The Near-Earth Encounter of 2005 YU55: Thermal Infrared Observations from Gemini North. Lucy F. Lim[1], Joshua P. Emery[2], Nicholas A. Moskovitz[3], Mikael Granvik[4], [1]NASA/Goddard Space Flight Center (lucy.f.lim@nasa.gov) [2]University of Tennessee, Knoxville [3]Carnegie Institution of Washington (DTM) [4]University of Helsinki.

As part of a multi-observatory campaign to observe 2005 YU55 during its November 2011 encounter with the Earth (Moskovitz *et al.* [1], this volume; Fig. 1), thermal infrared photometry and spectroscopy (7.9–14 and 18–22 μm) were conducted using the Michelle instrument at Gemini North [2, 3]. The campaign as a whole and the visible and near-IR observations are discussed in the complementary abstract by Moskovitz *et al.*

The Gemini data will enable the asteroid's thermal emission to be characterized, permitting a robust estimate of its surface thermal inertia and thus of the depth and texture of its regolith. In addition, spectral emissivity variation in this wavelength region may yield mineralogical information. Combining these thermal data with tight constraints on size and rotation state from the radar data and visible reflectance from optical observations will also enable accurate determinations of the albedo and effective emissivity of this C-type object.

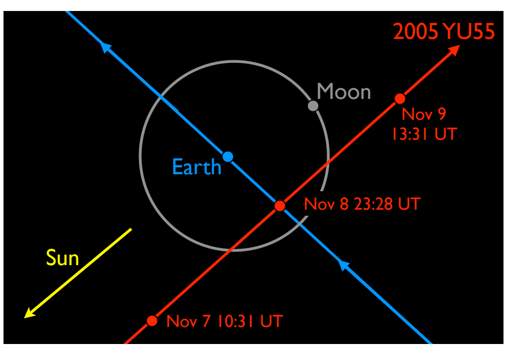

Figure 1: **The November 2011 encounter of 2005 YU55 provided a rare opportunity to obtain high-precision ground-based thermal emission photometry and spectroscopy of a sub-km C-type asteroid.** Geometry of 2005 YU55's close approach to the Earth. Orbital directions of the Earth (blue) and 2005 YU55 (red) are indicated with the arrows. Based on a diagram by J. Giorgini (JPL).

To support these observations, the Gemini staff amended the telescope pointing software in order to enable the asteroid to be tracked sufficiently accurately for spectroscopy at rates exceeding 10,000"/hour using the ephemeris that had been updated on the basis of new Goldstone radar data from the previous few days. Although the impossibility of guiding during these observations resulted in suboptimal point-spread functions, there were no other problems with tracking or guiding during the two nights of our observations. However, inclement weather early in the evening resulted in the loss of several hours of observing time from both nights.

During the night of the closest approach, UT 2011-Nov-9, we measured the thermal emission of 2005 YU55 in three sets of narrowband photometry (7.9–18.5 μm; Table 2), two sets of N-band spectra (7–14 μm), and one set of Q-band spectra (officially 16–26 μm; in reality generally compromised by telluric water vapor features longward of 22 μm). On the second night (UT 10 Nov.), three complete sets of narrowband photometry (in the same seven filters) and two sets of N-band spectra were measured, all at relatively low phase angles of 15.35–15.85°. Calibration stars included α Ari, β And, and ζ And.

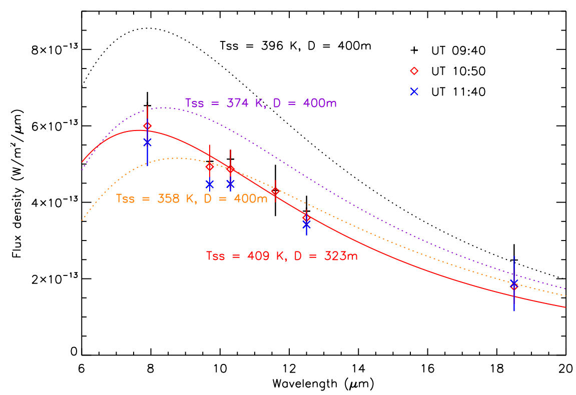

Figure 2: **Preliminary thermal-IR flux densities of 2005 YU55 on UT 2011-Nov-10.** Three separate sets of narrowband photometry are represented (Table 1). The dotted lines indicate the predictions of a simple standard thermal model [4] at varying maximum (subsolar-point) temperatures calculated for a spherical asteroid at UT 10:40. Using the 2010 radar diameter of 400m [5] these preliminary data are most consistent with a subsolar temperature between 360 and 370 K ($\eta \approx$ 1.25–1.5, dotted lines). However, a fit with a floating diameter (solid red trace) results in a smaller diameter of 322 $\pm$ 18 m and a maximum temperature of 409 $\pm$ 12 K ($\eta \approx 0.93$).

Preliminary Results: A preliminary reduction of the photometry of 10-Nov-2011 has been completed and the results are plotted as Figure 2. Three sets of seven-filter photometry are represented, separated by approximately one-hour intervals. The results are broadly consistent with the 2010 radar diameter of 400 m [5] if the maximum temperature is ≈360–370 K. However, the data are somewhat better fit by emission from a smaller asteroid at a higher temperature (diameter 322 ± 18 m, T_{ss} = 409 ± 12 K). A very preliminary radar diameter estimate from the 2011 data is 360 ± 40 m (M. Busch, personal communication); this diameter will be refined considerably.

Reduction of the 8.8 μm photometry and the spectroscopy from UT Nov-10 as well as of all the Gemini data from UT Nov-9 is in progress. Results will be discussed.

Table 1: Summary of Observations

Data	Time (UT)	Δ (AU)	Phase (Degrees)
UT 09-Nov-2011			
Photometry	08:43–08:53	0.0037	39.9
Photometry	09:43–09:55	0.0040	37.3
Photometry	01:02–01:15	0.0043	34.2
N-band spectrum	09:38–09:42	0.0039	37.4
N-band spectrum	10:47–10:50	0.0042	35.0
Q-band spectum	10:51–11:01	0.0043	34.6
UT 10-Nov-2011			
Photometry	09:32–09:42	0.011	15.8
Photometry	10:47–10:58	0.012	15.6
Photometry	11:40–11:52	0.012	15.4
N-band	10:37–10:43	0.012	15.6
N-band spectrum	11:29–11:40	0.012	15.4

Future work: An extensive campaign to observe 2005 YU55 by radar was successfully carried out by investigators at Goldstone, Green Bank, and Arecibo. Analysis of the radar data is still in progress (M. Busch, personal communication). When these results become available, the radar data will be used to independently constrain the size, shape, and rotation state of YU55 as inputs to a detailed thermophysical model of the asteroid's thermal emission. From this, an accurate estimate of the asteroid's thermal inertia, effective emissivity, and other thermal properties can be derived and the presence and character of regolith on the surface can be determined.

In addition, during the encounter, other investigators have measured the thermal emission from 2005 YU55 in L-band (3–4 μm) with IRTF SpeX [1] and at 70, 100, and 160 μm from Herschel (Mueller *et al.*, IAUC 9241, [6]). These results will also be compared with our data.

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Table 2: Michelle filters used in photometry of 2005 YU55. Bandpasses for all filters are approximately 10%.

Filter	Wavelength (μm)
Si-1	7.9
Si-2	8.8
Si-3	9.7
Si-4	10.5
Si-5	11.6
Si-6	12.5
Qa	18.5

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