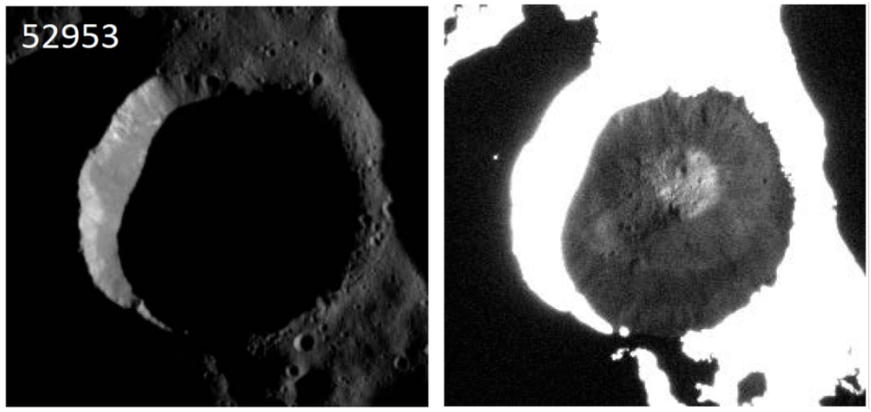
Ice in Ceres' Shadowed Craters Linked to Tilt History

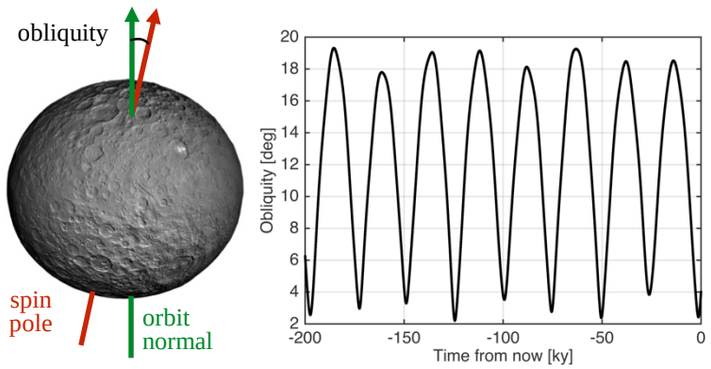
Science Question: What are the bright deposits observed in some dark polar craters on Ceres?

What are the findings?

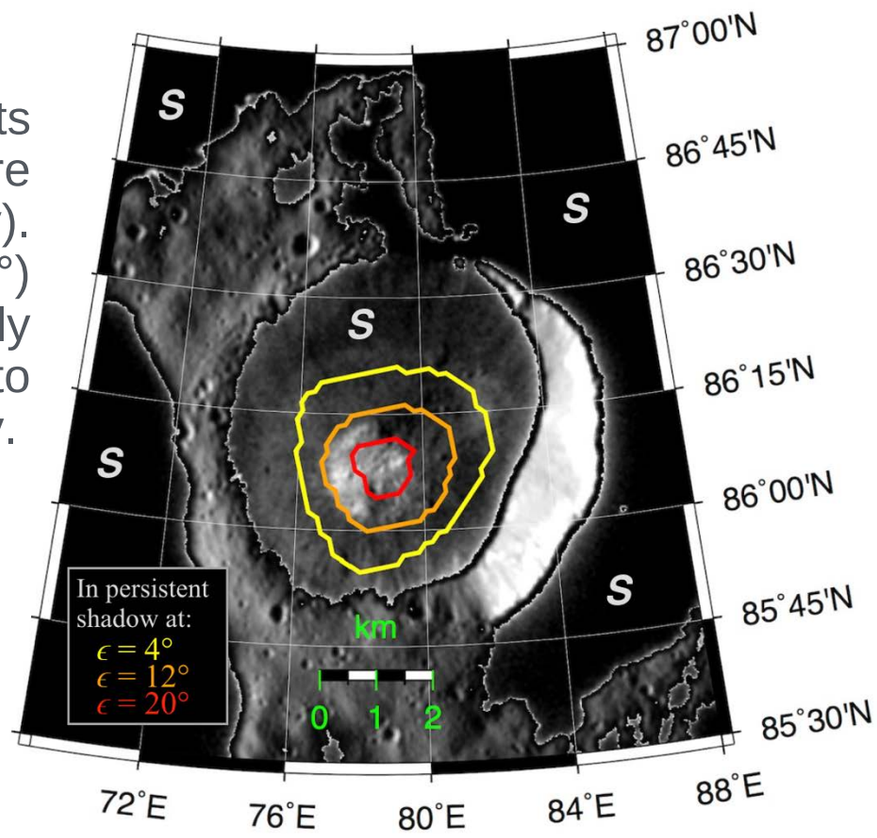
The Dawn Framing Camera (FC) has observed bright crater floor deposits (BCFDs) near the poles of Ceres, but in only a handful of the craters that are observed to be in permanent shadow given Ceres' current 4° tilt (or obliquity). Using Dawn shape and gravity data, we have calculated large variations (2-20°) in Ceres' tilt over 25 kyr timescales. Numerical modeling of the permanently shadowed regions (PSRs) at the greatest tilt shows fewer PSR's compared to current conditions, but with a strong correlation with the BCFDs observed today.



Bright Crater Floor Deposits have been observed in a few dark polar craters by the Dawn FC. The enhanced image at right reveals BCFDs illuminated by scattered light.



Ceres' tilt (or obliquity ε) was found to vary between 2° and 20° with a 25 kyr period, due to combined secular perturbations (mostly from Jupiter and Saturn). We computed PSRs for the whole range of obliquities.



Projected images of BCFDs and the outlines of PSRs for different obliquities. Image enhancement shows both the shadowed (marked with S) and illuminated parts of the surface. We find a correlation between BCFDs and higher-obliquity PSR outlines for many of the rare craters.

What is the impact?

Areas that stay in shadow over long periods of time are called "cold traps," because they are so cold and dark that volatiles — substances easily vaporized — that migrate into these areas can't escape, even after a billion years. These bright crater floor surface deposits are likely composed of water ice trapped at earlier times in Ceres' history.

Why does it matter to non-scientists?

The presence of volatiles in cold traps on Ceres has implications for the origin of volatiles (like water) in the inner Solar System, whether derived from solar wind, delivered from comets, or released from the interior. This result provides yet another piece of the puzzle of how the Earth got its water in the distant past.

Reference: Ermakov, A. I., E. Mazarico, S. Schröder, U. Carsenty, N. Schorghofer, F. Preusker, C. A. Raymond, C. T. Russell, and M. T. Zuber, "Ceres' obliquity history and its implications for the permanently shadowed regions", *Geophys. Res. Lett.*, doi:10.1002/2016GL072250, 2017.