PROBING THE BARYON DENSITY OF THE UNIVERSE

USING LIGHT ECHOES OF HIGH REDSHIFT RADIO SOURCES

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Abstract. It is shown that the high redshift intergalactic gas that probably contains most of the baryonic density $\Omega_b = 0.05(H_0 = 75\text{km}\text{s}^{-1}\text{Mpc}^{-1})$ in the standard Cold Dark Matter model can be detected through "true" intergalactic Thompson-scattered halos or light echoes around isotropic radio-loud quasars and radio galaxies. These cosmological halos, which form in the uniform ionized medium around "old" non-evolving sources, have a very large degree of polarization, up to $p_{\text{max}} \approx 94$ percent at a projected distance half the light-age radius, and a plateau in the annular polarized flux density within $\leq 1/3$ of the light-age radius, which is about 4 arc min for sources older than $10^7$ years at $z \approx 4$. The optimal wavelength range for halo polarimetric observations is 20 – 30 cm, depending on the Galactic rotation measure in the direction of the source, the spectral index of the source, and the specific maximized parameter of the halo. If observed with large single-dish radiotelescopes, the 21 cm polarized brightness temperatures of some inner halos, for example the halo around the quasar OQ 172 ($S_{1400} = 2.5$ Jy, $z = 3.33$), are of the same order of magnitude as the current total-intensity limits for cosmic background fluctuations on arc min scales. The halos can be extended to larger volumes of space by co-adding of source-normalized halos around the much more numerous isotropic radio galaxies. The expected ensemble-averaged profile of the polarized flux density around the symmetry center is calculated by integrating over the halo ages, assuming a uniform source-age distribution. In addition to the electron density or a lower limit for $\Omega_b$ based on the halo brightness, the characteristic life time of the radio emission can be derived based on its angular size. If there is a moderate deviation of the density evolution of the intergalactic gas from the conservative cubic law due to galaxy formation, high redshift radio halos may be on the rising branch of their brightness beyond its minimum, similar to the well known nonmonotonic behaviour of angular sizes.