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by

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of

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## DEDICATION

I dedicate this to all MSU students who use L<sup>A</sup>T<sub>E</sub>X. Dedication is optional and may be no longer than one page, single spaced, and should precede the acknowledgments page.

## ACKNOWLEDGEMENTS

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## TABLE OF CONTENTS

|  |   |
|--|---|
| 1. INTRODUCTION .....  | 1 |
| Charged Particle Motion in Electric and Magnetic Fields .....          | 2 |
| Particle Populations and Their Interactions in the Magnetosphere ..... | 2 |
| Radiation Belts .....  | 2 |
| Particle Acceleration .....  | 2 |
| Adiabatic Heating .....  | 2 |
| Wave Resonance Heating .....   | 2 |
| Particle Losses .....  | 2 |
| Electromagnetic Ion Cyclotron Wave Driven .....                        | 2 |
| Whistler Mode Chorus Wave Driven .....                                 | 2 |
| Scope of Reserach .....  | 2 |
| 2. CONCLUSION .....  | 3 |
| REFERENCES CITED .....   | 4 |

## NOMENCLATURE

|              |                   |
|--------------|-------------------|
| $\mu$        | Dynamic viscosity |
| $\mathbf{n}$ | Normal vector     |
| $\mathbf{u}$ | Velocity vector   |

## INTRODUCTION

Above Earth's atmosphere are the radiation belts, a complex and dynamic plasma environment that can effect our technology-driven society. These effects include: a higher radiation dose for astronauts and cosmonauts, higher chance of spacecraft failure due to single event upsets that can lead to catastrophic latchups, cumulative degradation of silicon (changing the silicon doping) from an extended radiation dose that can degrade a transition to the point where it no longer function as a switch, and the degradation of the ozone layer due to the chemical production of NOX and HOX. With these effects in mind, it is no surprise that the radiation belts have been extensively studied since their discovery in the 1960s.

A topic of interest in the space physics community is wave-particle intersections that as we will see later in the introduction, can accelerate particles and scatter them into the atmosphere. [Van Allen, 1959]

The goal of this dissertation is to study the wave-particle mechanism that scatters microbursts into Earth's atmosphere. This goal will be achieved by first introducing single charged particle motion in electric and magnetic fields, the major particle populations and how they couple in the magnetosphere, and then describe the history and current state of the fields relating to microbursts and wave-particle scattering

## Charged Particle Motion in Electric and Magnetic Fields

### Particle Populations and Their Interactions in the Magnetosphere

#### Radiation Belts

#### Particle Acceleration

##### Adiabatic Heating

##### Wave Resonance Heating

#### Particle Losses

##### Electromagnetic Ion Cyclotron Wave Driven

##### Whistler Mode Chorus Wave Driven

#### Scope of Reserach

This dissertation furthers our understanding of the microburst scattering mechanism and is organized into the following chapters. Chapter **X** will describe the spacecraft missions used to study microburst precipitation and wave-particle scattering. Then Ch. **Y** will describe a microburst scattering event observed by NASA's Van Allen Probes and the quasi-linear diffusion model that was developed. Next, Ch. **Z** will describe a bouncing packet microburst observation made by MSU's FIREBIRD-II mission where the microburst's lower bound longitudinal and latitudinal scale sizes were estimated. Chapter **ZZ** then expands the case study result from Ch. **Z** to a statistical study of microburst sizes and the microburst size models developed to interpret the data. Lastly, **ZZZ** will summarize the dissertation work and make concluding remarks about research to be done.



## CONCLUSION

L<sup>A</sup>T<sub>E</sub>X produces documents that look great, automatically handles references and citations, and easily incorporates figures and tables. This is not a guide to L<sup>A</sup>T<sub>E</sub>X but rather an introduction to the MSU style. If you want more information about L<sup>A</sup>T<sub>E</sub>X many introductory guides can be found online.

## REFERENCES CITED

- [Van Allen, 1959] Van Allen, J. A. (1959). The geomagnetically trapped corpuscular radiation. *Journal of Geophysical Research*, 64(11):1683–1689.