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The effect of the porosity of dust aggregates on the 10-micron silicate feature

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Recent theoretical studies have predicted the presence of highly porous dust aggregates in protoplanetary disks. In order to verify this prediction by astronomical observations, it is important to investigate optical properties of the aggregates.

Observationally, a prominent silicate feature appears around $\lambda \sim 10$ μm. Its strength, peak wavelength and profile are used as a diagnosing tool of the size, composition and crystallinity of dust grains. We study how the porosity of dust aggregates affects on the structure of 10 μm silicate feature. We calculated optical properties of dust aggregates using the T-Matrix Method that is one of most rigorous method. Our results show that the strength of the feature increases with the porosity. We also find that the feature of highly porous aggregates does not broaden with increasing aggregate size, which is contrast to that of compact spheres. This can be interpreted as follows. The broadening of the feature is caused by a large refractive index. Highly porous dust aggregates have effectively almost same optical constants as vacuums and therefore broadening does not occur. Next, we calculate the feature profile by taking into account the size distribution of dust grains using the effective medium theory. We confirm that the feature of porous aggregates does not broaden even if the size distribution is taken into account. Our results suggest that the presence or non-presence of broadening of feature profile can be used as a diagnosing tool of porosity. For example, it can be verified by comparing the strength at the peak wavelength ($\sim$10 μm) and at a longer wavelength ($\sim$12 μm).

Keywords: protoplanetary disks, dust aggregates, optical properties