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Effects of the temperature dependences and surface roughness of the asteroid 1999JU3 on the surface temperature mapping

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The observational program with thermal infrared imager to detect it's target asteroid 1999JU3 and the strategies to estimate the surface physical state with obtained data are now under constructed in Hayabusa 2 mission. It is necessary to clear and understand the mechanism to realize the observed space-resolved data of surface temperature. We consider the temperature dependence of surface material plays important role in surface temperature of airless small bodies, especially NEA asteroids which maximum and minimum temperature differ significantly. In addition to this, we are now investigating the effect of the surface roughness on surface temperature distribution of asteroids and comets. The beaming parameter which has close relationship with surface roughness is necessary for the explaining the ground based spatially-none-resolved surface brightness and temperature of asteroids. Recent DEEP-IMPACT or EPOXI missions have revealed that the shape model alone could not be enough to reproduce the observed surface temperature distributions but it would be possible with the help of the effect of surface roughness in some appropriate ways. The surface roughness would also generate the interactive heating effect through radiative energy exchanges between it's and adjacent surfaces.

We took six orbital elements into account to calculate the planetary position of the asteroid as well as the orientation of the spin axis so as to simulate the distance from the sun and the incident angle of solar energy into the surface. The shape of the numerical model is set to be spherical and subject to one dimensional heat conduction equation in none steady state. We have made the temperature mapping of the target asteroid to use this model. The distribution of thermal properties of heat conduction medium is constant toward inner direction, which has temperature dependencies except for the density. We applied the experimental result of temperature dependencies of lunar samples to this model. The numerical calculation showed that the difference of surface maximum temperature in one rotation near perihelion was about 10K between temperature dependent and none-dependent models. Thus we thought this effect would not be negligible to derive the thermal inertia of the asteroid with TIR instrument. We have now been performing the estimation of the effect of surface roughness on the surface temperature to construct some simple models. We will present the result of this effect on this meeting.

It is important to distinguish the geometric effects from the thermo physical effects to estimate the physical state of the planetary surface. This is not only indispensable with the determination of sampling rate of TIR thermal images but also practical in SCI impact experiments in terms of finding the locations of impacting center and the smashed debris.

Keywords: Hayabusa2, thermal infrared imager, thermal inertia, temperature dependence, roughness, equation of heat conduction