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PHYSICAL CHARACTERIZATION OF CHELYABINSK-SIZED (~20 METER) NEAR-EARTH ASTEROIDS: IMPLICATIONS FOR IMPACT HAZARD, METEORITE SOURCE BODIES, AND HUMAN EXPLORATION

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ABSTRACT

Impacts due to small (~20 meters) near-Earth asteroids (NEAs) are interesting because they are more probable than previously thought and have been seen to cause extensive damage. On February 15, 2013, a 17-20-meter-diameter asteroid entered the Earth's atmosphere over Chelyabinsk, Russia, and disintegrated in an airburst with an estimated energy of ~500±100 kilotons of TNT. As a result, well over 1000 people were injured and there was a huge financial cost in damages to buildings. NEAs in this size range in near-Earth space deliver meteoritic material to Earth on a regular basis. A review of bolide events over the last 20 years suggests that on an average 27 objects between 1-20 meters impact the Earth every year.
Recently, there has been increased interest in 'exploring' small NEAs, as evidenced by NASA's Asteroid Redirect Mission concept. Prior to mounting any spacecraft

mission to such a small body, extensive observations (e.g., astrometric, spectroscopic, radar, etc.) are required to better characterize the NEA.
Following the Chelyabinsk event, we began a systematic physical characterization study of NEAs ~20 meters in diameter in an effort to constrain their surface composition, albedo, rotation state, binary frequency using ground-based telescopes. When possible, we also used archival data to enhance our existing sample size.
Here we present preliminary results on five NEAs with absolute magnitude (H) >26.0 or diameter ~20 meters assuming albedo of ~0.15. Due to their inherent small size and extremely limited observing windows, the number of observable targets is very low in a given year. Results presented here focus on constraining the mineralogy, albedo, and meteorite analogs.
Near-IR spectral observations (0.7-2.5 microns) of NEAs were made at the NASA Infrared Telescope Facility on Mauna Kea, Hawai'i, using the SpeX instrument in low-resolution prism mode. All spectral data were reduced using Spextool, an IDL-based software package provided by the IRTF. Spectral band parameters were extracted using Matlab based tool, and thermal modeling to constrain the albedo will be performed using Thermflx code.
Of the five ~20-meter-diameter asteroids we observed, three of them (2009 KW2, 2014 WY119, 2014 WC201) show silicate absorption bands due to the minerals olivine and pyroxene with a range of meteorite analogs including basaltic achondrites, impact melts, and ordinary chondrites. Two other small NEAs (2014 UV210 and 2014 XB6) show a sharp rise in reflectance beyond 2 microns, indicative of the shorter wavelength end of the Planck curve. Low albedo objects (<0.10 albedo) show this behavior suggesting that these two objects might have surface composition similar to primitive carbonaceous meteorites.
Recent enhancements to NASA's Near-Earth Objects Observations program have led to a 45% increase in NEO discovery rate over the past year. The new survey efforts are yielding close Earth encounter predictions, which in turn provide substantial opportunities for the IRTF to characterize a size-range of objects that includes Earth impactors such as Chelyabinsk and recent close flybys of small NEAs (e.g., 2008 TC3 and 2014 AA).

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