Near-Infrared Spectroscopy of (3122) Florence and (357439) 2004 BL86 During Near-Earth Encounters

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Near-Earth asteroids (NEAs) are widely thought to be the source of water and organics delivered to early Earth. Additionally, some NEAs, including Florence and 2004 BL86, are considered potentially hazardous objects (PHOs), and they could make threateningly close approaches to Earth.

The NEAs (3122) Florence, an S-type trinary asteroid, and (357439) 2004 BL86, a V-type binary asteroid, flew by Earth in 2017 and 2015 respectively. We conducted near-infrared (NIR) spectroscopic observations of these two NEAs as they flew by Earth to investigate their surface compositions; in other research, variable star astronomers use similar spectroscopic techniques of different wavelengths to study multiple features of variable stars, including but not limited to radii, surface temperature, and apparent brightness. Our hypothesis is that Florence and 2004 BL86 are featureless in the 3-μm band and do not possess features indicating water or organics; as S-type and V-type asteroids they are seemingly not carbonaceous/primitive objects.

We used the Infrared Telescope Facility (IRTF) located at Mauna Kea, Hawaii to measure long wavelength cross-dispersed (LXD) spectra of both Florence and 2004 BL86 with SpeX mode. The measured spectra wavelength ranged from 1.67-4.2 μm, which includes the 3-μm feature attributed to water/hydroxyl. The data were processed and reduced using Spextool, an IDL based spectral reduction program provided by the IRTF. To model and correct the data's thermal emission component (beyond 2.5 μm) and isolate the desired reflected component, we used the Near-Earth Asteroid Thermal Model (NEATM). The band depth at approximately 2.90 μm was calculated and used as a proxy to whether or not water was present.

Preliminary results suggest that Florence potentially exhibits a 3-μm band feature indicating the presence of water/hydroxyl, while 2004 BL86 lacks this feature.

In this investigation, we will explore the possible causes of the 3-μm band feature detected on Florence. There are multiple possible and/or theorized explanations for the detection of water/hydroxyl on small solar system objects, including the presence of endogenic hydrated minerals on their surfaces, and exogenic sources such as solar wind implantation or carbonaceous impactors. The presence of water/hydroxyl on Florence is unexpected and relevant; trace amounts of water may be found on objects never considered to host this volatile compound. This analysis has relevance to the effect of solar wind interactions on celestial bodies.