Study of the Physical Properties of Interstellar Dust with the Frequency Dependence of the Degree of Polarization in Millimeter Wave Bands

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Detection of B-mode polarization signals imprinted in the cosmic microwave background (CMB) originated from primordial gravitational waves is the smoking gun signature of the inflation theory. A lot of efforts have been carried out to detect the signal. Since the wanted signals are buried under the Galactic dust emission, the success is controlled by how accurately one can separate the dust emission and the CMB. Further, high precision millimeter and sub-millimeter waves wide field polarization maps obtained by up coming CMB polarization experiments provide unique opportunity to study the physical properties of the interstellar dust. Therefore, it is important to clarify how the spectral properties of intensity and polarization emission from the interstellar dust are linked to the physical properties of the interstellar dust. In this study, we focus on how the frequency dependence of the degree of polarization depends on the physical properties of the dust and what we can study on them by using the available data.

We showed the degree of polarization of ellipsoid dust depends only on the real part of the complex permittivity in the millimeter wave range. On the other hand, the emissivity depends on both real and imaginary part. Therefore, these results indicate that observing the frequency dependence of the degree of polarization and intensity provides that of complex permittivity. For the various physical properties of amorphous dusts, the frequency dependence of absorption efficiencies and the degree of polarization in the millimeter waveband are demonstrated. Observational constraints on the frequency dependence of the degree of the polarization in millimeter wavebands by fitting the available data are going to be reported. Based on these results, physical properties of the interstellar dusts are going to be discussed.