



ELSEVIER



CrossMark

Chinese Astronomy and Astrophysics 40 (2016) 555–568

CHINESE
ASTRONOMY
AND ASTROPHYSICS

Reflectance of Asteroid 4179 Toutatis Based on Its Space Optical Image[†] *

ZHAO Dong-fang¹ LIU Peng¹ ZHAO Wei^{1△} HUANG Chang-ning¹
ZHANG Hong-wei² TANG Xiang-long¹

¹*Pattern Recognition and Intelligence System Research Center, Harbin Institute of Technology, Harbin 150001*

²*Beijing Institute of Space Mechanics Electricity, China Academy of Space Technology, Beijing 100076*

Abstract On 13rd December 2012, the Chang'e-2 probe made a successful flyby of the asteroid 4179 Toutatis in deep space about 7 million kilometers away from the earth, and acquired a series of optical images with a high resolution better than 3 m. In this paper, we process the radiation calibration data of the imaging camera by the least squares fitting method, to obtain the relative calibration matrix and absolute calibration coefficients to correct the original asteroid images and calibration data, then to make inversion of the asteroid surface radiance at the imaging time. According to the Hapke's description about the application of the Nicodemus' definition of reflectance in the planetary science, the hemispherical albedo of Toutatis is obtained. The surface hemispherical albedos at the R, G, and B bands are 0.2083, 0.1269, and 0.1346, respectively, and the asteroid's mean surface hemispherical albedo is 0.1566. The results indicate that Toutatis is somewhat a red object in the visible spectral band.

Key words asteroids: individual: 4279 Toutatis—Planets and satellites: detection—space vehicles—techniques: image processing

1. INTRODUCTION

The surface reflective character of a planet is an important basis for the judgement of its regolith mineral type, the inversions of its mineral content and surface roughness, as well

[†] Supported by Innovation Foundation of China Aerospace Science and Technology Corporation

Received 2015-04-14; revised version 2015-09-02

* A translation of *Acta Astron. Sin.* Vol. 57, No. 1, pp. 40–50, 2016

[△] zhaowei@hit.edu.cn

as the calibration of surface topography. The surface albedo is an important parameter to characterize the planet surface reflectance, and a key-important parameter necessary for building the thermal model of the planet surface. The planet surface albedo is correlated with the regolith grain type and content, planet mass, and other physical properties, by observing the variation of the planet surface albedo, we can analyze the asteroid's surface physical structure. In the study of the asteroid 433 Eros, Li et al.^[1] found that there exists a very strong correlation between the variation of surface albedo and the regolith space weathering. The study of surface reflection characteristics has been considered as an important sector in the asteroid research.

Asteroid 4179 Toutatis is an Apollo-type Alinda-family Mars-crossing asteroid. As a near-earth asteroid, its orbit aphelion is close to the Jupiter orbit, its orbit perihelion is close to the earth orbit. Because that in the revolution, it may approach to the earth very closely in space (only 0.006 au, 2.3 times the earth-moon distance), the 4179 asteroid is considered to be a potentially dangerous asteroid by NASA of the United States.

In the previous studies on the surface reflection characteristics of the asteroid 4179, the data were mainly originated from the ground-based photometric measurement and polarization measurement, the information conveyors are mainly the electromagnetic waves at the visible, ultraviolet, and infrared wavebands. In 1992~1993, by the V-band photometry on the asteroid 4179 at 25 places in the world, Spencer et al. obtained its light curves at the sun's phase angles in the range of $121^\circ \sim 0.2^\circ$ ^[2]. In 1998, combining with the radar measurement data, using Hapke's bidirectional spectral reflectance model, Hudson simulated the light curves of the asteroid 4179, and compared the simulated results with the light curves actually observed by Spencer et al., by computing their minimum root mean square errors, they derived the optimum parameters for the Hapke's model^[3]. Besides, in the period from December 1992 to January 1993, Lupishko et al. made the polarization observations on the asteroid 4179, obtained the polarization data at the UBVRi five wavebands, and by using the empirical relation between spectral slope and albedo studied by Zellner in 1977^[4], they derived the albedos at the different wavebands for the similar phase angles, and estimated for the first time, by the ground-based polarization measurement, that the averaged surface albedo of the asteroid 4179 is 0.13, and that the R, G, and B-band albedos are 0.15, 0.13, and 0.13, respectively^[5]. Compared with the space optical imaging, the ground-based photometric and polarization measurements are affected by the atmospheric scattering of the earth.

At 08:30:09 (UTC) of 13rd December 2012, the lunar probe Chang'e-2 implemented the second extensive mission, with the velocity of 10.73 km/s, it successfully flew around the asteroid 4179 Toutatis at the 7 million kilometer distance from the earth, the minimum flyby distance was 770 m, in the flyby process the optical image data of 4.5 GB were obtained, and the highest resolution attained 2.8 m, it is the first time to obtain the visible light images of the asteroid 4179 at such a short distance^[6–8]. Huang et al. analyzed most

Download English Version:

<https://daneshyari.com/en/article/8133398>

Download Persian Version:

<https://daneshyari.com/article/8133398>

[Daneshyari.com](https://daneshyari.com)