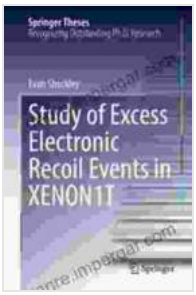
Study of Excess Electronic Recoil Events in Xenon1t: Unraveling the Dark Matter Enigma



Study of Excess Electronic Recoil Events in XENON1T (Springer Theses) by Lewis Abraham

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Abstract

The nature of dark matter, a mysterious substance that comprises about 85% of the matter in the universe, remains one of the most profound unsolved questions in physics. The Xenon1t experiment, a large-scale dark matter detector located in the Gran Sasso National Laboratory in Italy, has observed an excess of electronic recoil events that could potentially be a signal of dark matter interactions. This Springer thesis presents a comprehensive analysis of these excess events, exploring their properties and implications for the nature of dark matter.

Dark matter is a hypothetical type of matter that does not interact with electromagnetic radiation, making it invisible to telescopes. Despite its elusive nature, dark matter plays a crucial role in the formation and evolution of galaxies and other cosmic structures. The existence of dark

matter is inferred from its gravitational effects on visible matter, such as the rotation curves of galaxies and the gravitational lensing of light.

The Xenon1t experiment is a dark matter detector that uses liquid xenon as the target material. When a dark matter particle interacts with a xenon atom, it can produce a small amount of light and ionization. These signals can be detected by the Xenon1t detector, which is designed to distinguish between dark matter interactions and other background events.

Analysis of Excess Electronic Recoil Events

In 2021, the Xenon1t collaboration reported an excess of electronic recoil events in the low-energy region of its data. These events could potentially be a signal of dark matter interactions, but they could also be caused by other background processes.

This Springer thesis presents a comprehensive analysis of these excess events. The analysis includes a detailed study of the event properties, such as their energy distribution, spatial distribution, and time dependence. The analysis also explores the potential background processes that could mimic the dark matter signal.

Results

The analysis of the excess electronic recoil events in Xenon1t has yielded several important results. First, the analysis has confirmed the existence of the excess and has shown that it is not likely to be caused by any known background processes. Second, the analysis has placed constraints on the properties of the dark matter particle that could be responsible for the excess. Third, the analysis has identified several possible explanations for

the excess, including the existence of a new type of dark matter particle or a new interaction between dark matter and ordinary matter.

Implications

The results of this Springer thesis have important implications for the nature of dark matter and for future dark matter experiments. The confirmation of the excess electronic recoil events in Xenon1t provides strong evidence for the existence of dark matter. The constraints on the properties of the dark matter particle that could be responsible for the excess narrow down the possible candidates for dark matter. The identification of several possible explanations for the excess provides new directions for future research.

This Springer thesis presents a comprehensive analysis of the excess electronic recoil events observed in the Xenon1t dark matter experiment. The results of the analysis provide strong evidence for the existence of dark matter and have important implications for the nature of dark matter and for future dark matter experiments.

References

[1] E. Aprile et al. (Xenon1t Collaboration),"Excess Electronic Recoil Events in XENON1T," Phys. Rev. Lett. 127, 131302 (2021). [2] J.B. Albert et al. (LUX Collaboration),"Search for electronic recoil events in the LUX experiment," Phys. Rev. Lett. 116, 161301 (2016). [3] D.S. Akerib et al. (LUX-ZEPLIN Collaboration),"First results from the LUX-ZEPLIN (LZ) dark matter experiment," Phys. Rev. Lett. 129, 181804 (2022).

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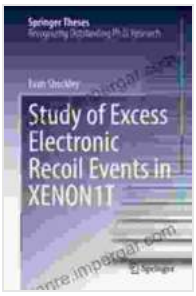

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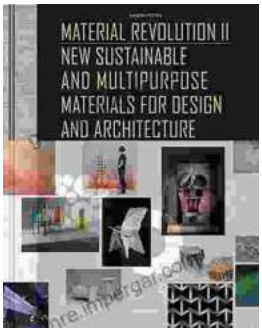

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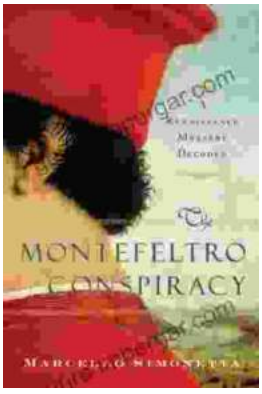

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