Modeling Thermophysical Properties of 2100 Ra-Shalom. K. D. McFadden[1], E. S. Howell[2], R. J. Vervack Jr.[3], Y. R. Fernández[4], C. Magri[5], and L. M. Carter[6], [1]Lunar and Planetary Laboratory, U. Arizona, (Tucson, AZ 85721, kiana@lpl.arizona.edu), Lunar and Planetary Laboratory, U. Arizona, (Tucson, AZ 85721, ehowell@orex.lpl.arizona.edu

Introduction: As one of the largest Aten asteroids known, near-Earth asteroid 2100 Ra-Shalom has been extensively studied at visible, near-infrared, thermal-infrared, and radar wavelengths, but its physical nature is still poorly understood. We have utilized the shape-based thermophysical model SHERMAN to investigate the thermal properties of Ra-Shalom's surface. This model has proven successful in constraining surface roughness, thermal inertia, and albedo of near-Earth asteroids [1,2]. New observations in the near-IR provide an opportunity to better characterize the surface.

Methods: Our thermal models for Ra-Shalom are constrained using new spectra we obtained at multiple viewing geometries in the near-infrared and thermal region at NASA's Infrared Telescope Facility (IRTF) over the course of five nights in August-September 2019. For this study, we utilized the shape model of [3], which has a retrograde spin pole and agrees with all the lightcurve observations. The previous prograde-rotation, radar-derived shape model of [4] provided initial thermal parameters for Ra-Shalom.

Our shape-based thermophysical model, SHERMAN, requires certain inputs to model the thermal properties of Ra-Shalom's surface. Some of the inputs include: the asteroid's reflectance spectrum, shape model, optical photometric properties, and orbital position. Other parameters such as albedo, thermal inertia, and crater fractions (a proxy for surface roughness) can be varied by the user. SHERMAN then produces the surface temperature distribution for the given properties and illumination history.

We were able to determine a range of homogeneous thermal properties that fit four of the fived observed spectra of Ra-Shalom in the wavelength range of 0.8-5.1 μm. However, the thermal properties obtained from [4] are not consistent with our observations. We are using the revised rotation state to redetermine the thermal properties, consistent with all of the observations.

Figure 1 illustrates how the thermal properties from [4] are not consistent with our current data. The combination of a very high thermal inertia, low albedo, and no surface roughness (craterfrac = 0.0) do not fit the August 26 data shown in figure 1. Figures 2 and 3 demonstrate a range of values where the model agrees with the data relatively well. These figures assume we are seeing the same side of the asteroid for August 26, 2019.

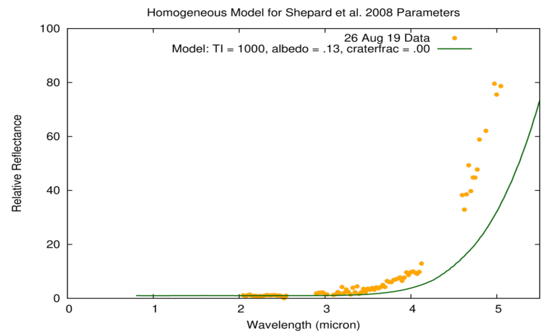

Figure 1. The SHERMAN parameters shown here are the thermal parameters used in [4]. They include thermal inertia (TI) = 1000, albedo = 0.13, and the crater fraction = 0.0. This image shows how the model does not agree with the data obtained on August 26, 2019.

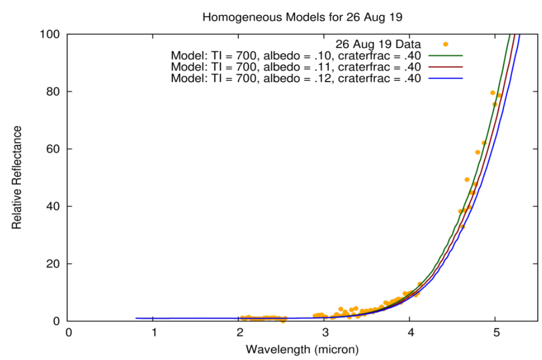

Figure 2. The SHERMAN parameters shown here are thermal inertia (TI) = 700, albedo = 0.10 - 0.12, and the crater fraction = 0.40. These ranges show relatively good fits between the model and data for August 26, 2019. Each spectrum is representing the same side of the asteroid but with different SHERMAN parameters.

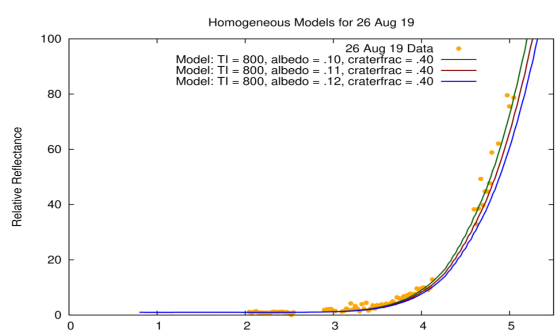

Figure 3. The SHERMAN parameters shown here are thermal inertia (TI) = 800, albedo = 0.10 - 0.12, and

the crater fraction = 0.40. These ranges show relatively good fits between the model and data for August 26, 2019. Each spectrum is representing the same side of the asteroid but with different SHERMAN parameters.

Future Work: We will continue to model Ra-Shalom using different sets of values to determine a singular range of parameters that fits all our spectra simultaneously. Our goal is to utilize SHERMAN and our data to model the mid-infrared (8-13 μm) properties of Ra-Shalom. These results will be used to make comparisons with mid-infrared data and model used in [4]. We will also use existing radar observations to create an improved shape model.

References: [1] Magri C. et al. (2018) *Icarus,303,* 203-219. [2] Howell E. S. et al. (2018) *Icarus, 303*, 220-233. [3] Ďurech J. et al. (2018) *Astronomy and Astrophysics,609*, 1-10. [4] Shepard M. K. et al. (2008) *Icarus, 193*, 20-38.