

## Vita

Candidate's name: Kaili Song

Universities  
Attended: Heze University (2015)  
Bachelors of Science

Jilin University (2018)  
Masters of Science

University of New Brunswick (2021)  
Masters of Science  
Physics

### Presentations/Conferences/Publications:

K. Song, K. Meziane, A. Kashcheyev, P. T. Jayachandran (2021), Multifrequency observation of high latitude scintillation: A comparison with the phase screen model, IEEE Transactions on Geoscience and Remote Sensing

K. Song, P. T. Jayachandran (2020), Scintillation Characteristics Across GPS Frequency Band, Division of Atmospheric and Space Physics (DASP) conference, University of New Brunswick, Canada, February 19-21 2020

## Multifrequency observation of high latitude scintillation

UNIVERSITY OF NEW BRUNSWICK  
THESIS DEFENCE AND EXAMINATION

in Partial Fulfillment  
of the Requirement for the Degree of  
Master of Science

by

**Kaili Song**

in the Department of Physics

U.N.B., Fredericton, N.B.

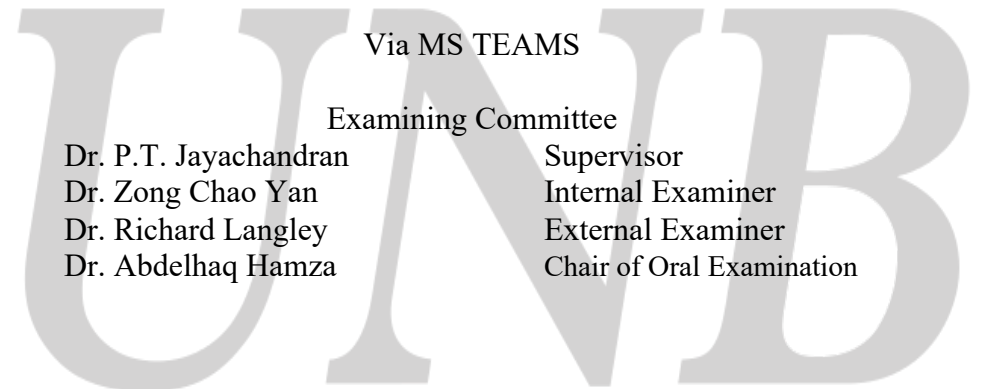
**Monday, August 30<sup>th</sup>, 2021  
10:00 a.m.**

Via MS TEAMS

Examining Committee

Dr. P.T. Jayachandran  
Dr. Zong Chao Yan  
Dr. Richard Langley  
Dr. Abdelhaq Hamza

Supervisor  
Internal Examiner  
External Examiner  
Chair of Oral Examination



## Abstract

Ionospheric scintillation, random amplitude and phase fluctuations of a trans-ionospheric radio signal, is caused by the Fresnel scale electron density irregularities in the ionosphere. Understanding the plasma instability mechanism that generates these ionospheric irregularities requires proper understanding and interpretation of the scintillation measurements made by the receivers on the ground. Using multifrequency Global Positioning System (GPS) measurements from the Canadian High Arctic Ionospheric Network (CHAIN), an assessment of the weak scattering theory (phase screen model) of ionospheric scintillation at high latitudes is performed. Scintillation data collected by Global Navigation Satellite System (GNSS) Ionospheric Scintillation and TEC Monitor (GISTM) receivers of the CHAIN provide a good background for testing the phase screen theory given the weak nature of the scintillation amplitude. In this study, sixty-four scintillation events are studied in terms of their spectral characteristics and fluctuation

levels. Both amplitude ( $S_4$ ) and phase ( $\sigma_\phi$ ) scintillation indices, as well as the power spectral index, are determined at multiple carrier frequencies (L1 1575.42 MHz, L2 1227.60 MHz and L5 1176.45 MHz). Using the weak scatter theory, we found that the average frequency dependence of  $S_4$  is  $f^{-1.27}$ . This implies that ionospheric irregularity spectra are steeper compared to those obtained directly from the power spectral density of signal amplitude fluctuations. Our results suggest that the frequency scaling of amplitude scintillation fails to account for the ionospheric irregularities of the smallest scales. Otherwise, the multifrequency scrutiny of the signal amplitude spectrum rollover frequency and the signal phase variation index provide results that are in good agreement with the weak scatter theory.