Title: PWARI-G Halo Formation and Comparison to Observed Galaxy Rotation Curves

Objective: To test whether the PWARI-G framework, under different initial soliton conditions, can reproduce dark matter halo profiles observed in galaxies, specifically matching or diverging from Burkert and NFW expectations.

Approach:

1. **Core Hypothesis:** In PWARI-G, dark matter is modeled as stationary solitons, while visible matter consists of moving solitons that emit twist fields. Halo profiles emerge dynamically from wave interactions rather than imposed potentials.
2. **Galaxy Matching Strategy:**
    - Use SPARC rotation curve data (e.g., 2MASSJ00385299-5529210) to inform the seeding distribution.
    - Perform decomposition using photometric `f.prof` files to isolate residual dark matter.
    - Fit Burkert and NFW profiles to both observational data and simulated halos.
3. **Simulation Parameters:**
    - Grid: 1024x1024
    - Spatial resolution: 0.109 kpc/grid unit
    - Time evolution: 10,000 steps
    - Soliton count: 120,000
    - Moving ratio: 10%
    - Snap threshold: 1.5 (moving), 2.0 (stationary)

Experiments Conducted:

A. Reproduction of 2MASSJ00385299-5529210

- Used Burkert-inspired radial distribution for stationary solitons.
- Simulation yielded a rotation curve that matched the observed galaxy extremely well by step 9500.
- Final radial density profile also matched Burkert with low RMSE.

B. NFW Seeding Experiment

- Modified initial conditions to follow an NFW density falloff.
- Final profile did not match NFW or Burkert exactly.
- Showed intermediate behavior: regulated core with a steep outer drop.
- NFW and Burkert both yielded higher RMSE than the curve itself.

Comparison Results:

Configuration	Best Fit Profile	RMSE (Burkert)	RMSE (NFW)
Real Galaxy Seeding	Burkert	Low (~0.03)	High
NFW Seeding	Neither	Medium	Medium-High

Conclusions:

1. **PWARI-G can reproduce real galaxy halos:** When seeded with light-distribution-matching soliton conditions, the final halo profile agrees with SPARC observations and is well-fit by a Burkert profile.
2. **Halo shapes are emergent, not forced:** Changing the initial condition to an NFW distribution does not guarantee an NFW outcome. The field self-organizes, and soliton interactions regulate central steepening.
3. **Implication for dark matter theory:** PWARI-G does not require exotic particles. It naturally produces cored or intermediate halos depending on wave-based field dynamics.
4. **Next directions:**
    - Explore further galaxies with known poor Burkert fits.
    - Quantify halo diversity across a broader soliton configuration space.
    - Test longer simulations for stability and late-time behavior.

Supporting Tools and Outputs:

- Rotation curve decompositions from SPARC profiles (`rc.prof`, `f.prof`).
- Automated RMSE calculator for Burkert vs. NFW.
- Standalone profile extractor and halo overlay tools.