THERMAL INFRARED OBSERVATIONS OF ASTRONOMICAL OBSERVATIONS OF ASTEROID 2005UY55 DURING CLOSEST APPROACH


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Introduction

Since asteroids approaching to the earth are potentially hazardous to the human race, study of them is strongly demanded. Such asteroids have surface temperature of 200-300K, and emit thermal radiation with spectral peaks in the 10-20 μm region. Observations at these mid-infrared wavelengths therefore are quite important for studying them. However adequate observations have not been carried out because of the limited number of mid-infrared cameras in addition to limited opportunities of the observations.

Asteroid 2005UY55 was made an exceptionally close approach to the Earth, passing within 0.0217 AU (325,000 KM) on 2011-08-23 24:24. Such a close approach was incredibly rare event and a valuable opportunity to study near earth asteroids in detail. We carried out mid-infrared observations of the asteroid 2005UY55 and successfully obtained photometric variation at the 10 and 20 μm wavelengths during the close approach.

Telescope and Instrument

A mid-infrared camera MAX38 attached on mini-TAO telescope was used for this observation.

Figure 1. Atmospheric transmittance at the summit of Co. Chajnantor (1.84km)

Results

Observations and Reduction

We observed the asteroid 2005UY55 from 2011-Nov-08 23:04 to 25:51 and Nov-09 23:56 to 26:04. It covered the closest approach timing and 24 hours later to the approach. The weather conditions were excellent through the observations. Imaging observations in the 8.9μm(ΔA=0.5μm), 12.2μm (0.5μm), and 18.7μm (0.5μm) were carried out. Observing log is summarized in Table 2, and the variations of the sun-asteroid-observer angle and the mini-TAO-centric distance during the observations are plotted in Figure 2.

The near earth asteroid apparently moved very fast on the sky. To follow the asteroid movement, the telescope was pointed at repeated intervals. The intervals were set to 1 minute and 3 minutes on Nov. 8 and 9, respectively. Normal sidereal tracking was applied in the period between the telescope pointings. Images were taken at a frame rate of 3.8 Hz with an effective integration time of 0.197 sec. The frame rate is fast enough to not to extend the image of the asteroid on each frame. Chopping technique was not applied because background can be canceled out with using frames just before or after an object frame.

On Nov. 8, the asteroid was so bright that it was detectable on each frame. We applied aperture photometry with an aperture radius of 3′/ for each frame and averaged every 5 minutes. On Nov. 9, it was difficult to detect the asteroid on each frame. We added every 92 frames into one frame with shifting pixels of 3 pixel. We observed the asteroid movement on the sky. The asteroid was detected in the added frame as a point like source. We applied aperture photometry for the subtracted images and averaged all the photometric values as a result.

Thermophysical Model Analysis

Photometric data in the thermal infrared wavelength range are very useful for modeling the asteroid.

Due to the degeneracy between roughness and thermal inertia there are two reasonable solutions.

a. assuming nominal roughness would point to a prograde solution of a body with about 340 m size and an albedo of 0.056, but this is in contradiction with the radar 9σ solution.

b. assuming an extremely high roughness (r=1.0, f=1.0) would change the situation: the radar S solution is now more likely and produces a "reasonable" thermal inertia of about 550, but the corresponding size is then only 298 m and the albedo 0.073 which is in clear contradiction to the radar results.

c. also the Keck AO solutions (Merline 2012, Warner 2012, Busch 2012, Lim 2012) seems to favor now also the retrograde solution (warm terminator during close approach).

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We applied thermophysical model program (TPM) analysis for the presented mid-infrared data and far infrared data at 70 and 160 micron obtained by Herschel/PACS (Mueller 2011). We assumed - a spherical body - rotation period : 19.31±0.026n (Warner 2012 in this conference) - Spin Vector orientation : given in Merline+2012 in this conference - H, V = 21.3 ± 0.1 Img - G-slope = 0.15

The TPM solution fit the data set of MAX38 and Herschel very well.

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Table 1: Specifications of MAX38

<table>
<thead>
<tr>
<th>Wavelength [μm]</th>
<th>Transmittance [%]</th>
<th>Frequency [10Hz]</th>
<th>Spatial Resolution</th>
<th>Angular Resolution</th>
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</thead>
<tbody>
<tr>
<td>8.7μm</td>
<td>50</td>
<td>128</td>
<td>122</td>
<td>10.7</td>
</tr>
<tr>
<td>12.2μm</td>
<td>50</td>
<td>128</td>
<td>122</td>
<td>10.7</td>
</tr>
<tr>
<td>18.7μm</td>
<td>50</td>
<td>128</td>
<td>122</td>
<td>10.7</td>
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</tbody>
</table>

Table 2: Observing log

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Object</th>
<th>Filter</th>
<th>Altitude</th>
<th>Distance [AU]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov-8</td>
<td>23:04</td>
<td>Asteroid</td>
<td></td>
<td>0.002</td>
<td>1.4</td>
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<tr>
<td>Nov-8</td>
<td>23:56</td>
<td>Asteroid</td>
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<td>0.001</td>
<td>1.4</td>
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<tr>
<td>Nov-9</td>
<td>23:56</td>
<td>Asteroid</td>
<td></td>
<td>0.001</td>
<td>1.4</td>
</tr>
<tr>
<td>Nov-9</td>
<td>26:04</td>
<td>Asteroid</td>
<td></td>
<td>0.001</td>
<td>1.4</td>
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</tbody>
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