Magnetic Alignment of Forsterite Grains at Low Temperatures and Detection of Magnetic Field in Planetary Formation Regions

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Magnetic alignment of dust in interstellar regions has been detected by the polarization of starlight.1) Dust alignment in the circumstellar region has been observed recently which may be caused by the magnetic field. The circumstellar field is theoretically assumed to be an essential factor that controls stellar and planetary formation. The major components of circumstellar dusts are identified as silicate minerals such as forsterite and enstatite.2) It is necessary to clarify the efficiency of magnetic alignment of these minerals at circumstellar condition, in order to determine the structure of magnetic field from observed polarization data. The measurement of magnetic alignment of forsterite grains were carried out with liquid ethanol medium previously. Recently a new method for magnetic alignment with He gas medium was developed in order to detect the field intensity of magnetic alignment, Bs below the melting point of ethanol.3) Here we report the magnetic alignment of micron-sized forsterite and graphite achieved at temperatures down to T=80 K. The alignment proceeded by the balance between magnetic anisotropy energy induced in the crystal and the energy of Brownian motion. The field intensity of magnetic alignment, Bs is reduced by the decrease of temperature. The practicability of grain alignment by weak circumstellar field is discussed based on the measured Bs-T relastionship. The experiment of magnetic alignment at lower temperatures are required to evaluate the possibility of the magnetic alignment in planetary formation regions where the temperature is T=10 K. The application of the alignment to practical use may increase when the field intensity of magnetic alignment is reduced to a low level.4)

References 1) Davis L et al, ApJ 114 (1951) 206-240. 2) Molster FJ et al (2002) Astromineralogy, Springer, 121-170. 3) Uyeda C, et al, Astron Astrophys 400 (2003) 805-810. 4) Proc. 7th Symp. New Magneto-Sci., NIMS (2003)