Erratum: Observational constraints on supermassive dark stars

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Key words: errata, addenda – stars: Population III – dark ages, reionization, first stars – dark matter.

The corrected halo formation rate is presented as a function of redshift. The raw simulation data are represented by the thin line, whereas the thick line traces a second-degree polynomial fitted to the data.

Figure 1. The corrected formation rate of $1-2 \times 10^8 M_\odot$ haloes per comoving Mpc$^3$ and year, as a function of redshift. The raw simulation data are by Erik Zackrisson,\* Pat Scott, Claes-Erik Rydberg, Fabio Iocco, Sofia Sivertsson, Göran Östlin, Garrelt Mellema, Ilian T. Iliev and Paul R. Shapiro

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Figure 1. The corrected formation rate of $1-2 \times 10^8 M_\odot$ haloes per comoving Mpc$^3$ and year, as a function of redshift. The raw simulation data are represented by the thin line, whereas the thick line traces a second-degree polynomial fitted to the data.

Figure 2. Corrected upper limits on the fraction $f_{\text{SMDS}}$ of $1-2 \times 10^8 M_\odot$ dark matter haloes that form $T_{\text{eff}} = 27,000$ K (solid line) and $T_{\text{eff}} = 51,000$ K (dashed line) $10^{7} M_\odot$ dark stars at $z \approx 10$ (i.e. scenario A), as a function of their lifetimes $\tau$.

epochs). For instance, $\log_{10} f_{\text{SMDS}} \lesssim -3.2 (-2.5)$ if $\tau \sim 10^7$ yr and $\log_{10} f_{\text{SMDS}} \lesssim -2.2 (-1.5)$ if $\tau \sim 10^6$ yr for the $T_{\text{eff}} = 27,000 (51,000)$ K SMDS from Freese et al. (2010). These upper limits are a factor of 10 weaker than those originally reported.

In scenario B, where $f_{\text{SMDS}}$ is assumed to be effectively zero at $z = 10$, current observational data can be used to set upper limits on $f_{\text{SMDS}}$ at $z = 15$ (the formation redshift assumed by Freese et al. 2010), provided that the SMDS forming at $z = 15$ have sufficiently long lifetimes to survive until $z = 10$. In the adopted cosmology, this requires $\tau > 2.1 \times 10^6$ yr. For SMDS that obey this age criterion, the constraints relax to $\log_{10} f_{\text{SMDS}} \lesssim -2.9 (-2.2)$ for the $T_{\text{eff}} = 27,000 (51,000)$ K, $10^7 M_\odot$ SMDS. These upper limits are a factor of 30 weaker than those originally reported.

Despite these revisions, our discussion concerning the prospects of detecting SMDS with the James Webb Space Telescope (JWST) remain unimpeded. Given the corrected halo formation rates, a single JWST detection of an $\sim 10^7 M_\odot$ SMDS at $z = 15$ would suggest $\log_{10} f_{\text{SMDS}} \approx -1.8$ if $\tau \sim 10^6$ yr. However, this combination of $f_{\text{SMDS}}$ and $\tau$ is still ruled out at $z = 10$ (Fig. 2). Hence, if $f_{\text{SMDS}}$ and $\tau$ are approximately the same at $z = 15$ and 10, our constraints predict that no $10^7 M_\odot$ SMDS will be detectable within a single JWST field at $z = 15$. Of course, JWST observations would still be

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highly relevant for dark stars at lower masses, and for scenarios in which $f_{\text{SMDX}}$ evolves strongly with redshift.

A corrected version of the Letter has been posted on arXiv.

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REFERENCES


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