Dark Matter Capture and Annihilation on the First Stars: Preliminary Results

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Wimps on Fire

- Neutralinos annihilate in the stars core and add to energy output of the star.
- Stars treated as being formed classically without the dark matter stalling the collapse of the gas cloud.

Dark Matter Burners

- Only achieved today near galactic centers because the density of dark matter is the greatest.

- Not a lot of stars though...

The Young Ones

- Primordial Universe is a bit different...
- Primordial star at the center on the galaxy is formed with population III stars w/ little to no metals and masses on the order of 50-300 Solar Masses.

And the survey says...

- Simulations show 10 solar masses of dark matter in primordial stars with a radius of 10^15 cm.
- Primordial galaxies have 10^6 solar mass halos according to Turk's cosmology.

Uniformity

- Capture rates of 75-100 Solar mass population III stars differ less that an order of magnitude.
- Radii of both 75 and 100 solar mass stars are roughly the same during the helium burning stage (~100 solar radii).

Simulation Values

$M_*(M_\odot)$	L_χ(erg/s)	r_χ(cm)	R_*(cm)	L_χ/L_*^{ZAMS}
50	4×10^{40}	2×10^{9}	2×10^{11}	25
70	7×10^{40}	3×10^{9}	2×10^{11}	22
100	1×10^{41}	4×10^{9}	3×10^{11}	21
200	3×10^{41}	5×10^{9}	4×10^{11}	20
300	5×10^{41}	5×10^{9}	5×10^{11}	21
500	1×10^{42}	6×10^{9}	7×10^{11}	23
600	2×10^{42}	6×10^{9}	8×10^{11}	24

TABLE 3
SAME AS IN TABLE 1, FOR ZAMS METAL–FREE STARS.

A_n	L_χ(erg/s)	τ_χ(s)	r_χ(cm)	n_χ^c(GeV/cm^3)	ϵ_χ(erg/s/cm^3)
1	10^{40}	10^{7}	10^{10}	10^{18}	10^{3}
4	10^{38}	10^{8}	10^{9}	10^{17}	-10^{2}
1	10^{38}	10^{10}	10^{11}	10^{16}	1

TABLE 1
VALUES FOR A 75 $M_\odot$, INITIAL METALLICITY $Z=10^{-4}$, IN A NEUTRALINO CASE WITH m_χ=100GEV. $\mathcal{D}=10^{-32}(/10^{-37})$GEV S/CM^2 FOR THE SPIN DEPENDENT(/INDEPENDENT) CASE. LAST LINE REFERS TO THE H SHELL DURING HELIUM BURNING.

Discussion

- Dark matter luminosity may start before fusion.
- Dark matter may stabilize population III stars in late stages.
- Nucleosynthesis...