Comparing radial migration in dark matter and MOND regimes

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Introduction

- Radial migration changes stellar guiding radii without necessarily heating the disc.
- It is driven by spiral arms and the bar.
- It redistributes stellar ages and metallicities and may contribute to thick-disc formation.
- Well studied in Newtonian gravity, but largely unexplored in MOND.
- **Aim:** compare radial migration and resonant dynamics in the DM and MOND regimes.

Model

- **Disc:** exponential density profile.
- **Bulge and bar:** rotating, non-axisymmetric central potential.
- **Spiral arms:** rotating two-armed perturbation.
  - Pattern speed Ω_{sp} = 19, 25, 31 km s^{-1} kpc^{-1}.
  - Amplitude 850 and 1200 km^2 s^{-2} kpc^{-1}.
- **DM model:** NFW halo (Navarro et al. 1996).
- **MOND model:** McGaugh et al. (2016), no DM halo.
- **Simulation:** 2 million stars for 6 Gyr.

Radial migration

- Radial migration is substantially stronger in MOND than in DM (Fig. 2).
- At 2 – 6 Gyr, **~ 5×** more stars in MOND show a guiding-radius change $|\Delta R_g| > 1.5$ kpc.
- Higher spiral amplitude enhances migration in both models.
- Higher spiral pattern speed generally reduces the DM–MOND difference.
- **Time dependence:** in MOND, more stars migrate inward in the first 3 Gyr.

Resonances

- Dominant resonances (Fig. 1): spiral CR, bar and spiral OLR, and combined bar–spiral CR ($2\Omega = \Omega_b + \Omega_{sp}$).
- Spiral CR is key for migration, and its interplay with the OLR redistributes angular momentum.
- MOND: faster evolution, with the CR first dispersing and then recapturing stars.
- DM: stable concentration of stars near the CR.

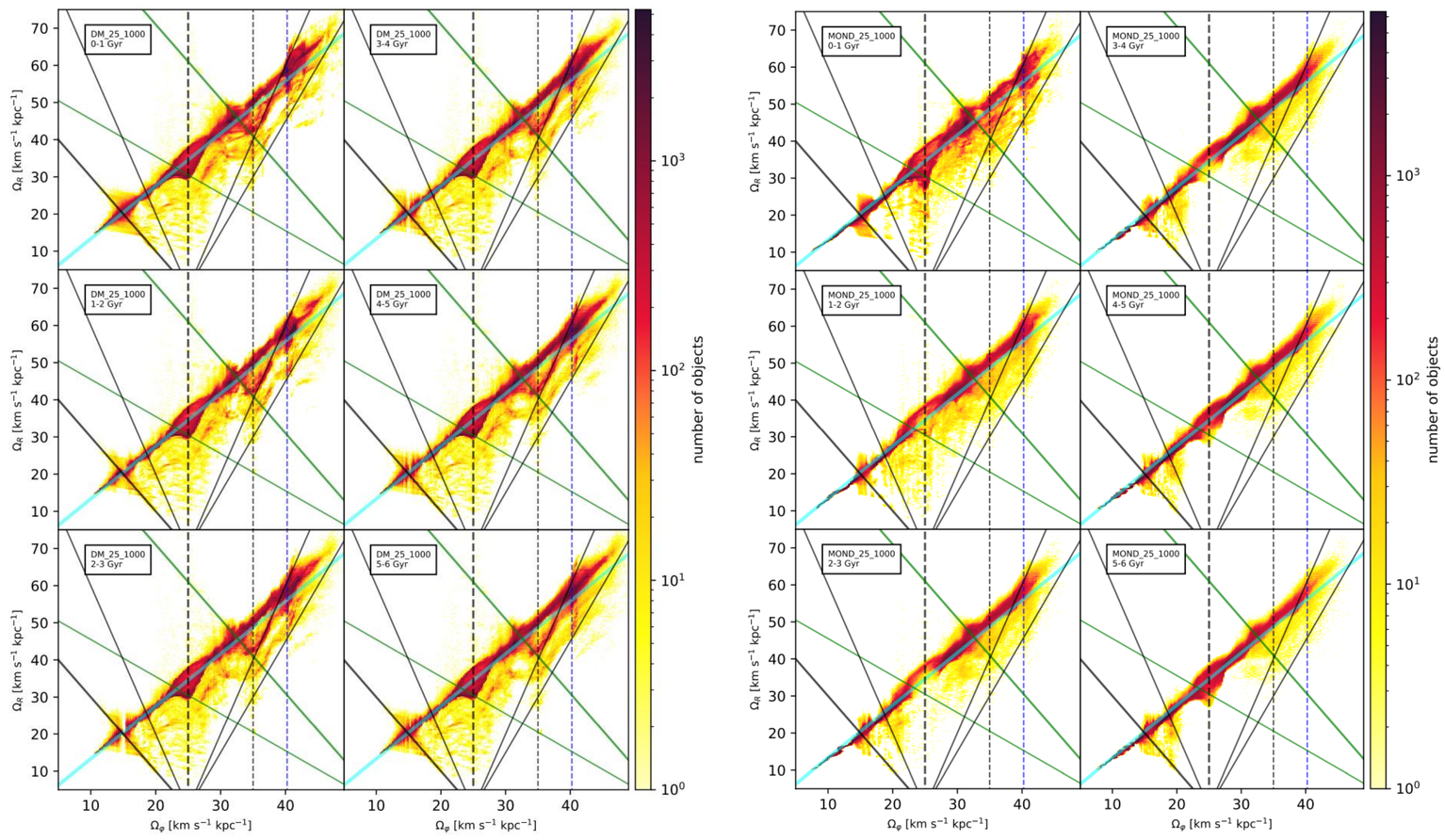


Fig. 1: Frequency phase space evolution (Δt = 1 Gyr) for Ω_{sp} = 25 km s^{-1} kpc^{-1} and A_{sp} = 1000 km^2 s^{-2} kpc^{-1} for DM (left panel) and MOND (right panel). Light blue: epicycle approximation, dashed grey – spiral co-rotation; dashed blue – combined bar–spiral co-rotation; solid grey – spiral OLR and other spiral resonances; solid green – bar OLR and l = m = p = 1 bar resonance.

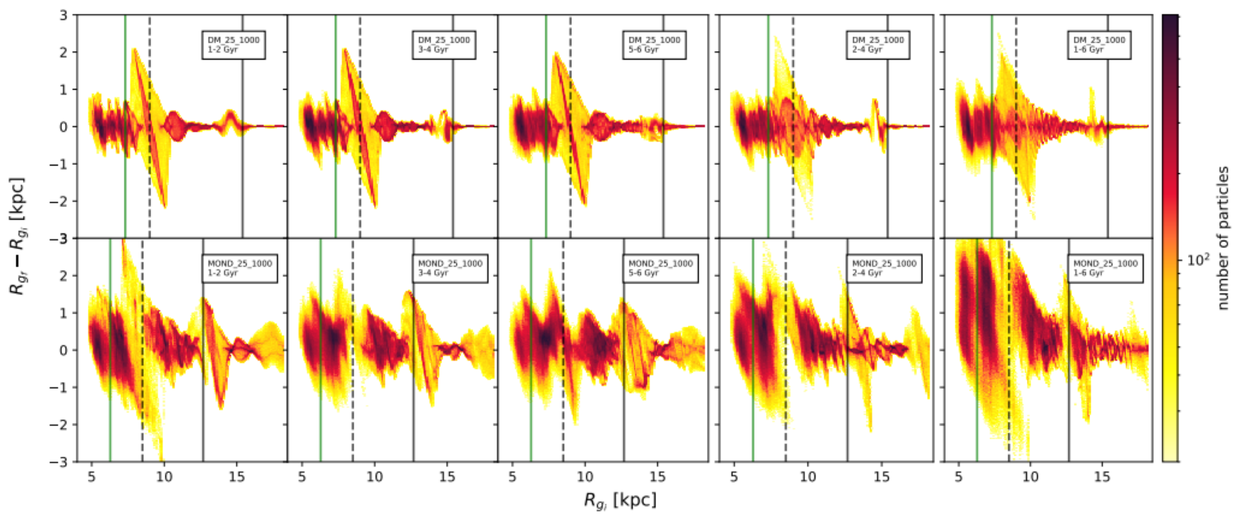


Fig. 2: Guiding-radius change versus initial guiding radius at different time; 6 Gyr run; Ω_{sp} = 25 km s^{-1} kpc^{-1}, A_{sp} = 1000 km^2 s^{-2} kpc^{-1}. Lines: bar (green) and spiral (grey) resonances; solid = OLR, dashed = CR.

Discussion and limitations

Conclusions

- MOND: Migration is substantially stronger, **~5×** more stars with $|\Delta R_g| > 1.5$ kpc.
- The bar and spirals contribute more to the total acceleration for MOND, which gives stronger resonant interactions.
- Spiral CR and the bar and spiral OLR dominate.
- Spiral amplitude boosts migration, and pattern speed reduces the DM–MOND difference.

Limitations: 2D, static potential, fixed analytical spiral.

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MATFYZ CONNECTIONS

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