STUDYING THE POPULATION OF ASTEROIDS WITH REMOTE SENSING.

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Introduction: Returned samples and meteorites are our most detailed sources for compositional information about individual asteroids. Meteorites suffer from delivery biases and don't retain the geologic context from which they are sampled, and returned samples remain extremely rare. For these reasons, remote sensing, mostly ground-based, remains critical to the study of the population of asteroids. A combination of techniques

Radar: Radar imaging allows us to study the physical structures of those asteroids that come close enough to the Earth to be imaged, directly measuring sizes, shapes, and rotation states, but does not typically provide compositional information. Radar imaging has demonstrated a wide variety of asteroid structures, and that the size, shape, and spin distributions of asteroids are not simply the result of collisional evolution for near-Earth asteroids. Radar observations are mostly limited to objects that come quite near the Earth, typically within 0.1 AU.

Thermal Infrared: By comparing the amount of visible light reflected from an asteroid with the amount of thermal radiation emitted, it is possible to compute its albedo, and thus its size. There are a number of simplifying assumptions required to actually determine the size, so measurements of individual asteroids may be unreliable, and the method is particularly well suited to population studies.

Vis/IR Spectroscopy: Asteroid reflectance spectroscopy is able to identify signatures of a number of rock-forming minerals. Unlike laboratory samples, we are almost certainly looking at unresolved mixtures. For many asteroids, we have only whole-body average spectra, though rotationally-resolved observations are available for some objects. "Space weathering" processes alter the surfaces in ways that do not occur in terrestrial samples, and cannot be controlled. Spectroscopy reveals the composition distribution of asteroids within the asteroid belt, which is vital for understanding the formation mechanisms and biases in the delivery of meteorites. As we gain ground truth from returned samples and meteorites, we will better understand ambiguous spectral results. As an example, for decades, there was debate as to whether S-type asteroids were undifferentiated ordinary chondrites or differentiated stony-irons. The results from Itokawa and Eros have demonstrated that at least some S-type asteroids are undifferentiated ordinary chondrites, deepening the mystery of the origin of stony-irons.

Recent results from Vesta suggest that asteroids may be "contaminated" by material from impactors, so that it is difficult to infer the asteroid composition from the surface composition. However, a wide diversity of asteroid spectra are evident in the population, and the two largest asteroids, Ceres and Vesta, which should best retain impactor material, have extremely different spectra. Thus, while impactors may affect the spectra of asteroids, they do not dominate them.