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Exploring Links between Direct Dark Matter Detection, Astrophysical and Cosmological Observations Involving Self-interacting Dark Matter

Maurizio Kappos*
Department of Astrophysics, Teesside University, Middlesbrough, Tees Valley TS1 3BX, UK

Introduction

Dark matter remains one of the most enigmatic and fundamental components of the universe. While its gravitational effects are evident through various astrophysical and cosmological observations, the precise nature of dark matter particles continues to elude scientists. Over the years, numerous theories and models have been proposed to explain dark matter's properties, including the intriguing concept of Self-Interacting Dark Matter (SIDM). This theory suggests that dark matter particles can interact with one another through non-gravitational forces, potentially leading to observable effects on various scales. In this exploration, we delve into the evolving connections between direct dark matter detection, astrophysical observations, and cosmological studies, with a focus on the role of self-interacting dark matter. Direct detection experiments aim to capture the rare interactions between dark matter particles and ordinary matter. These experiments are often situated deep underground to shield against cosmic rays and other background radiation. The traditional assumption has been that dark matter particles interact solely through gravity, resulting in very weak interactions with normal matter. However, this assumption has faced challenges in explaining certain anomalies observed in these experiments.

Description

The concept of self-interacting dark matter introduces an alternative perspective. If dark matter particles can interact with each other through additional forces, it can significantly alter their behavior within direct detection experiments. This is particularly relevant in scenarios where dark matter clumps together due to self-interactions, potentially leading to enhanced interaction rates with ordinary matter. Therefore, exploring self-interactions has the potential to explain unexpected signals seen in direct detection experiments and reshape our understanding of dark matter's fundamental nature. Astrophysical observations, ranging from galaxy rotation curves to the large-scale structure of the universe, have provided strong evidence for the existence of dark matter [1]. However, conventional dark matter models struggle to explain certain observations, such as the "core-cusp" problem – the contrast between the predicted dense centers of dark matter halos and the observed flattened cores in dwarf galaxies.

Self-interacting dark matter has been proposed as a solution to this discrepancy. The mutual scattering between dark matter particles can redistribute their kinetic energy, potentially preventing the formation of overly dense cores in halos. As a result, SIDM models can better reproduce the observed density profiles of galaxies and provide a more accurate description of astrophysical phenomena. On cosmological scales, the behavior of dark matter influences the growth of cosmic structures and the cosmic microwave background. While Cold Dark Matter (CDM) models have been successful in explaining large-scale structure formation, they face challenges in explaining certain discrepancies on small scales, such as the "missing satellite problem" – the dearth of small satellite galaxies predicted by simulations compared to observations.

Self-interacting dark matter presents a possible resolution to this issue as well. The self-scattering of dark matter particles can dampen small-scale fluctuations, potentially suppressing the formation of numerous small halos. This effect can align with observations and provide a solution to the missing satellite problem, further highlighting the potential impact of self-interactions on cosmological theories [2]. The connections between direct dark matter detection, astrophysical observations, and cosmological studies have gained prominence with the advent of more advanced experimental techniques and sophisticated simulations. As direct detection experiments continue to improve their sensitivity, they become capable of probing a wider range of dark matter models, including those involving self-interactions [3].

Moreover, the combination of direct detection results with astrophysical observations and cosmological simulations allows for a more comprehensive exploration of dark matter's properties. The consistency between different lines of evidence can help refine our understanding of dark matter and provide insight into its fundamental characteristics. While the concept of self-interacting dark matter offers a promising framework for resolving various discrepancies, challenges remain. Determining the exact nature of self-interactions, understanding the particle physics responsible for such interactions, and reconciling SIDM with other observational constraints are on-going areas of research [4].

These simulations can help refine our predictions and guide the design of experiments to target specific SIDM scenarios. The exploration of connections between direct dark matter detection, astrophysical observations and cosmological studies involving self-interacting dark matter opens up exciting avenues for understanding one of the universe's most significant mysteries. The potential impact of self-interactions on resolving long-standing discrepancies, from direct detection anomalies to astrophysical and cosmological challenges highlights the need for interdisciplinary collaboration between particle physicists, astrophysicists, and cosmologists. As experimental techniques and simulations continue to advance the puzzle of dark matter's nature may finally be unravelled, unveiling a deeper understanding of the universe's underlying structure and dynamics [5].

Conclusion

In the pursuit of unraveling the enigma of dark matter, the exploration of fresh links between direct dark matter detection, astrophysical observations, and cosmological studies involving self-interacting dark matter is both timely and promising. The intriguing concept of self-interactions challenges traditional assumptions and has the potential to bridge gaps between theory

***Address for Correspondence:** Maurizio Kappos, Department of Astrophysics, Teesside University, Middlesbrough, Tees Valley TS1 3BX, UK, E-mail: Kappos.m@rizio.ac.uk*

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and observation. As research progresses, the interplay between these diverse lines of inquiry may finally unlock the secrets of dark matter's true nature, revealing its role in shaping the cosmos and expanding our understanding of the universe's fabric.

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Conflict of Interest

None.

References

1. Ren, Xiangxiang, Li Zhao, Abdusalam Abdukerim and Xun Chen, et al. "Constraining dark matter models with a light mediator at the PandaX-II experiment." *Phys rev lett* 121 (2018): 021304.
2. Yang, Jijun, Abdusalam Abdukerim, Wei Chen and Xun Chen, et al. "Constraining self-interacting dark matter with the full dataset of PandaX-II." *Sci China- Phys Mech Astron* 64 (2021): 111062.
3. Huo, Ran, Manoj Kaplinghat, Zhen Pan and Hai-Bo Yu, et al. "Signatures of self-interacting dark matter in the matter power spectrum and the CMB." *Phys Lett* 783 (2018): 76-81.
4. Depta, Paul Frederik, Marco Hufnagel and Kai Schmidt-Hoberg. "Updated BBN constraints on electromagnetic decays of MeV-scale particles." *J Cosmol Astropart Phys* 2021 (2021): 011.
5. Arya, Manan, Nicolas Lee and Sergio Pellegrino. "Ultralight structures for space solar power satellites." In 3rd AIAA Spacecraft Structures Conference (2016): 1950.

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