

1 Leveraging Multi-Messenger Astrophysics for Dark
2 Matter Searches

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4 ¹HAWC

5 ¹IC3

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Abstract

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I did Dark Matter with HAWC and IceCube. I also used Graph Neural
Networks

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1 Acknowledgments

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I love my friends. Thanks to everyone that helped me figure this out.

12

Amazing thanks to the people at LANL who supported me. Eames, etc

13

Dinner Parties Jenny and her child Kaydince Kirsten, Pat, Andrea Family.

14

Roommate

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51 **2 List of Tables**

52 Proof I know how to include

53 **3 List of Figures**

54 Make the figures document at some point...

4 Introduction

Is the text not rendering right? Ah ok it knows im basically drafting the doc still

5 Dark Matter in the Cosmos

5.1 Introduction

Dark Matter (DM) has been a whispering problem in physics for almost 100 years. Anomalies have been detected by way of weird galaxy behaviour, budding Cosmology, and more [NEEDS A SOURCE]. It was sometime in 1930's when the super duper smart Zwicky measured that it was definitely there. It's kind of a big deal because we have no idea what the nature of this stuff and there's a lot of it. According to Lambda CDM, the most legit model, [NEEDS A SOURCE]DM is about 85% [FACT CHECK THIS], of all mass in the universe. It's called dark in fact because we cannot see it. [NEEDS A SOURCE]Finding out what the hell it is, is an active field of research and hopefully it interacts with the standard model.

Here's what we do know about DM so far...DM is dark, it doesn't interact readily with light. DM also doesn't interact noticably with the other standard model forces (EM, Strong, Weak) at a rate that matters [NEEDS A SOURCE]. DM is cold. By cold I mean that it is most likely not moving at relativistic speeds like neutrinos and photons. [NEEDS A SOURCE]If it was moving that fast, the structures we see like galaxies would be much more diffuse than what is observed. [NEEDS A SOURCE]DM is old. DM played a critical role in the formation of the universe and the structure within it. [NEEDS A SOURCE]We know this from Cosmology and computer universe simulations [NEEDS A SOURCE].

The search for DM is basically summarized by trying a bunch of different models and performing measurements of all kinds to test them. These models of course have to nominally agree with the known observations seen over the last century. Whenever we perform a test and don't see anything, the parameter spaces gets more constrained. I discuss some of the ideas and approaches further on. I Especially discuss the models that are relevant to my thesis.

5.2 Evidence for Dark Matter

Let me show you why we're pretty sure DM is a thing and why it might be particle like in nature. My thesis focuses on WIMP dark matter which is one of the better motivated things out there.

91 **5.2.1 First Clues: Stellar Velocities**

92 THE STARS ARE MOVING TO FAST AAAAHAAHHAHA

93 **5.2.2 Mounting Evidence for Dark Matter**

94 SPACE TIME CURVY THE UNIVERSE IS A SIMULATION. THE WIG-
95 GLES IN GEOMETRY ARE THICCCC

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