Thermal Modeling of the Binary Asteroid Didymos

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Introduction

Thermal imaging is a powerful measurement technique to characterize the physical surface of aerosols bodies. Recently, the analysis of thermal images from the Thermal infrared imager (TIR) on-board the Hayabusa spacecraft, revealed the highly porous nature of the C-type asteroid 162173 Ryugu [9]. The ongoing work to improve the model includes the modeling of surface roughness and crater...

Basic thermophysical model


Application to Didymos

We considered the same parameters as in the reference model document of Didymos from ESA [3]. Predictions from the extended thermophysical model are shown in Figure 1 on the 3D shape model of Didymos.

HERA predicted observations

To plan scientific observations using the TIR on the HERA spacecraft, the NASA/NAIF Space database is a useful tool. We propose to study the future observations of the HERA spacecraft images with the objective to prepare as much as possible the mission. The current study will also help the proximity operations of HERA. The simulated thermal maps of the Didymoon system and thermal properties are used to simulate the thermal fluxes produced by the impact of the DART spacecraft on-board HERA. A proximal view of the Didymoon system is shown in Figure 2.

Conclusion and further works

A thermophysical model for the secondary in the Didymos system has been developed to explore the possible surface temperatures. The case study performed covers the extreme thermal range of 30 – 2000 J.m-2.s-1/2 with different heliocentric distances. Compared to the previous work, mutual heating from the primary and the secondary’s self-heating are included in the model. In addition, the wind of debris is considered. A low temperature region (T<100K) can be expected at the north pole depending on the obliquity of the binary system. The effect of the surface temperature decrease between day and night can be more than 200K at 1 AU from Sun for a thermal inertia of 1000 J.K-1.m-2.s-1/2. This thermal temperature decrease decreases as the distance from the sun increases, reaching ~100 K at 1.9 AU.

The ongoing work to improve the model includes the modeling of surface roughness and cratered terrain.

A good thermophysical model for Didymos is needed for the design and operation planning of TIR instrument and for the data inversion. In addition, it provides the environmental conditions which are critical for survival of landers and their surface operations.

References


Figure 1 – Surface temperature on the ESA shape model of Didymos

Figure 2 – Distance, phase angle (Sun & Hera) and FOV of Didymos with respect to Hera. DCP3 and very close flyby

Figure 3 – Influence of the thermal inertia and heliocentric distance on the difference of temperatures

Figure 4 – Influence of the self heating for roughness surfaces

Figure 5 – Influence of the thermal inertia and heliocentric distance on the difference of temperatures

Figure 6 – FOV of Didymoon from Hera.