**Final Momentum Distribution of Dark matter-Lepton Collisions**

Abstract by Emma Modesitt

The final velocity distribution of dark matter is determined by interactions with normal matter during the Universe's first second. To understand these interactions, we need to know the dark matter scattering rate – found by integrating the collision operator over all possible configurations of a scattering event.

I have derived expressions for final energy and momenta in terms of the scattering angles in the center of momentum frame for a dark matter particle and a relativistic lepton after a collision. With these relationships, I have verified that momentum and energy are conserved during the scattering event. Since the expressions of energy and momenta are in terms of scattering angles, the collision operator was recast into those variables. I also performed a series of substitutions to make the resulting integral dimensionless and found the collision rate to be $1.23373 \times 10^{-10}\ \gamma\ m_\chi/T_L$, where $\gamma$ is the momentum transfer rate, $m_\chi$ is the mass of the dark matter particle, and T is the lepton temperature

Compared to previous work by Charlie Mace in his thesis *Simulating the Thermal Evolution of Dark Matter During an Early Matter-Dominated Era*, there is a discrepancy of many orders of magnitude[1]. Throughout the process of this work, there were a few inconsistencies, mainly from different constant factors, however, there was a large disparity in the calculation of the collision operator integral. Further comparison to other studies of similar work must be done to converge on a final value for the collision rate of these interactions.

[1] Mace, Charle. *Simulating the Thermal Evolution of Dark Matter During an Early Matter-Dominated Era*. Chapel Hill: Department of Physics and Astronomy, 2020.