Abstract

Images of dust continuum and CO line emission are powerful tools for deducing structural characteristics of galaxies such as disk sizes, H2 gas velocity fields, and enclosed H2 and dynamical masses. We report on a fundamental constraint set by the Cosmic Microwave Background (CMB) on the observed structural and dynamical characteristics of galaxies as deduced from dust continuum and CO line imaging at high redshifts. As the CMB temperature rises in the distant Universe, the ensuing thermal equilibrium between the CMB and the cold dust and H2 gas progressively erases all spatial and spectral contrasts between their brightness distributions and the CMB. This strongly biases the recoverable H2 gas and dust mass distributions, scale lengths, gas velocity fields, and the dynamical mass estimates, for high redshift galaxies. This limitation is unique to mm/submm wavelengths, and unlike its known effect on the global dust continuum and molecular line emission of galaxies, it cannot be simply addressed. We nevertheless identify a unique signature of CMB affected continuum and line brightness distributions, namely a rising rather than diminishing contrast between such brightness distributions and the CMB once frequencies beyond the Raleigh-Jeans limit are used for imaging the cold molecular gas and dust in distant galaxies. Such effects progressively change the apparent gas and dust distribution and velocity field, leading to biased size and mass estimates of high-redshift galaxies, which will be obtained with ALMA, JVLA, and SKA.