Local phase-space structure of dark-matter and direct detection experiments

Based on

Vogelsberger, Helmi & Aquarius coll.

(MNRAS, 2009)

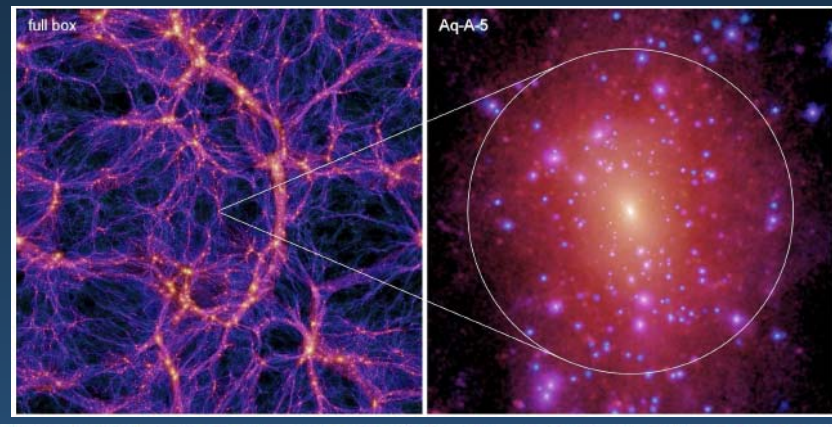
university of groningen

faculty of mathematics and natural sciences

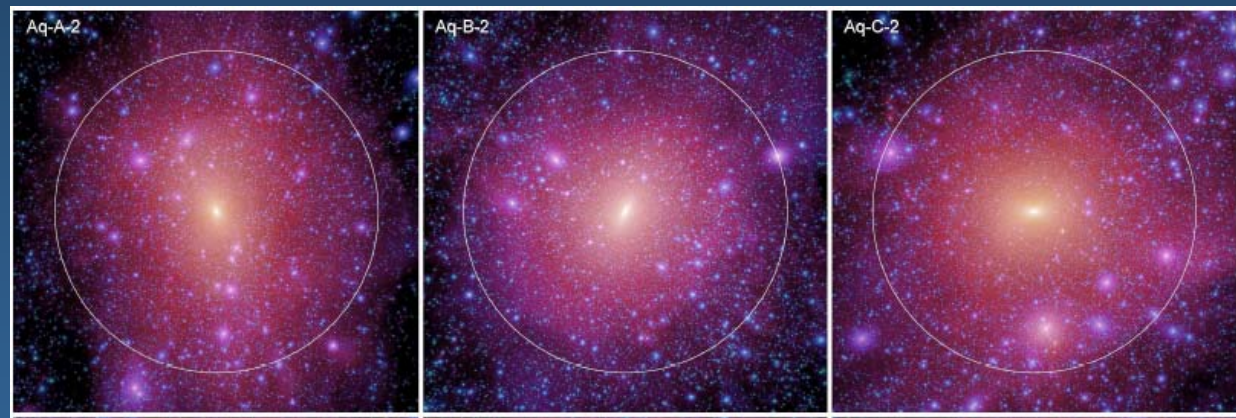
kapteyn astronomical institute

Direct detection & Aquarius

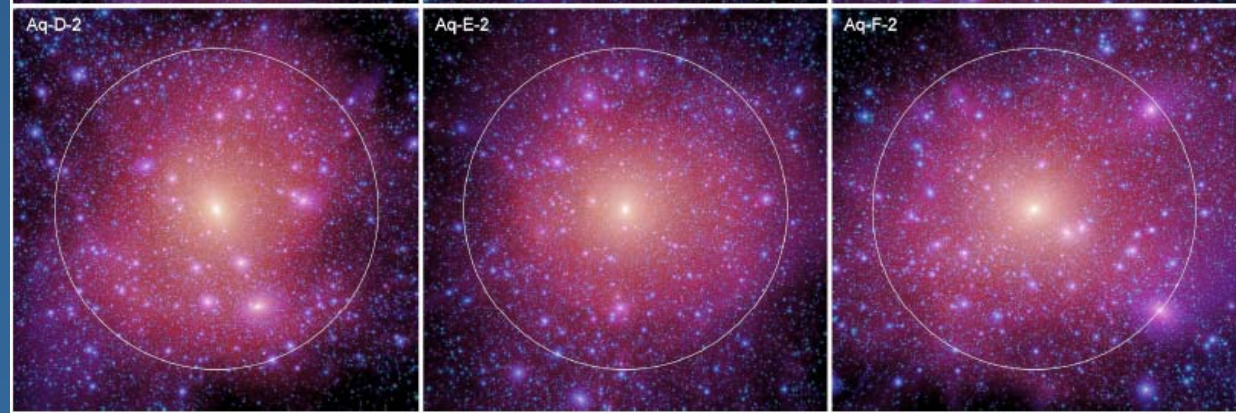
- Set of very high-resolution simulations of a MW-like dark matter halo



Aquarius A:
- 5 different resolutions
- Ideal for convergence tests

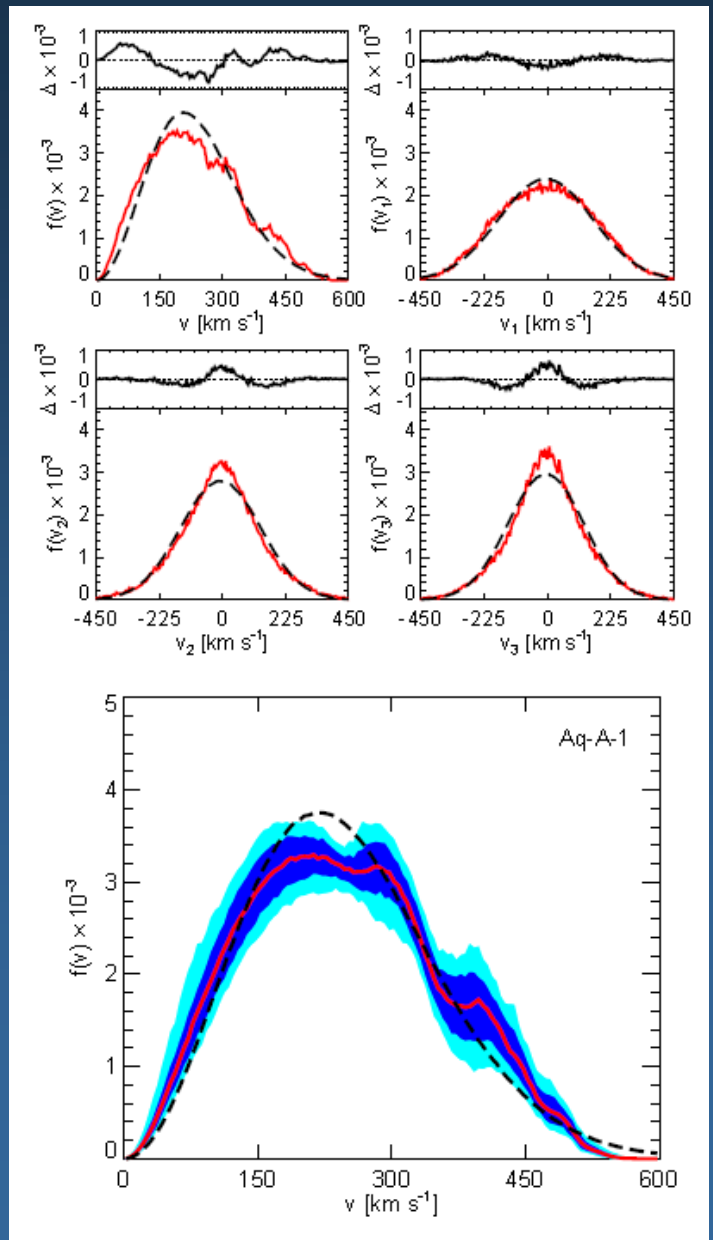


Aquarius B-F:
- 6 different dark halos
- Individual formation histories
- Test scatter in properties



Velocity distribution near the "Sun"

- Velocity distribution of particles in small volumes on the "solar circle"
  - No v-component follows a Gaussian
  - Distribution of the modulus of velocity
    - Does not correspond to Gaussian
    - shows bumps
  - Bumps are visible in all volumes (at the same velocity value) and in all experiments



Vogelsberger, AH et al (2009)

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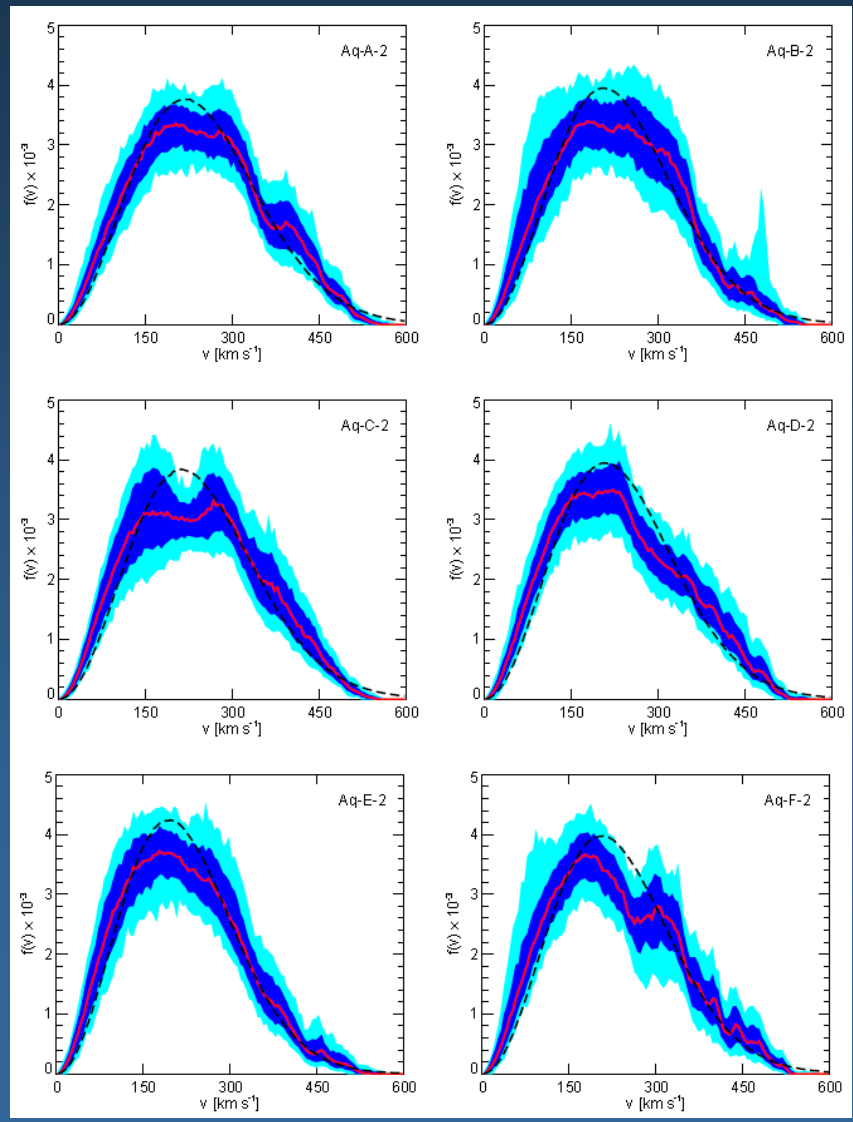

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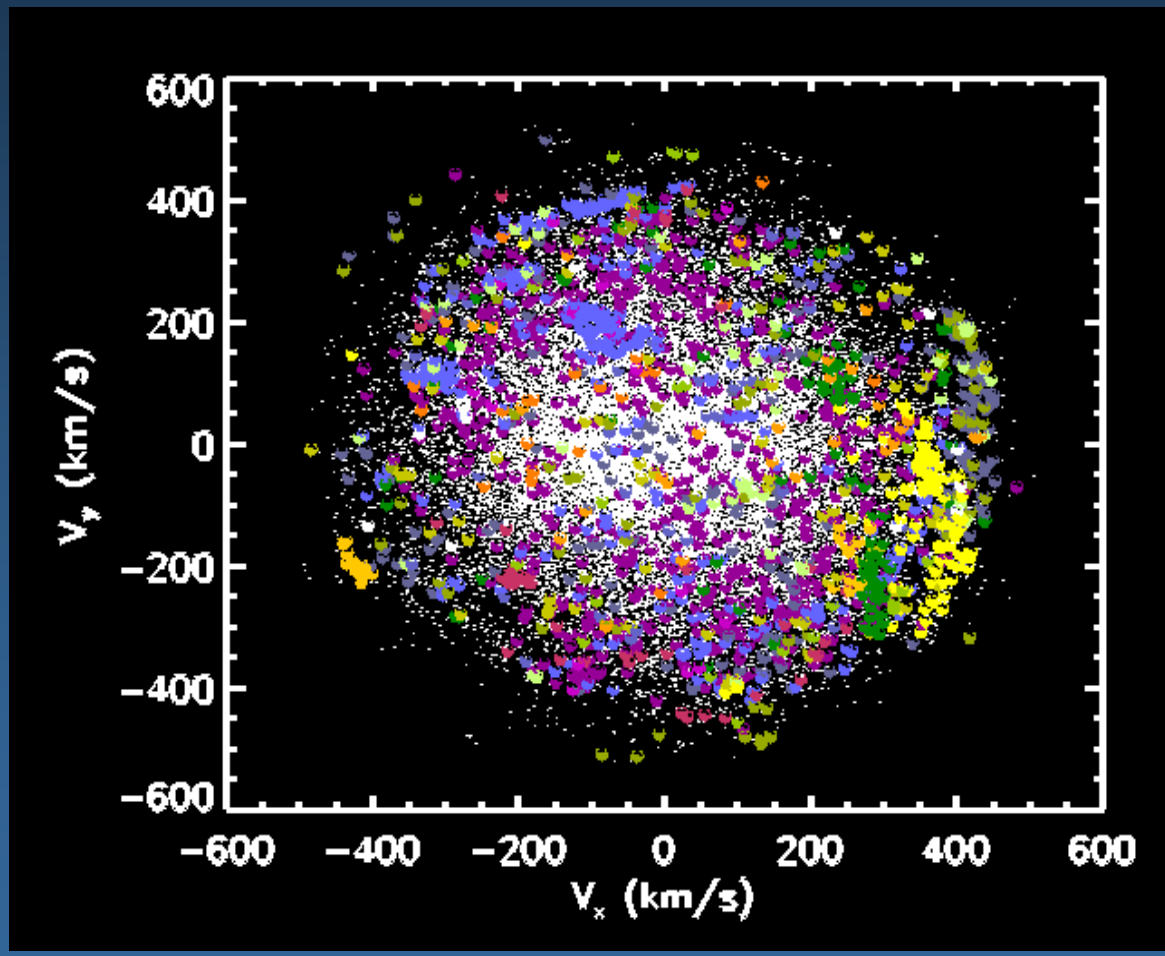
Aquarius: dark matter near the Sun

- Streams from past mergers clearly resolved the first time near Sun
- No massive (dominant) streams near the "Sun"
- $4x10^4$ particles in volume
  - 27 halos contribute at least 10 particles (0.025% of the total)
  - Most prominent streams have ~ 100 particles (0.25% of the total)



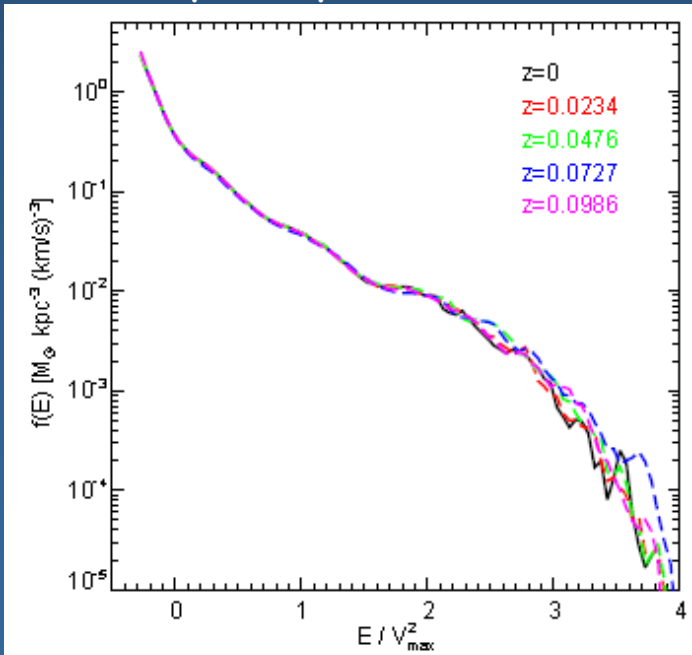
Vogelsberger, AH et al. 2009

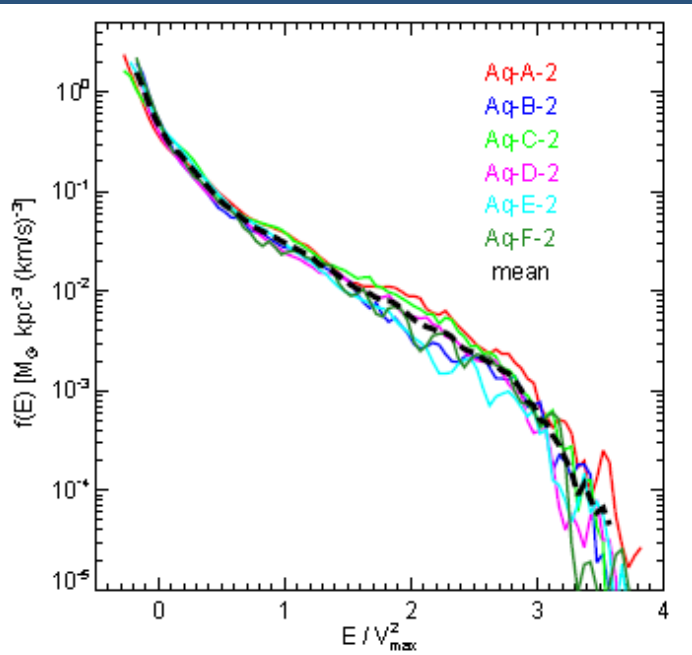
Phase-space distribution f(E)

- Bumps in f(v) must be present also in energy space:

  $E = \frac{1}{2} v^2 + \mathrm{Phi}(r)$

- f(E) shows wiggles
  - in all resolutions for Aq-A (in the same location-> convergence)
  - all experiments (must be related to different histories)
  - Even for the highest binding energies (typically associated to material accreted very early on)

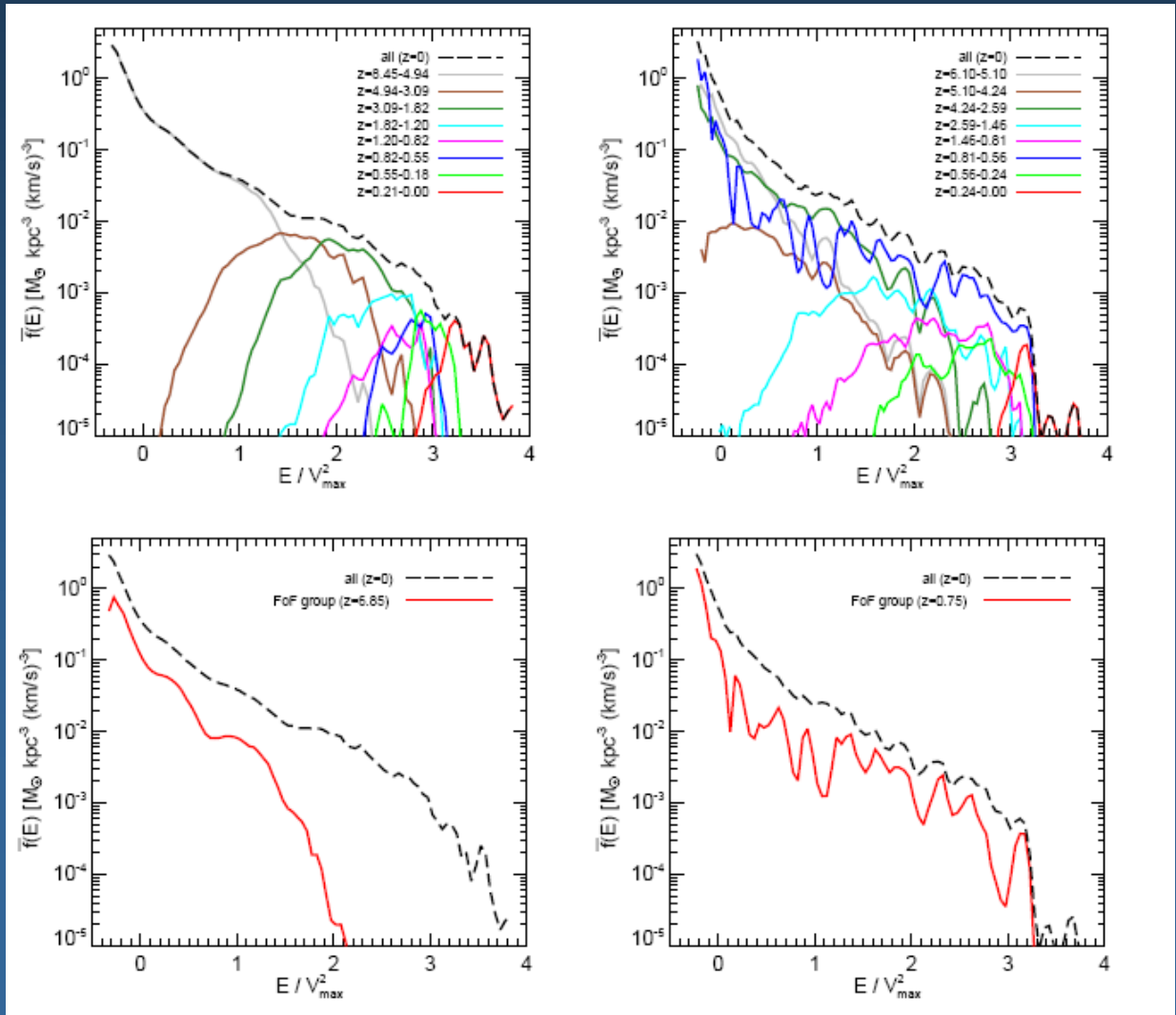




Vogelsberger, AH et al (2009)

Phase-space distribution f(E)

- Wiggles can be linked to mergers
  - As early as z = 7 (> 12.5 Gyr ago)
- less wiggles -> quiescent history
- many wiggles -> recent major merger event
- If we could measure f(E) -> reconstruct history of dark halo!



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