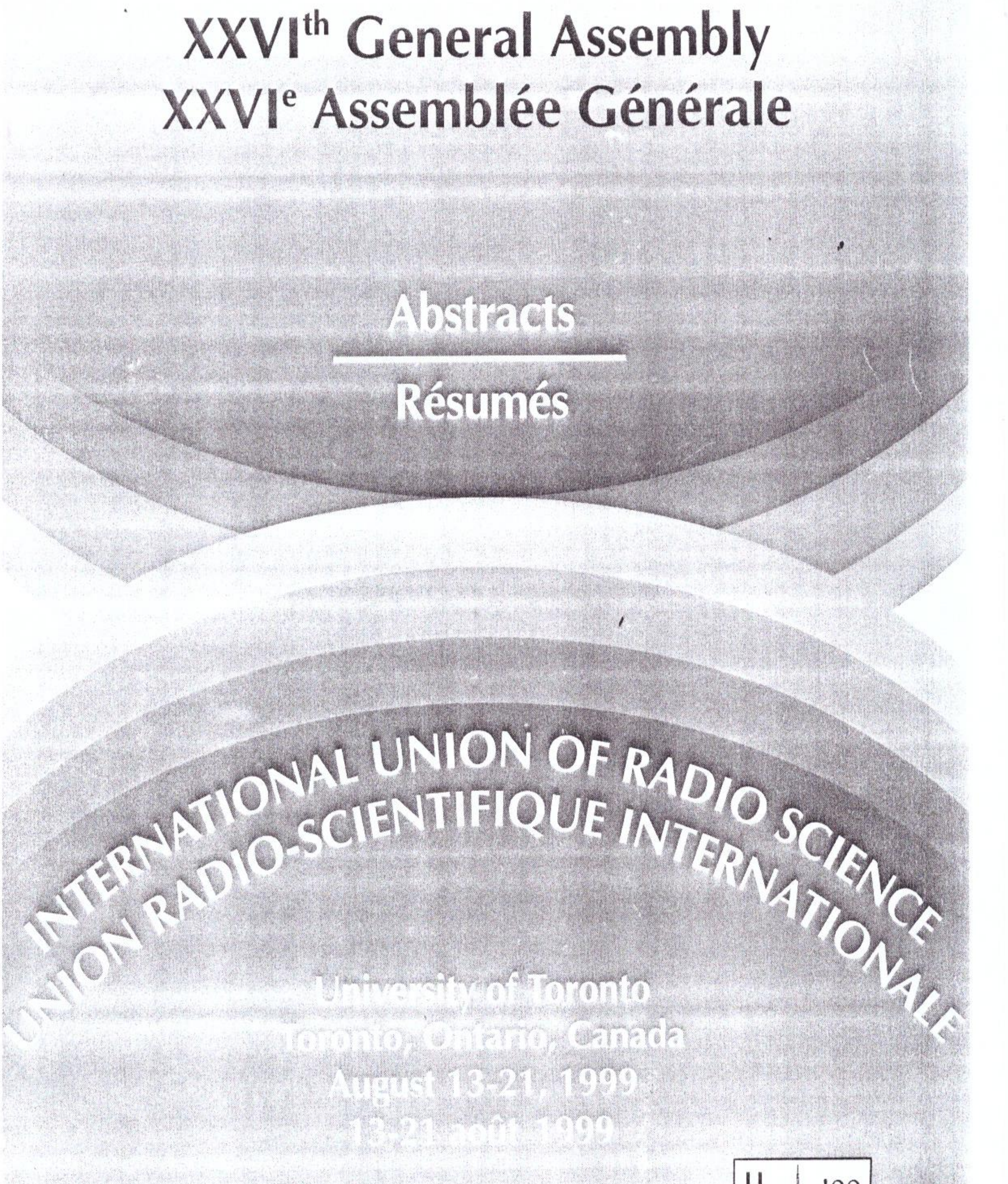

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Abstracts

Résumés

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Ionospheric Propagation Anomalies due to Celestial X-Ray and Gamma Ray Sources

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Introduction

The first reported celestial effect on ionospheric radio propagation [1] was a seasonal variation in the diurnal phase change in the 20kHz signal from WWVL, Boulder received in Wellington associated with the transit of the galactic x-ray source, Sco XR-1. The reality of this effect was initially challenged on both observational [2] and theoretical [3] grounds and subsequent analysis revealed that the sidereal component of the variation, although statistically significant, was smaller than expected. Numerous observations of stellar x-ray induced VLF phase advances were subsequently reported. A comprehensive study [4] involving the evaluation of thirty different VLF propagation paths supported the New Zealand results but concluded that propagation anomalies reported on some other paths could not be reliably attributed to stellar sources. This report reviews the ionospheric parameters revealed by transient and steady celestial sources of ionizing radiation including the recent intense gamma ray burst of August 27 1998.

Transient Celestial Sources of Ionizing Radiation

Ionospheric monitoring of transient x-ray and gamma ray burst sources can provide both useful ionospheric and source information. Thus, the ionospheric detection of the x-ray nova Cen XR-2 [4,5] and the non-(ionospheric) detection [6] of the supernova SN1987A were both of astrophysical interest. Current ionospheric interest attaches to the detection of two large gamma ray bursts which have been associated with large VLF phase and amplitude disturbances [7,8,9].

The Gamma ray burst of August 27 1998

A pulsating radiation burst of five minutes duration from the most recent and the larger of these, on August 27.4321 UT 1998, [10] was monitored at energies greater than 40keV by six spacecraft and at least three terrestrial VLF networks, two of these [8,9] recording near day-time ionization levels in the nocturnal D region. HF effects have also been reported [11]. This event offers a unique opportunity to model the lower D region as well as providing useful burst source information otherwise lost because of the saturation of satellite borne instruments.

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Investigation of mechanisms for 2-4 MHz radio wave scattering from plasma irregularities in the lower ionosphere

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Introduction

For studying spatial and temporal changes in parameters of the ionospheric D region, the partial reflection (PR) technique is used. For determining electron number density profiles $N(z)$, it is important to reveal the mechanisms of partial reflection of radio waves. Frequencies of the order of 2-4 MHz are usually used. The nature of partial reflection signals is studied using distributions of their amplitudes A.

Results of Investigations

For extracting the reflected E_r and scattered E_s components of PR signals, it is used the technique of [1] according to which the ratio $p=\langle A^2\rangle/\langle A\rangle^2= 1.27$ for scattered signals. In the presence of reflection and scattering simultaneously, $1< p < 1.27$; $\beta^2 = \langle| E_r |\rangle^2/\langle| E_s |\rangle^2 \neq 0$. When the component $\langle| E_r |\rangle^2$ is dominant, $p\to 1$, $\beta^2\to \infty$. The height profiles $\beta^2(z)$ are determined using $\langle A^2\rangle=\langle|E_r|\rangle^2(1+\beta^2)$ and the functional relation $\langle A^2\rangle/\langle A\rangle^2= f(\beta^2)$ [1]. Measurements of the partial reflection amplitudes A and the noise amplitudes A_n are made with the instrumentation [2] near Kharkiv using a frequencies of 2-4 MHz. Observations are made during day-time or diurnal campaigns continuously, or in 30-90 min, or at constant solar zenith angles in different seasons. The data are divided into two sets: a summer set from the spring to autumn equinox, and a winter set from the autumn to spring equinox. The duration of the records is 10 min, random measurement errors in β^2 are $\delta\beta^2<0.2$. The investigation is made in two height regions: $z<81$ km and $z>81$ km. The total number of measurements of β^2 is 380 in summer and 430 in winter. A characteristic feature for $z<81$ is the absence of E_r (β=0) in about 70% of the cases in winter and 75% in summer. The values $p>1.27$ are observed in 26% and 28% of the cases, respectively, and the value of β cannot be determined. For $z>81$, $1<p<1.27$, and $\beta\neq 0$ in about 55% of the cases in summer and 55-60% in winter; the values $p>1.27$ occur in 32% and 30% of the cases, respectively. For the rest of the cases, β=0. The most probable values of β occur within the interval 0-3. The distributions of β^2 for reflected signals and radio noise are also analyzed. The events with $p>1.27$ took place in 27% and 29% of the cases in summer and in 29% and 34% in winter, respectively.

Discussion

The results presented along with the data in the literature allow us to claim that the mechanisms of formation of plasma irregularities in the upper and lower part of the undisturbed D region: at heights of $z\leq 80$-85 km, the mechanisms of volume scattering are prevailing, while at heights of $z\geq 85$ km, scattering on small-scale irregularities and Fresnel reflection from «sharp» irregularities in plasma occur. In the future, it is necessary to study processes from which E_r originates.

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