

RELATIVELY DARK MATTER: THE LOCAL MASS DENSITY OF STELLAR REMNANTS

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The Palomar-Green Survey produced statistically complete samples of hot white dwarfs and subdwarfs, from which the local mass density of these objects can be determined. The luminosity function of hot hydrogen-atmosphere white dwarfs (DA's) was recently re-determined by Fleming, Liebert, and Green (1985, Ap. J., submitted). The contribution of each of the 353 objects to the local space density was calculated from the ensemble of limiting magnitudes and a spectroscopically or photometrically derived absolute magnitude. The local surface density of white dwarfs with $M_V < 12.75$ ($\log L/L_\odot > -3.1$; $T_E > 9000$ K) is $0.32 \pm 0.03 \text{ pc}^{-2}$. Assuming an exponential disk with scale height 250 pc, we derive the differential luminosity function in the figure; the total volume density is 0.65 ± 0.06 per 1000 pc^3 . He atmosphere degenerates add another 20%.

The cooling time to this limiting luminosity is modeled to be $\sim 1.2 \times 10^9$ yrs. In $\sim 1 \times 10^{10}$ yrs, degenerates can cool to $\log L/L_\odot < -4.5$, $\log T_E < 4000$ K. At this limit, there is an apparent deficit of cool degenerates detected. Assuming a constant local birthrate over this entire time interval leads to a total density for all degenerates of 6.5 per 1000 pc^3 or 3.2 pc^{-2} . With $0.6 M_\odot$ per degenerate core, the mass density is $3.9 M_\odot$ per 1000 pc^3 or $1.9 M_\odot \text{ pc}^{-2}$. This value is 2.2% of the Oort limit of $0.18 M_\odot \text{ pc}^{-3}$, an insignificant contributor. Halo degenerates contribute $\sim 1\%$ of the local density.

Do hot subdwarfs add significantly to the mass density? It can be seen from the figure that hydrogen atmosphere subdwarfs (sdB's) exceed the white dwarfs in cumulative counts by almost a factor of two. Their volume density is estimated by assuming that the coolest ones make the largest density contribution, and adopting for them $M_V = +5.2$. Using Downes' galactic plane survey objects and the PG galactic pole objects, we find $Z_0 = 300$ pc to match $\rho \sim 2 \times 10^{-6} \text{ pc}^{-3}$. Although an order of magnitude higher than previous estimates, this value represents only 0.3% of the white dwarf mass density.

