The Near-Earth Encounter of 2005 YU55: Thermal inertia and inferred surface properties. Joshua P. Emery[1], Lucy. F. Lim[2], Nicholas A. Moskovitz[3], [1]University of Tennessee (jemery2@utk.edu), [2]NASA Goddard Space Flight Center, [3]Carnegie Institute of Washington (DTM).

Introduction: Near-Earth asteroids (NEAs) are exciting targets for both science and exploration. These small bodies conceal within their orbital, physical, and compositional properties important clues to the formation of terrestrial planets and the later evolution of the Solar System. Due to their proximity to Earth, NEAs also provide excellent targets for robotic and human exploration. Hayabusa (JAXA) has returned samples from the S-type asteroid Itokawa, OSIRIS-REx (NASA) will return samples from the B-type asteroid 1999 RQ36, and MarcoPolo-R (ESA) and Hayabusa-2 (JAXA) also plan to return samples from NEAs. Despite their scientific importance and interest as spacecract targets, however, NEAs remain fairly poorly characterized, due mostly to their small size, which makes them quite faint as viewed from Earth.

The close approach to Earth of the C-type asteroid 2005 YU55 in November 2011 presented a rare opportunity for detailed observations of a NEA in the size range likely to be visited by spacecraft and possibly humans. Among the important, yet poorly understood, properties of NEAs are the compositions of primitive spectral classes and properties of the regoliths. As part of a multi-telescope campaign to measure visible and infrared spectra and photometry, we obtained mid-infrared (~8 to 22 μm) photometry and spectroscopy of 2005 YU55 using the Michelle instruement on the Gemini North telescope. The observations and measurements are presented in a companion abstract [1], as is thermal modeling from the thermal contribution to the measured near-infrared (NIR) spectrum [2]. In this work, we will present thermophysical modeling of the mid-IR thermal emission measurements.

Previous measurements and close approach: Observations during previous apparitions by radar astronomers indicated a fairly spherical object with a diameter of ~400m [3]. Reports from several different observations during the Nov 2011 apparition suggest a slightly smaller size. The visible geometric albedo calculated from this size and the measured absolute magnitude (21.27) is only a few percent. Visible wavelength spectra place 2005 YU55 in the C-type taxon [4], consistent with the low albedo. NIR spectra support this classification [2].

On 8 Nov 2011 (~23:30 UT), 2005 YU55 passed to within about 325,000 km (0.85 lunar radii) of the Earth. The approach trajectory brought the asteroid in from roughly the sunward-facing direction and out in the anti-sunward direction. As a result, over the few days around close-approach, the phase angle of the asteroid as viewed from Earth changed dramatically. This situation is fortuitous for estimates of thermal inertia in that it resulted in observations centered on different times-of-day on the asteroid.

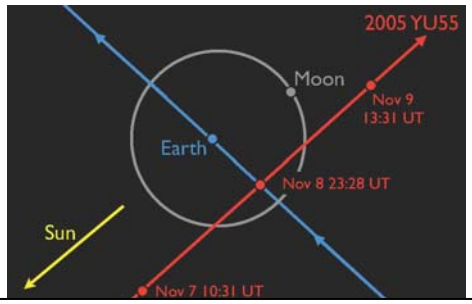

Figure 1. Diagram of the November 2011 encounter of 2005 YU55. Based on a diagram by J. Giogini (JPL).

Thermal inertia: There are a few approaches that are commonly used for determining thermal inertia of Solar System bodies. One relies on deriving temperatures from flux measurements as a function of time-of-day. The character of the change in temperature over the diurnal cycle is very sensitive to thermal inertia. A second relies on high-quality full-disk flux measurements that cover a broad wavelength range (ideally including the peak in emitted flux). The temperature distribution across the surface of the body sensitive to thermal inertia and is modeled to match the observed thermal flux spectrum. With the multi-wavelength observations of 2005 YU55 covering different local times-of-day, we can apply a combination of these two approaches for a tight constraint on the thermal inertia.

Along with presenting the thermal inertia of 2005 YU55, we will compare the result with other measurements of the physical properties of this asteroid and in the context of other well-studied NEAs, such as 1999 RQ36 and Itokawa.

Many different observers, using different techniques and observing at different wavelengths, had their sights trained on 2005 YU55 last November. The composite picture that emerges of this small asteroid will be fascinating to see.

References: [1] Lim, L.F. et al. (2012) *ACM 2012*, this volume. [2] Moskovitz, N.A. et al. (2012) *ACM 2012*, this volume. [3] Nolan, M.C. et al. (2010) *42nd AAS/DPS Meeting*, abstract #1056. [4] Hicks, M. et al. (2010) *ATEL* 2571.