Warm Dark Matter Cosmological Structures
-from Collapse to Caustics and Cores-

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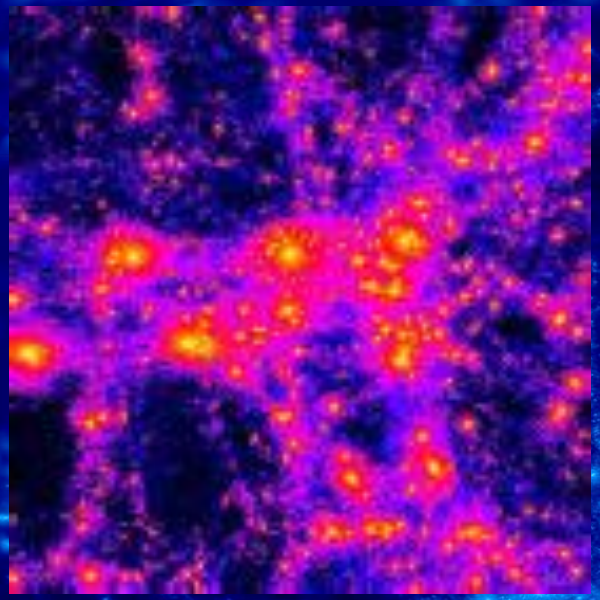
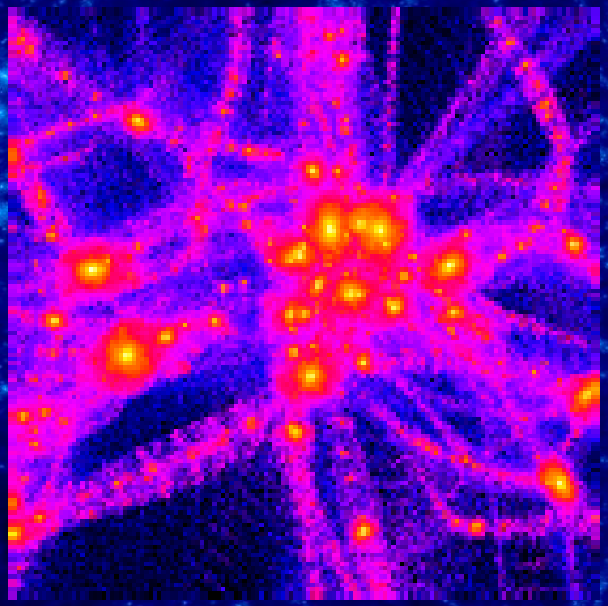
CDM vs WDM - Motivation

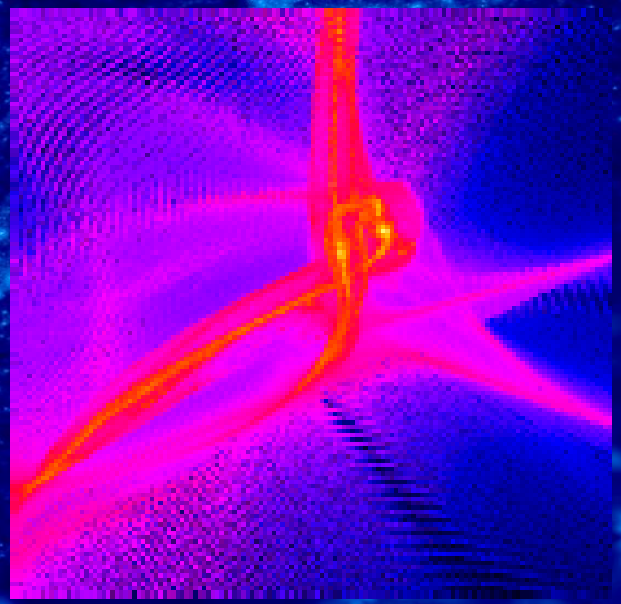
- ΛCDM fails to explain observed properties of galaxies
- Missing Satellites Problem
- Cores vs Cusps
- Mergers vs No Mergers
- Pure Disk Galaxies
- Where is the WIMP?



CDM



WDM – 200 eV



HDM – 50 eV

Label	velocities z_i km/s	cutoff eV	box size Mpc/h	N	softening pc
CDM	no	-	40	300^3	50
WDM1	no	200	40	300^3	50
WDM2	36.6	200	40	300^3	50
WDM3	no	1000	40	300^3	50
WDM4	4.2	1000	40	300^3	50
WDM5	36.6	200	30	256^3	100

Simulations details: 2.72x10^5 M_o / particle
355 pc spline gravitational softening
WMAP7 cosmological parameters
z=100 initial redshift

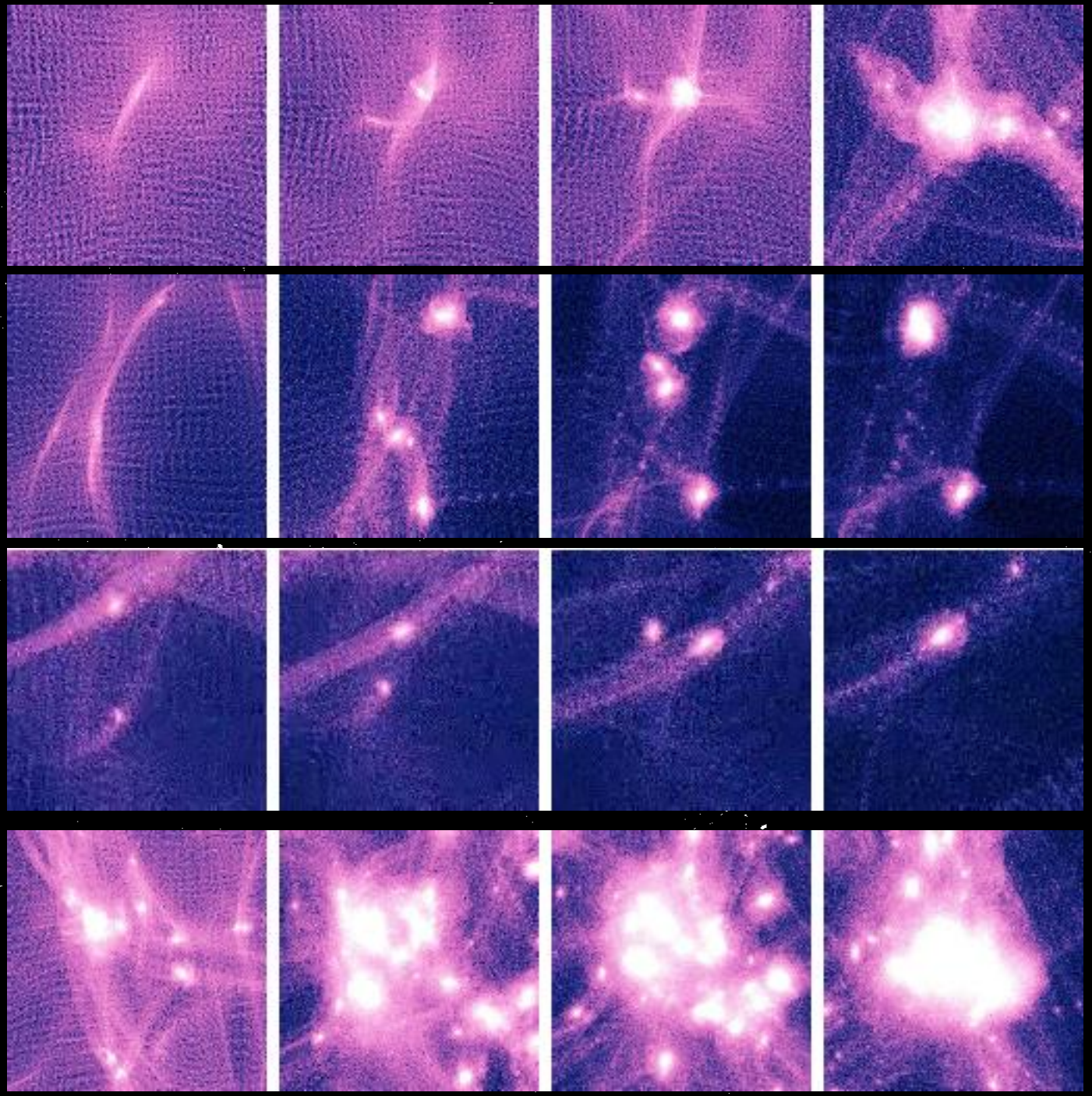
Mass	Bode et al. $v_0 \times 3.571$	Pierpaoli et al.	Paduroiu et al.	Boyarsky et al. TR	Boyarsky et al. NRP
keV/c^2	km/s	km/s	km/s	km/s	km/s
0.2	0.366	0.4032	1.113	0.29	0.785
1.0	0.0429	0.0225	0.223	0.034	0.157
3.5	0.00806	0.0230	0.0636	0.0064	0.00448

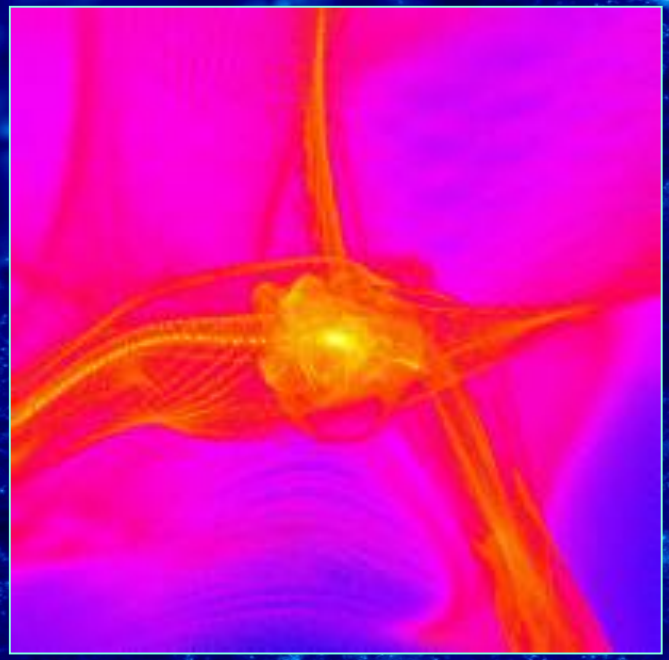
Movies on youtube

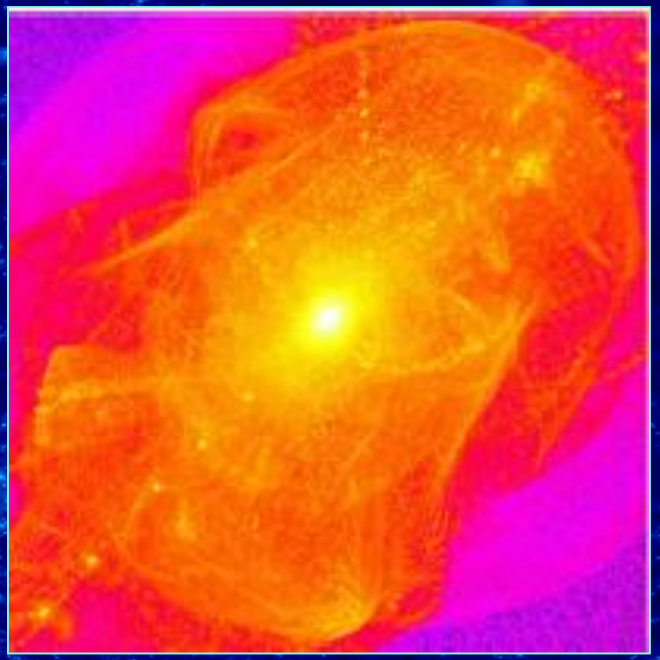
(simply search ‘warm dark matter’)

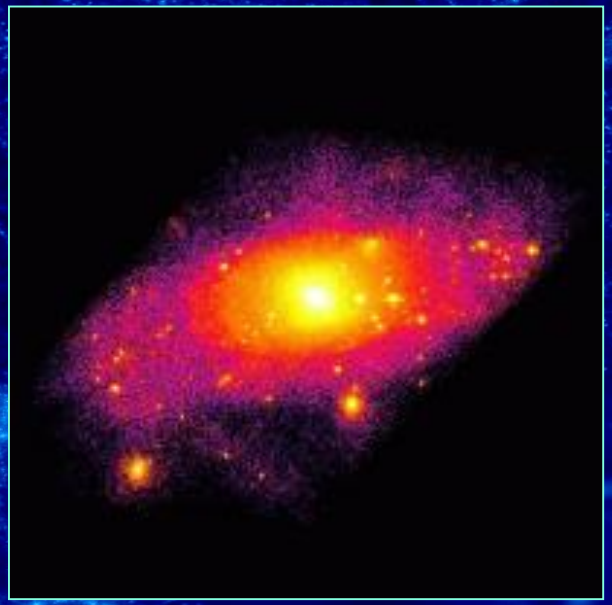
https://www.youtube.com/playlist?list=PLnGS4wkStJ1aqi3M9hTDaUzuZ-vs-Qg6i

or on demand ...









CONCLUSIONS and COMPLICATIONS

- Formation of haloes in WDM models differs from CDM.
  Hybrid mechanism - Top-Down & Hierarchical; long distance & nearest neighbours
  Looking at high redshift galaxies for T-D memory.

- The exact recipe for structure formation seems to depend only on the morphology and architecture of the environment.
  ☼ Quantum Pressure; Baryons and their physics

- Warm dark matter haloes contain visible caustics and shells.

- The finite initial fine grained PSD is also a maximum of coarse grained PSD..
  The turn over in PSD results in constant density core with characteristic size.

- Velocity dispersion is crucial when describing warm dark matter particles!
  There is no one to one correspondence between mass and thermal velocity.
  Thus, the constraints on the particle mass from simulations are weak.

- Spurious fragmentation below the free streaming scale hard to overcome – in case of infinite resolution a filament collapses into a two dimensional line
  $$ Adaptive softening?