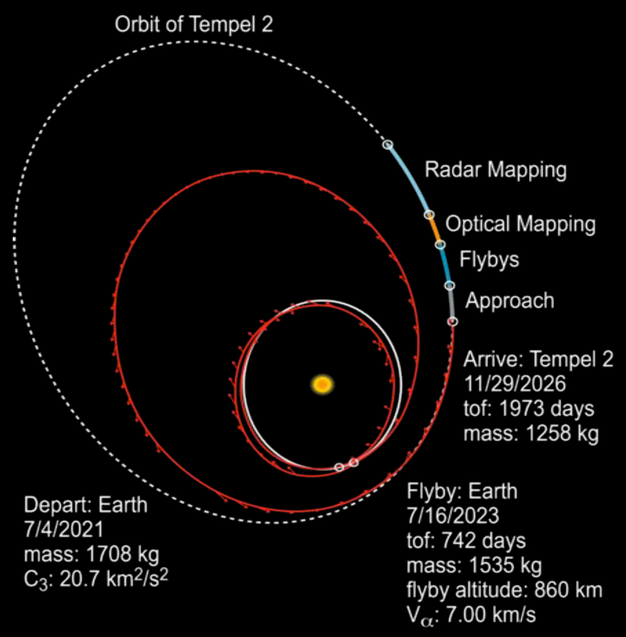
Comet Radar Explorer

Erik Asphaug, Arizona State University, PI



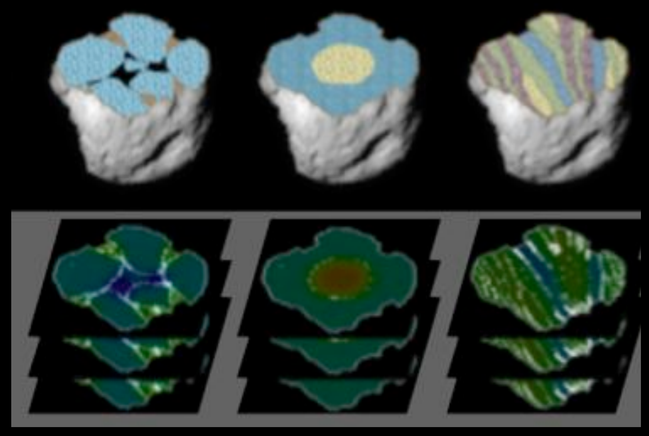
CORE rendezvous with Jupiter family comet Tempel 2 will be a tightly integrated global geophysics campaign:

- **How did it form?**
- **How does it work?**
- **Is it mostly ice?**
- **What are we seeing?**

Approach and Flyover phases: assess the active regions and obtain the required tracking and imaging data for orbit.

Optical Mapping Orbit (OMO) is a sequence of ~9 to 11 am/pm polar orbits for multi-wavelength visible imaging and photometry, and THEMIS-like measurements of temperature and thermal inertia.

The primary mission phase is Radar Mapping Orbit (RMO) where we perform a radar 'CAT scan' of the nucleus.

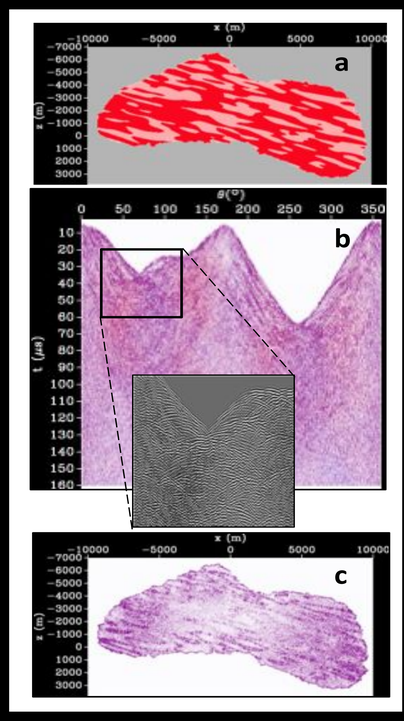


Schematic representation of hypothesis discrimination using 3D radar imaging.

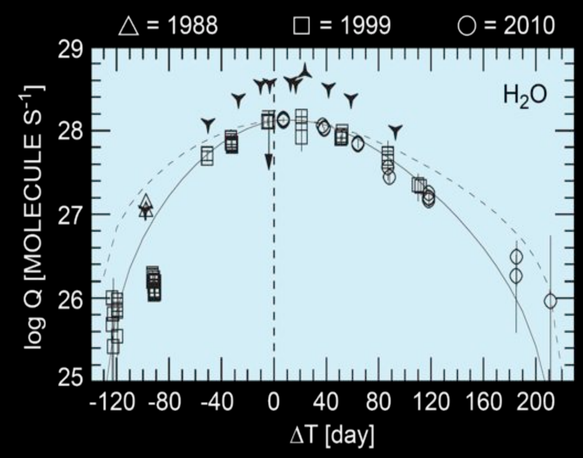
What's Inside?

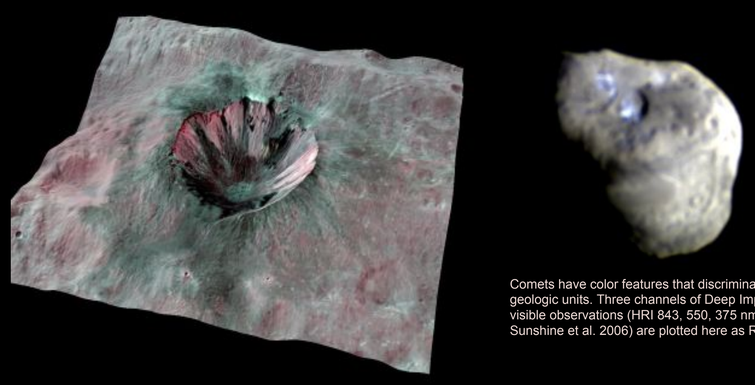
Comet radar imaging requires data. In this concept study (right) we simulate the procedure using a 2D joint travel-time tomography and wave-field migration, from an orbiting spacecraft. An Eros-shaped cometary target is assumed to be a layered body (a) in this example. Simulated radargrams are computed from orbit (b) showing the shape and internal multiple reflections (inset). Wavefield migration, here applying a blurred velocity model, recovers the internal structure (c).

Migration imaging does well for complex shapes and interiors. Projected imaging performance on the >20 Gb of 3D CORE data will be ~20m radial and ~200m cross-track resolved images.

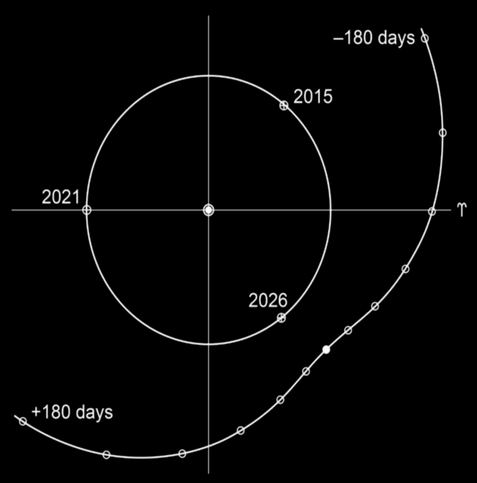


Four months before CORE's 2026 arrival, Tempel 2 will have its most favorable perihelion viewing from Earth in over a century. Five years earlier, observers will see the nucleus in the same season as the upcoming rendezvous, providing detailed measurements that will support the scientific analysis and mission planning.



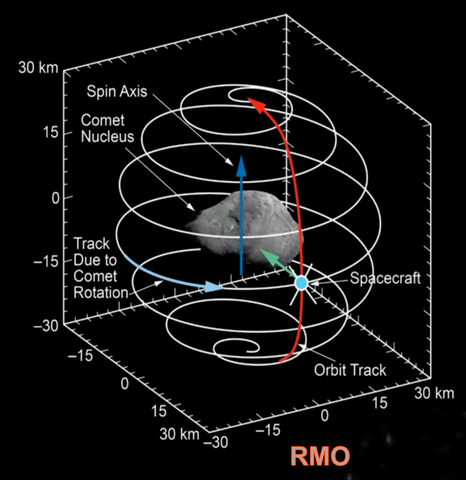


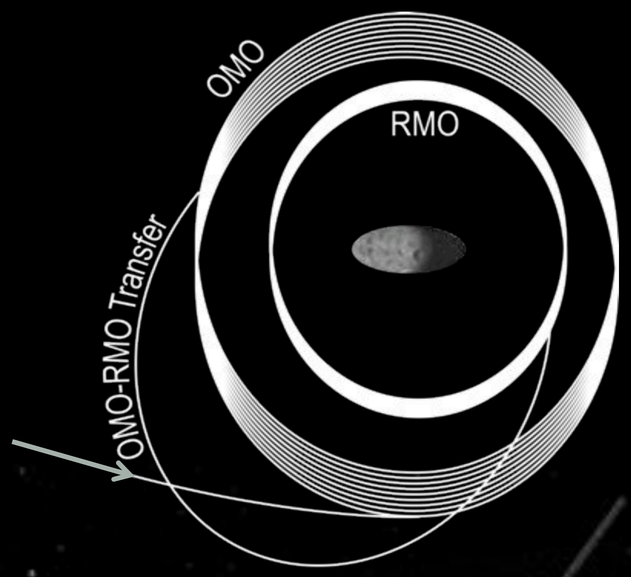
Comets have color features that discriminate geologic units. Three channels of Deep Impact visible observations (HRI 843, 550, 375 nm; Sunshine et al. 2006) are plotted here as RGB.



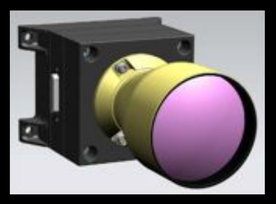
Earth's position at perihelion is marked on the circle relative to the position of Tempel 2.

The nucleus of 10P/Tempel 2 is a massive, prolate (~16x8 km), weakly-producing body that is active over ~2% of its surface (right). There is no evidence for complex rotation, but the nucleus is slowing down by 20 sec/orbit. Particle flux calculations indicate that the orbital environment will be like a spacecraft clean room, but CORE has substantial operational margin in case of unexpected activity or dust contamination.



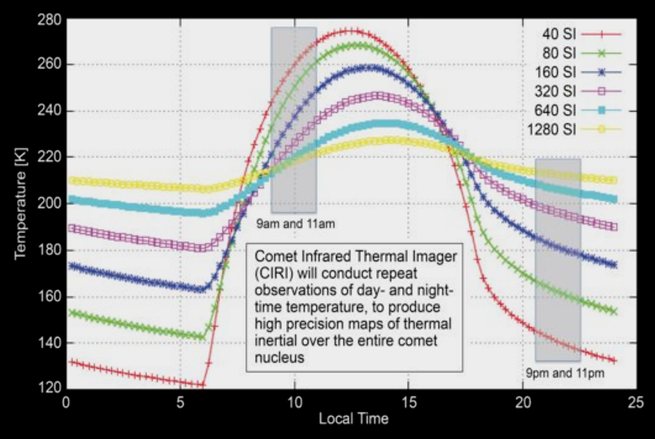


The Science and Navigation Camera (SNC) will be the same design as the DLR Framing Camera on NASA's Dawn mission (Sierks et al. 2011). Show is a three-dimensional color image of one of Vesta's smaller craters made using this camera. The instrument will obtain color images and photometric observations globally to a pixel scale < 3 m, for geology and for constructing the comet nucleus shape model and optical navigation.



CIRI/ASU

Comet Infrared Imager (CIRI) is a high-heritage microbolometer (7-25 μm) imager sensitive to the 120-350 K temperature range expected at the nucleus (modeled below). It will be built at ASU by the team that delivered THEMIS for Mars Odyssey. CIRI will obtain repeated daytime/nighttime images, that are co-aligned with the multi-wavelength visible images.



SHARAD radargrams of Mars south polar layered deposits (top right; Phillips 2011) converted to depth using ice permittivity (middle). There is a strong correlation with THEMIS daytime temperature (bottom), showing how RRI and CIRI are fundamentally connected investigations. Radar skin depth, thermal skin depth, and multi-wavelength visible measurements will perform a global characterization of the upper cm to meters.

