Search for Neutrino Transients Using IceCube and DeepCore

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by

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Search for Neutrino Transients Using IceCube and DeepCore

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PREFACE

This dissertation is based on data acquired with the IceCube Neutrino Observatory whose maintenance and operation is the result of an immense international collaborative effort. The bulk of the work pertaining to experimental hardware, data acquisition, reconstruction algorithms, systematics, and simulation presented in this document can be attributed to many IceCube collaborators. However, the refinement of the event selection and subsequent analysis of the data are the original work of the author.

ACKNOWLEDGEMENTS

I want to thank my fellow graduate student office mates whose constant distractions helped me retain my sanity.

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SUMMARY

*Observations indicate that there is a correlation between long duration gamma-ray bursts (GRBs) and core-collapse supernovae (SNe). The leading model for GRB production assumes that relativistic jets are generated by the core-collapse within the progenitor star. Charged particles undergo Fermi-acceleration within internal shocks of these jets and subsequently give rise to gamma ray emission once the jets breach the surrounding stellar envelope. Very few SNe result in the occurrence of GRBs, however, but it has been suggested that a significant fraction of core-collapse SNe manage to produce mildly relativistic jets. These jets are insufficiently energetic to break through the envelope and are effectively 'choked' resulting in a lack of observed gamma ray emission. In both the failed and successful GRB scenario, neutrino production can occur if protons are accelerated in the internal shocks of these jets. These neutrinos may be detectable by the IceCube neutrino observatory and its low energy extension DeepCore. This thesis presents the methods and results of a dedicated search for temporal and spatial clustering of neutrino events during the IceCube 2012 data season.

Needs tweaking, actual result

CHAPTER I

INTRODUCTION

The expansion of traditional optical astronomy into wavelengths unobservable to the human eye revealed myriad phenomena previously unknown to science. Use of wavebands of light spanning several orders of magnitude allowed for the discovery of completely new astronomical sources. Additionally, it allowed for the study of inherently different physical processes within and around source objects. Yet, for all the vast advances in our understanding of the universe the opening up of the electromagnetic spectrum has brought us, it relies entirely upon the physical properties of its messenger particle, the photon.

Absorption of light, either by intervening matter or other background photons, limits the number and type of source objects optical astronomy can hope to observe and characterize.

CHAPTER II

NEUTRINO ASTRONOMY

The nascent field of neutrino astronomy began in earnest with the detection of supernova 1987A, the first extra-solar neutrino point source.

CHAPTER III

DETECTOR

The IceCube Neutrino Observatory is km^3-scale neutrino detector located deep within the glacial ice of the Antarctic ice sheet at the geographical South Pole. This location provides IceCube with a pristine detection medium as the natural ice has optical properties far superior to that of any produced in a lab. The detector consists of 5,160 light sensors known as digital optical modules (DOMs) which are distributed along 86 cables (referred to as strings) that supply power and provide communication to the surface. Each cable is instrumented with 60 DOMs spaced 17 meters apart with the highest DOM located 1450 meters below the surface. A inter-string spacing of 125 meters on average results in a total instrumented volume of approximately 1 km^3.

Every DOM contains a photo-multiplier tube (PMT), attached digitizing electronics, and LED flashers all housed within a glass pressure vessel. A penetrator cable breaches the pressure vessel to connect the DOM electronics to the supporting string cable allowing DOM-to-DOM as well as DOM-to-surface communications.

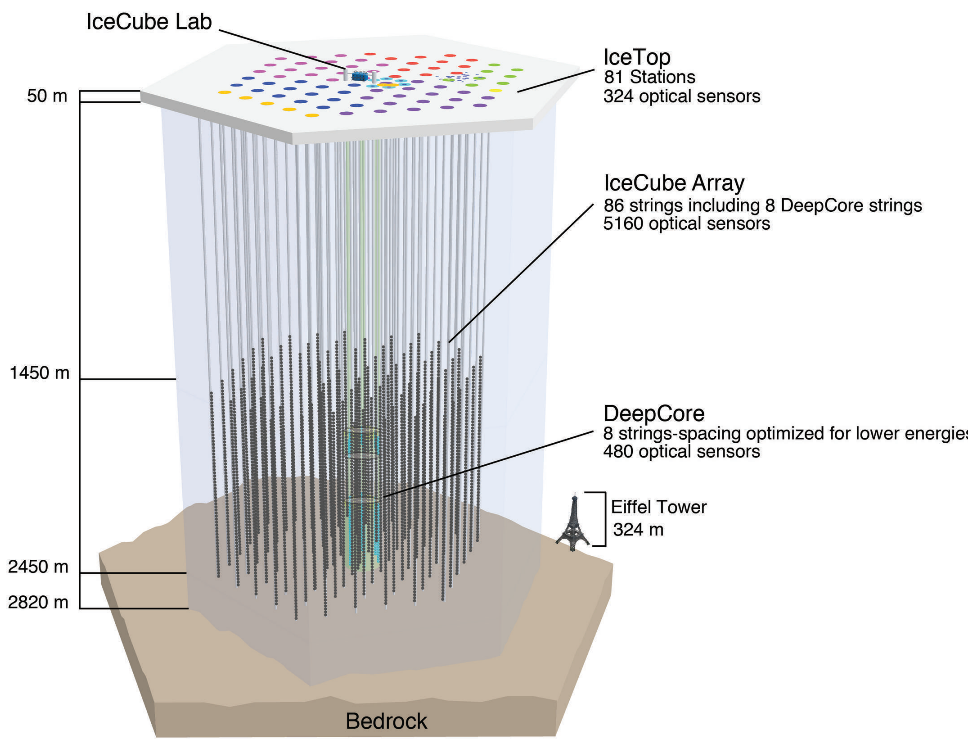

Figure 1: Diagram of the IceCube Neutrino Observatory (IceCube Collaboration).

CHAPTER IV

DATA ACQUISITION

Blah blah blah [1].

CHAPTER V

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APPENDIX PLACEHOLDER

Ancillary material should be put in appendices, which appear just before the bibliography.

REFERENCES

[1] The IceCube Collaboration, "The IceCube Data Acquisition System: Signal Capture, Digitization, and Timestamping," *ArXiv e-prints*, Oct. 2008.

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