

Exploring the Enigma: Aspects of WIMP Dark Matter Searches at Colliders and Other Probes

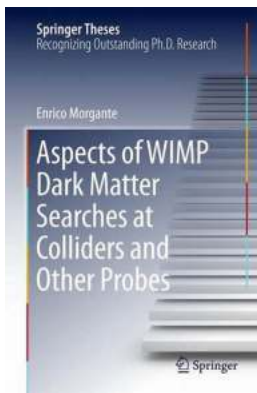


Dark matter has been a tantalizing mystery in the world of astrophysics and particle physics for decades. While its existence is inferred from its gravitational effects, the composition and nature of dark matter remain elusive. One of the most promising candidates for dark matter is the Weakly Interacting Massive Particle (WIMP). In this article, we will explore the various aspects of WIMP dark matter searches, focusing on collider experiments and other complementary techniques.

What is WIMP Dark Matter?

WIMPs are hypothetical particles that interact weakly with ordinary matter, allowing them to evade direct detection. They are postulated to be non-baryonic and have a mass larger than a proton. The high mass and weak interactive

nature of WIMPs make them excellent candidates for explaining dark matter's gravitational effects at the galactic and cosmic scales.



Aspects of WIMP Dark Matter Searches at Colliders and Other Probes (Springer Theses)

by Daniela Colombini (1st ed. 2017 Edition, Kindle Edition)

★★★★★ 5 out of 5

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Enhanced typesetting : Enabled
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Collider Experiments

Colliders, such as the Large Hadron Collider (LHC), have been instrumental in the search for WIMP dark matter. These experiments aim to produce WIMP particles by colliding high-energy protons or other subatomic particles. By analyzing the particles produced in these collisions, physicists hope to identify signatures of WIMPs interacting with the ordinary matter.

One of the primary detection methods involves looking for missing energy and momentum in the collision events. If a WIMP is produced, it would escape the detector without interacting strongly, resulting in an energy imbalance. By carefully analyzing the data and comparing it with theoretical predictions, scientists can search for these tell-tale signatures of WIMP production.

Other Probes for WIMP Dark Matter

Collider experiments are not the only means of probing WIMP dark matter. There are various other complementary techniques that researchers employ:

- **Direct Detection:** Experiments involve searching for the rare interactions between dark matter particles and ordinary matter. Sensitive detectors are placed deep underground to shield them from cosmic rays and other background radiations.
- **Indirect Detection:** Scientists search for the products of WIMP annihilation or decay, such as high-energy photons, neutrinos, or cosmic rays. Observations of these particles provide indirect evidence for the presence of WIMP dark matter.
- **Cosmological Observations:** By studying the large-scale structure of the universe, the cosmic microwave background radiation, and the distribution of galaxies, cosmologists can derive constraints on the properties of dark matter, including WIMPs.

Current Progress and Future Prospects

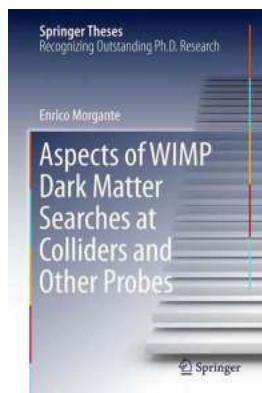
Although no conclusive evidence for WIMP dark matter has been found yet, collider experiments and other probes have yielded intriguing results.

Experimental collaborations like ATLAS and CMS at the LHC have placed stringent limits on the properties of WIMPs, excluding certain regions of the parameter space.

However, the quest is far from over. Future colliders, such as the proposed High-Luminosity LHC and the future Circular Electron-Positron Collider (CEPC), will provide even higher energies and more massive collision events, increasing the chances of WIMP production and detection. Additionally, advancements in direct

detection, indirect detection, and cosmological observations continue to contribute to our understanding of dark matter.

The search for WIMP dark matter is an exciting and multifaceted endeavor. Collider experiments and other complementary techniques offer complementary approaches to scrutinize the properties and interactions of WIMPs. As we continue to push the boundaries of scientific knowledge, the enigma of dark matter may finally be unraveled, bringing us closer to understanding the fundamental nature of the universe.



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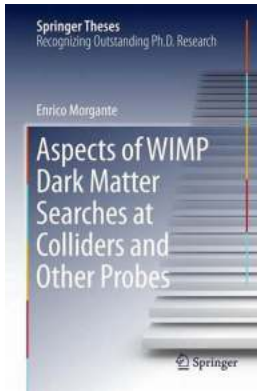
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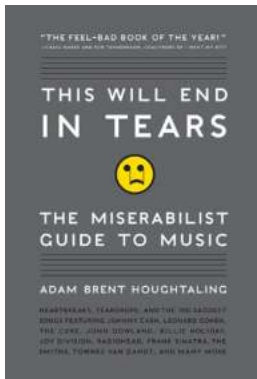
This thesis covers several theoretical aspects of WIMP (weakly interacting massive particles) dark matter searches, with a particular emphasis on colliders. It mainly focuses on the use of effective field theories as a tool for Large Hadron Collider (LHC) searches, discussing in detail the issue of their validity, and on simplified dark matter models, which are receiving a growing attention from the physics community. It highlights the theoretical consistency of simplified models, which is essential in order to correctly exploit their potential and for them to be a

common reference when comparing results from different experiments. This thesis is of interest to researchers (both theorists and experimentalists) in the field of dark matter searches, and offers a comprehensive to dark matter and to WIMP searches for students and non-experts.



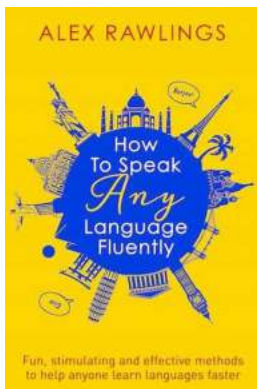
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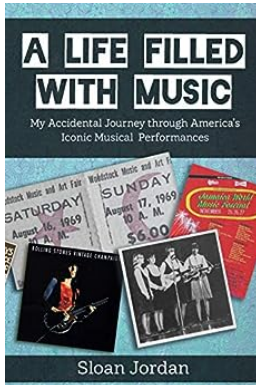
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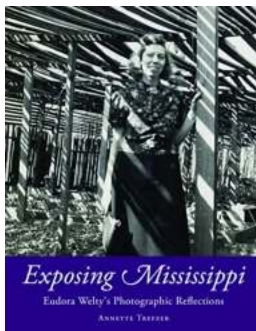
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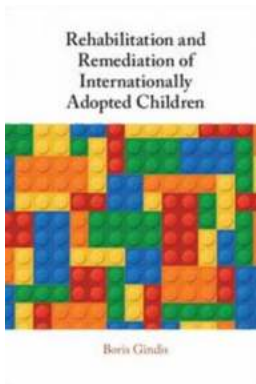
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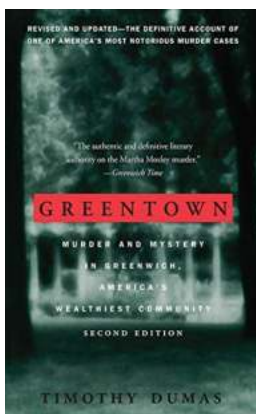
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