The properties of dust in protoplanetary disks as revealed by VLT/SPHERE observations

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The origin of planets begins with the initial steps of dust grain evolution in protoplanetary disks. These particles are the building blocks of planetary formation, but their capacity to coagulate, fragment, and grow depends heavily on their physical properties, which remain poorly understood. Better determining the size, shape, porosity, and composition of the grains is therefore a key step toward a better understanding of planet formation. The most promising approach is based on the analysis of scattered light images of disks, particularly through the scattering phase function. The recent rise of high-resolution disk observations led us to the development of DRAGyS, a new tool that provides a quick estimate of disk geometry and efficiently extracts the phase functions. Here, we report results from applying DRAGyS to a large sample of thirty VLT/SPHERE observations of protoplanetary disks.

We confirm that phase functions cluster into two distinct categories based on their shape and indicate different dust grain properties. The first category suggests porous fractal grains larger than a micron, while the second points to compact submicron-sized grains. These two distinct categories suggest that we observe different stages of the dust growth and planet formation process. However, the interpretation of dust properties within disks can become degenerate when analyzing a given disk. We demonstrate that the disk color obtained through multiwavelength analysis depends on the dust properties, especially the size of the monomers forming the aggregates. We show that combining the phase function with the color resolves this degeneracy and leads to a promising new method to characterize dust grains within protoplanetary disks and better understand the dust growth process during the early stages of planetary formation.

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