BACKGROUND LIGHT FROM POPULATION III STARS

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It has been proposed (e.g. Carr,Bond and Arnett 1984) that the first generation of stars may have been Very Massive Objects (VMOs, of mass above 200 $M_\odot$) which existed at large redshifts and left a large fraction of the mass of the universe in black hole remnants which now provide the dynamical 'dark matter'. The radiation from these stars would be present today as extragalactic background light. For stars with density parameter Ω_* which convert a fraction ϵ of their rest-mass to radiation at a redshift of z, the energy density of background radiation in units of the critical density is $\Omega_R = \epsilon\Omega_* /(1+z)$. The VMOs would be far-ultraviolet sources with effective temperatures of 10^5 K. If the radiation is not absorbed, the constraints provided by measurements of background radiation imply (for H =50 km/s/Mpc) that the stars cannot close the universe unless they formed at a redshift of 40 or more. To provide the dark matter (of one-tenth closure density) the optical limits imply that they must have existed at redshifts above 25.

There are several opacity sources which could redistribute the background radiation energy to longer wavelengths. If the stars are surrounded by dense clouds of hydrogen ($n>10^4$ cm^{-3}) the ionizing continuum could be reemitted as recombination radiation. In this case the Lyman-alpha flux could produce a near infra-red background whose spectrum would depend sensitively on the redshift range of VMO formation (Carr, McDowell and Sato 1983). If this absorption does not occur, such stars would ionize any intergalactic medium and the major remaining opacity source would be dust.

Intergalactic dust, if it existed at high redshift, could degrade the radiation into a distortion to the microwave background, or produce a separate far-infrared background. I have calculated the expected background with a code which models evolution of the background spectrum and the dust temperature in the expanding universe. The IRAS limits provide a good constraint if the far-IR background is well separated from the microwave background, true for heating at low redshift ($z\lesssim 5$); for higher redshift dust emission the limits are much weaker and cannot exclude $\Omega_*=0.1$. If intergalactic dust formed well after the VMOs, for instance in a model where galaxy formation occurs at redshifts of about 3, dust absorption is only significant if the amount of dust is within a factor of a few of the maximum amount allowed by measurements of quasar reddening.

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