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Two Different Grain Distributions within the Protoplanetary Disk around HD 142527

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Abstract. The origin of polarized emission from protoplanetary disks is uncertain. Three mechanisms have been proposed for such polarized emission so far, (1) grain alignment with magnetic fields, (2) grain alignment with radiation gradients, and (3) self-scattering of thermal dust emission. Aiming to observationally identify the polarization mechanisms, we present ALMA polarization observations of the 0.87 mm dust continuum emission toward the circumstellar disk around HD 142527 with a spatial resolution of ~ 0.2 arcsec as shown in Ohashi *et al.* (2018). We confirm that the polarization vectors in the northern region are consistent with self-scattering because of a flip of the polarization vectors. Furthermore, we show that the polarization vectors in the southern region are consistent with grain alignment by magnetic fields, although self-scattering cannot be ruled out. To understand these differences between the polarization mechanisms, we propose a simple grain size segregation model: small dust grains ($\lesssim 100$ microns) are dominant and aligned with magnetic fields in the southern region, and middle-sized (~ 100 microns) grains in the upper layer emit self-scattered polarized emission in the northern region. The grain size near the middle plane in the northern region cannot be measured because the emission at 0.87 mm is optically thick. However, it can be speculated that larger dust grains ($\gtrsim$ cm) may accumulate near this plane. These results are consistent with those of a previous analysis of the disk, in which large grain accumulation and optically thick emission from the northern region were found. This model is also consistent with theories where smaller dust grains are aligned with magnetic fields. We find that the magnetic fields are toroidal, at least in the southern region.

Keywords. polarization, protoplanetary disks, HD 142527

Reference

Ohashi, S., Kataoka, A., Nagai, H., *et al.* 2018, *ApJ*, 864, 81