Dark Matter Accretion into Supermassive Black Holes

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Physical Review, 2008

INTRODUCTION AND MODEL

- An analytic approach to solve for the accretion rate of dark matter into black holes located in the centre of galaxies and their halos.
- The accretion model is described by a relativistic steady spherically symmetric inflow of dark matter into the black hole
- The assumption for this model is that the phase space indicator $Q = \rho/\sigma^3$ remains constant during the inflow
- The above hypothesis is equivalent to saying that the inflow is adiabatic – since entropy density satisfies

  $s \infty - \log Q$

FINDINGS

- The critical radius is found to be always outside the black hole horizon (for typical host halos, critical radius is 30-150 times the horizon radius).
- The flow radial velocity at the critical point is of the order of a few percent of the speed of light.
- After crossing the critical point, numerical solutions of the equations describing the flow show that the velocity and density have power law profiles:

$$u \propto 1/r^{0.6} \qquad \rho \propto 1/r^{1.4}$$

NUMERICAL SOLUTION TO ACCRETION RATE

- The black hole accretion rate is given by:

$$\frac{dM_{\rm bh}}{dt} = \frac{27\pi}{\sqrt{125}}(GM_{\rm bh})^2 Q$$

- here, the dark matter phase space indicator, $Q = \rho_\infty/\sigma_\infty{}^3$, where ρ_∞ is the dark matter density far away from the black hole, where the flow velocity is negligible; σ_∞ is the velocity dispersion of the dark matter particles.

- The rate given above is higher by about five orders than the accretion rate for black holes hosted by typical dark halos, where we deal with non-relativistic and non-interacting particles.

NUMERICAL APPLICATIONS

- Numerical applications of the derived formula were made by computing the growth of black holes inside halos issued from cosmological simulations.
- Final mass of Halo 211 is $7.46 \times 10^{11} M_{Solar}$ and of Halo 3 it is $8.06 \times 10^{12} M_{Solar}$

Dark matter contributes not more than 10% of the total accreted mass

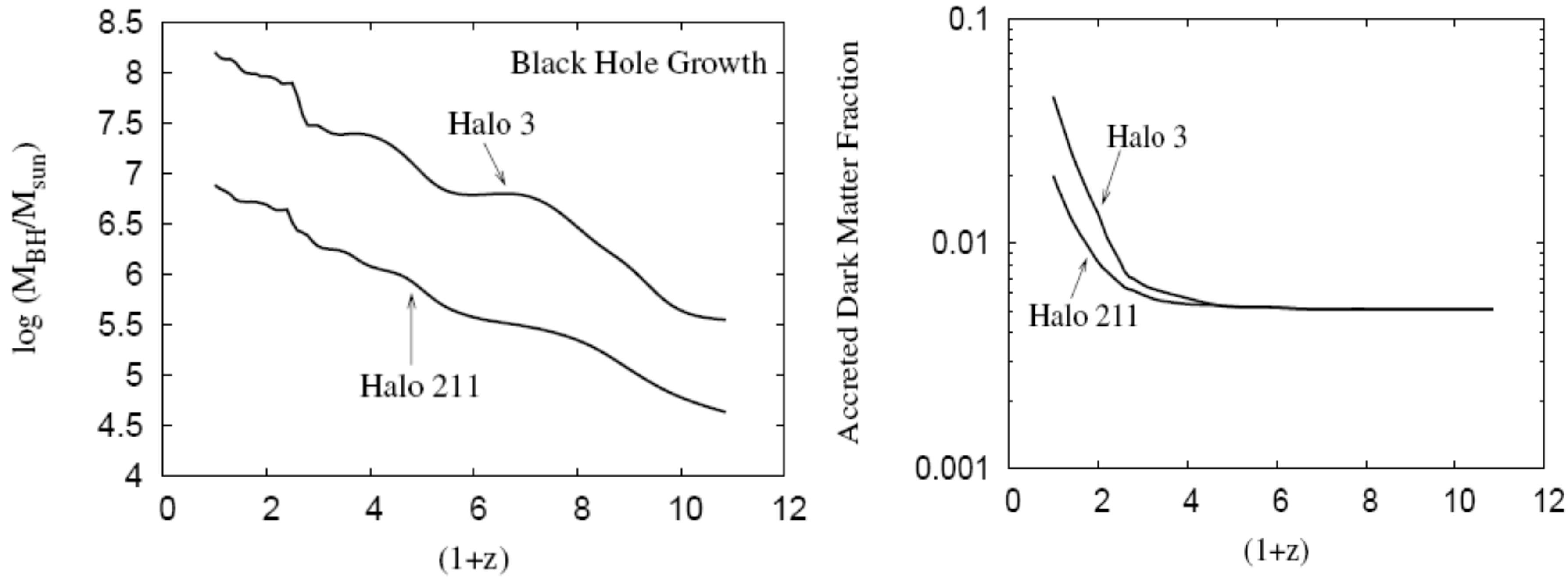
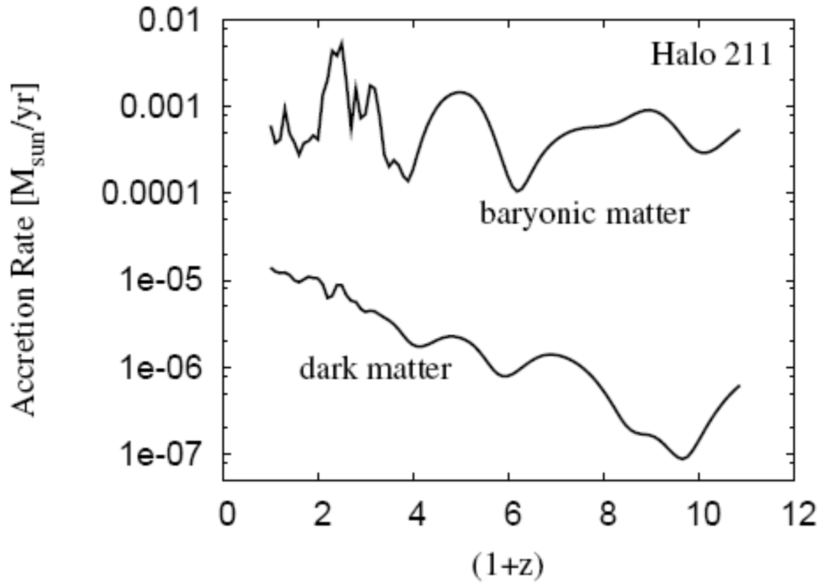
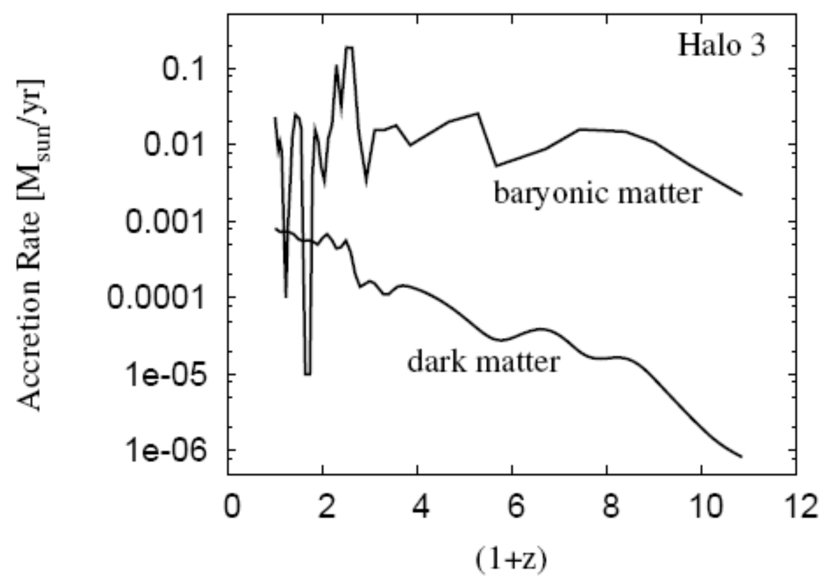


Fig: Left panel shows the mass evolution of black holes. Right panel shows the evolution of fraction of accreted dark matter.

BARYONIC AND DARK MATTER ACCRETION RATES COMPARED





- Different peaks in baryonic accretion rate are associated with major or minor mergers. Max. rate occurs at z = 1.5
- Baryonic accretion rate will probably be reduced by a factor of 2-6 if star formation process is included, based on detailed cosmological simulations.