Submillimeter excess emission from very small dust grains as a cause of Galactic dust spectral flattening

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Observations of the Galactic dust emission spectrum have revealed a flattening at far-infrared to millimeter (mm) wavelengths [1], deviating from what is expected from an ideal crystalline grain. Although several models have been proposed to explain this spectral flattening (e.g., emission from the very cold dust, magnetic nanoparticles, and amorphous dust), the underlying cause remains unresolved.

We propose that the sub-mm excess emission from very small dust grains (VSGs), predicted based on our new emission model [2], is responsible for the observed spectral flattening. In this emission model, we treat VSGs as mesoscopic systems — an intermediate scale between microscopic and macroscopic with unique physical properties. In such systems, the quantization of vibrational energy levels results in a minimum excitation energy equivalent to ~50 K, meaning that the thermal properties of VSGs can no longer be described by lattice vibrations below ~50 K. To address this, we applied a method of energy level statistics [3] to describe the low-temperature thermal properties of VSGs in terms of free electrons. This model enhances the emission from low-temperature carbonaceous VSGs, which possess free electrons, resulting in an excess emission in the sub-mm wavelengths.

To test our hypothesis, we derive dust size distributions that include both carbonaceous and silicate grains and are consistent with observed extinction and emission spectra by varying the carbonaceous dust constituents. Using these size distributions, we calculate the expected emission spectra under our new VSG model and compare them to observational data.

In this presentation, we will discuss whether the sub-mm excess emission predicted by the carbonaceous VSG model can account for the observed spectral flattening and evaluate how well it improves the fit compared to conventional models.

References

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[3] Kubo, R., *J. Phys. Soc. Jpn*., 17.6.