Toward Structural Constraints on Interstellar Amorphous Dust Based on Dielectric Properties

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Observations support that most of the large dust grains in interstellar space are composed of amorphous material. Interstellar dust emission models based on the two-level systems (TLS) model [1, 2] and its extended model, the soft potential (SP) model [3, 4], which are physically motivated by explaining the low-temperature thermal properties of amorphous materials, are considered promising for reproducing the characteristics of observations in the infrared to microwave wavelength ranges [5, 6, 7, 8, 9]. However, the specific structure and composition of amorphous dust that satisfy the dielectric properties expected from these models are unclear yet.

In this study, we aim to estimate the dielectric constant of interstellar amorphous dust using molecular dynamics simulations and impose constraints on the dust structure based on observationally constrained dielectric properties. We adopt a double-well potential for intermolecular interactions, which is assumed in the TLS and SP models. In simplified atomic systems, we then analyse the relationship between dust structure and macroscopic dielectric response. This study focuses on methodological aspects and qualitatively demonstrates the relationship between dielectric constant and structure through calculations in a system with significantly fewer atoms than large dust grains. In this presentation, we are going to introduce the characteristics of amorphous structures obtained in a double-well potential system and the trends in dielectric constants derived from them. By comparing these calculations with constraints on dielectric constants obtained from observations, we are going to discuss the limitations imposed on the microscopic structure of interstellar amorphous dust.

This study is expected to provide theoretical clues for elucidating the properties of amorphous interstellar dust.

References

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