Primordial Black Hole Atoms

David Zwick  
*Rowan University*

Tyler Hanover  
*Rowan University*

Brian Nepper  
*Rowan University*

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Primordial black holes are thought to have been formed at the early stages of the universe in the presence of non-homogeneous density distributions of dark matter. We are working under the assumption that dark matter consists of elementary low mass particles, specifically, spin 1/2 fermions. We further assume that dark matter is electrically neutral, thus its main interaction is gravitational. We investigate dark matter spin 1/2 fermions in orbit around a black hole atom and consider mass ranges for which the quantum description is appropriate. Solutions to the Dirac equation are utilized to describe the radial mass distribution of primordial black hole atoms. Stable black holes atoms could be the seeds for galaxy formation.

### Results

- The radial probability function for the mass distribution of the fermions is defined as:
  \[ P(r) = \sqrt{2} N \eta \eta^{3/2} \eta^2 \left( (n + \eta) F(-n + \eta + 2k + 1, x) - (n - \eta) F(-n + k + 1, x) \right) \]

- The summation of the probability functions for multiple \( n \) values is expressed as:
  \[ d(r, N) = \sum_{n=1}^{N} \left[ 2F_{n, n-1} + \sum_{k=2}^{n} (2\lambda - 1) F_{n, n-1} + \sum_{k=4}^{n-1} (2\lambda + 1) F_{n, n-1} \right] \]

### Future Work

In the future we will attempt to find an exact equation to express the probability distribution at any range of \( n \)'s. Our focus will turn to adding potential terms to account for the accumulated mass of the fermions at high \( n \)’s. Numerical calculations will be necessary to better represent the data at values of \( b > 1 \).