SPECTROSCOPY AND PHOTOMETRY OF THE EARTH GRAZER 2002 NY40. A. S. Rivkin, *Massachusetts Institute of Technology, Cambridge MA 02139, USA, (asrivkin@mit.edu)*, E. S. Howell, *Arecibo Observatory, HC03 Box 53995, Arecibo PR 00612, USA*, S. J. Bus, *Institute for Astronomy, 640 N. A'ohoku Place #209, Hilo HI 96720*, M. Hicks, *Jet Propulsion Laboratory, 4800 Oak Grove Dr., Pasadena CA 91109, USA*, W. T. Reach, T. H. Jarrett, *IPAC/Caltech MS 100-22, Pasadena CA 91125, USA*, R. P. Binzel, *Massachusetts Institute of Technology, Cambridge MA 02139, USA*.

The near-Earth asteroid 2002 NY40 was discovered on July 14, 2002 by the LINEAR survey. The object was predicted to make a close pass by the Earth on August 18, which led to observations at a large range of wavelengths, including radar. The combination of visible and near-infrared spectroscopy/spectrophotometry gives some indication of the composition. Thermal emission in the 3-μm spectral region gives constraints on the albedo, which is consistent with the spectral type and with the available size from the radar measurements. The lightcurve was well measured by a large number of observers, which helps to determine the rotation phase of the observations at the various wavelengths. The favorable observing conditions and rapid dissemination of the astrometry have led to a good physical characterization of this object, which is relatively rare for a newly discovered near-Earth asteroid. The data sets reported in this abstract are shown in Table 1.

Spectral Results: Spectrophotometry using *UBVRI* filters was performed on 7 and 17 August 2002 at the Table Mountain 0.6-m telescope. These data were primarily intended to determine the absolute magnitude (*H*) of 2002 NY40, but cover the visible part of the spectrum. Near-infrared (0.9–2.5 μm) spectroscopy were obtained from the IRTF on 9-11 August and 17 August 2002, with longer wavelength observations (1.9–4 μm) also obtained on 11 August. Infrared filter photometry was also obtained using the 5-m Hale Telescope at Palomar Observatory, with narrow-band filters calibrated to standard *JHK* bandpasses.

When combined, these datasets provide full spectral coverage of 2002 NY40 from 0.3–4 μm. Figure 1 shows the 0.3–2.5 μm section of these data. Obvious are absorption bands at 1 and 2 μm due to olivine and pyroxene. This asteroid would be classified as a Q-class body based on its visible spectrum [1]. Superimposed on the 2002 NY40 spectrum are spectra of two LL6 chondrites, Bandong and Karatu, provided by Tom Burbine [2]. The LL chondrites are a subset of the ordinary chondrites, characterized by low amounts of iron compared to other OC meteorites. The match is striking, with no additional spectral components required. There is no suggestion that regolith processes have changed the spectrum of 2002 NY40. This close spectral match is consistent with an interpretation of 2002 NY40 as an unmelted body which could be a progenitor of LL6 meteorites.

Radiometric Results: While the data quality beyond 2.5 μm precludes mineralogical interpretation for 2002 NY40 at those wavelengths, it can be used to constrain its albedo and thus its size. Asteroids typically emit thermal flux at wavelengths longer than 3.2 μm in the main belt, but 2002 NY40 approached the Sun sufficiently close to emit at somewhat shorter wavelengths.

Figure 2 shows the spectrum of 2002 NY40 beyond 2.5 μm, compared to models of thermal flux using the Standard Thermal Model [3], modified to use a beaming parameter of 1.2, as suggested by Harris for NEAs [4]. The asteroid flux is fit by model albedos in the range of 0.15-0.25, with perhaps a preference for the higher end of that range. This, too, is the albedo range of LL chondrites.

Given the measured absolute magnitude of 19.67 $\pm$ 0.13 for 2002 NY40, this results in a size range of 290-420 m for the indicated albedos. This is somewhat smaller than the original estimates [5]. However, this diameter assumes a spherical shape, and radar observations will allow better constraints to be placed on size and shape of this object.

Conclusions: The spectrum and albedo of 2002 NY40 are completely consistent with an interpretation of an LL6 mineralogy. Its effective diameter is 290-420 m.

References:

[1] Tholen PhD Thesis, U. of Arizona (1984)
[2] Burbine et al. *Ant. Met. Res.* **15** (2002)
[3] Lebofsky et al. *Icarus* **68** (1986)
[4] Harris *Icarus* **131** (1998)
[5] Minor Planet Electronic Circular 2002-017

Acknowledgments ASR acknowledges support from the NASA PGG program. Thanks to Arecibo Observatory for hosting our remote IRTF observations.

Data Set	UT Date	Telescope/Observer
Short-wave IR spectra	8/9-11,17/02	IRTF/Howell&Rivkin, Bus
Visible Photometry	8/7,17/02	Table Mountain 0.6-m/Hicks
JHK Photometry	8/18/02	Hale 5-m/Reach&Jarrett
Long-wave IR spectra	8/11/02	IRTF/Howell&Rivkin

Table 1: Data sets used in this work

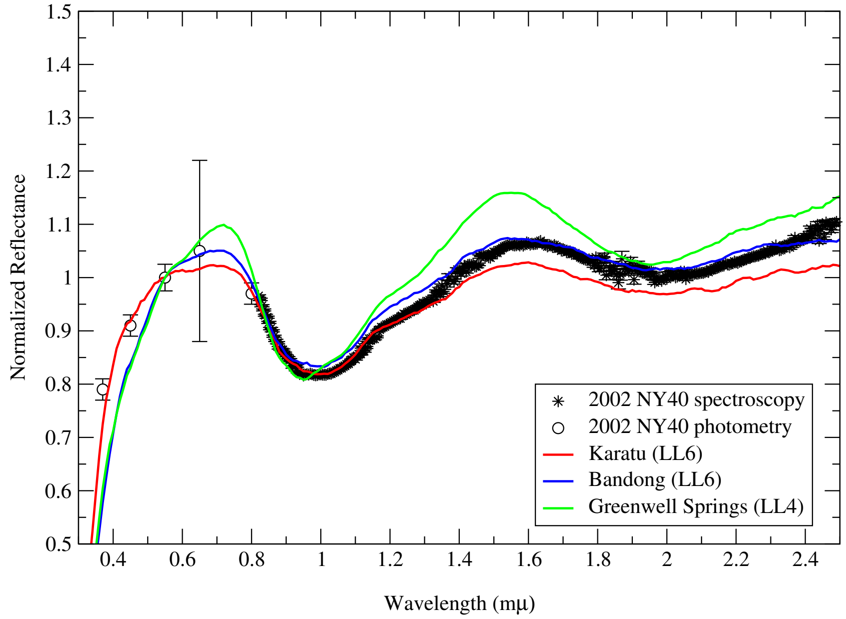

Figure 1: Combined photometry and spectroscopy of 2002 NY40, compared to LL chondrites. The match with LL6 chondrites is very close throughout the 0.3–2.5 μm spectral region. The data quality is such that we are able to distinguish an LL4-like spectrum from LL6. The n

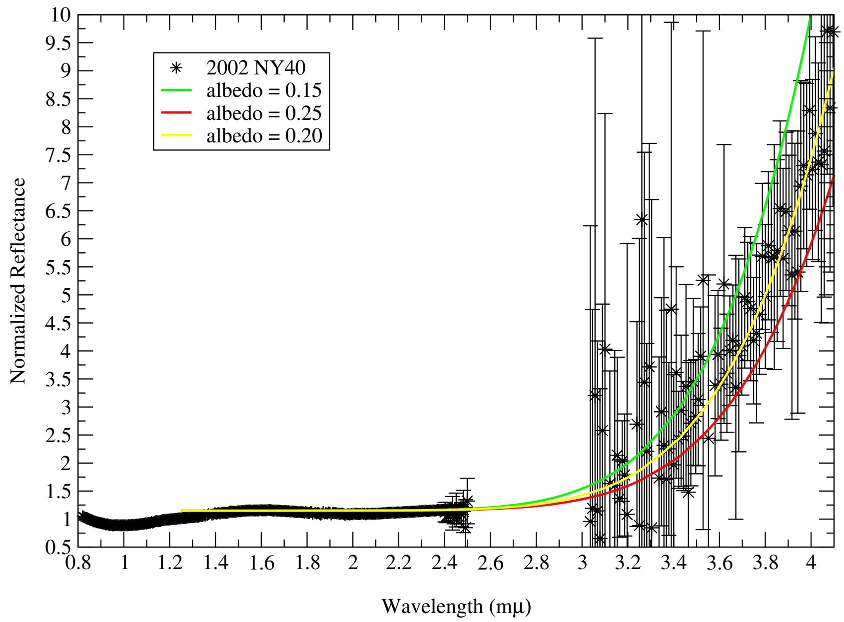

Figure 2: Longer-wavelength spectra of 2002 NY40, compared to thermal models. Because asteroids have non-zero temperatures, they emit in the infrared. 2002 NY40 was significantly warmer than main-belt asteroids, and so emits at significantly shorter wavelengths. The long-wavelength end of these data allow the albedo to be constrained to 0.15-0.25. These albedos are consistent with the LL chondrite class.