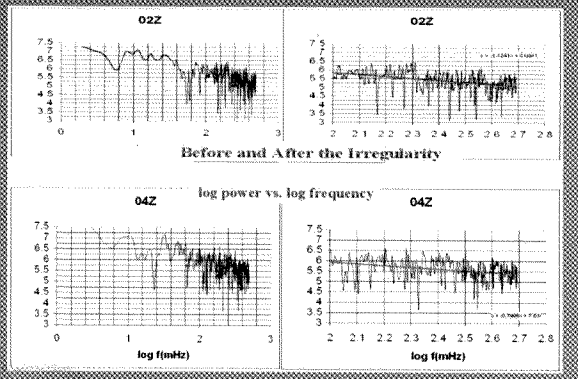






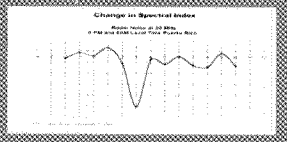





Data was collected hourly for a period before sunset to after sunrise (6 AM to 6 PM Atlantic Standard Time). Arbitrarily, the antenna signal was sampled for the first 10 minutes of each hour. The sampling rate was 1 Hz.

An increase in the base line pitch was recorded at 11:00pm local time (03Z). To listen for changes leading to changes in slope that might correspond to spectral index, we held the volume constant and made the pitch active. The volume range was kept at 70% of its 100% range; the tempo was at 4/4 and an observation log was filled during the hearing of the sonification.

Post-sunset (-01Z) and Pre-midnight (+04Z) Growth of Suspected Plasma Bubble




## Findings

On sonification, an increase in the base line pitch was recorded at 11:00pm local time (03Z). The spectral index calculated over San Juan PR was at 11:00 p.m. was -5.