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Intensity Mapping of the [CII] Fine Structure Line during the Epoch of Reionization

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The atomic CII fine-structure line is one of the brightest lines in a typical star-forming galaxy spectrum with a luminosity ~ 0.1% to 1% of the bolometric luminosity. It is potentially a reliable tracer of the dense gas distribution at high redshifts and could provide an additional probe to the era of reionization. By taking into account of the spontaneous, stimulated and collisional emission of the CII line, we calculate the spin temperature and the mean intensity as a function of the redshift. When averaged over a cosmologically large volume, we find that the CII emission from ionized carbon in individual galaxies is larger than the signal generated by carbon in the intergalactic medium (IGM). Assuming that the CII luminosity is proportional to the carbon mass in dark matter halos, we also compute the power spectrum of the CII line intensity at various redshifts. In order to avoid the contamination from CO rotational lines at low redshift when targeting a CII survey at high redshifts, we propose the cross-correlation of CII and 21-cm line emission from high redshifts. To explore the detectability of the CII signal from reionization, we also evaluate the expected errors on the CII power spectrum and CII-21 cm cross power spectrum based on the design of the future milimeter surveys. We note that the CII-21 cm cross power spectrum contains interesting features that captures physics during reionization, including the ionized bubble sizes and the mean ionization fraction, which are challenging to measure from 21-cm data alone. We propose an instrumental concept for the reionization CII experiment targeting the frequency range of $\sim$ 200 to 300 GHz with 1, 3 and 10 meter apertures and a bolometric spectrometer array with 64 independent spectral pixels with about 20,000 bolometers.

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