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Earth & Space

The closest dwarf planet to the Earth is alive

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ABSTRACT

Observations of Ceres from NASA Dawn spacecraft have detected recent variations in its surface, revealing that the only dwarf planet in the inner solar system is a dynamic body that continues to evolve and change.

Image credits: NASA

In our solar system, together with the planets, there are other small bodies: asteroids, comets, and dwarf planets, which keep memory of an ancient past. This because they are considered primordial, and as such, they can tell something of the dawn of our solar system.

Between the orbits of Mars and Jupiter, there is the so-called Main Belt, a place with millions of asteroids orbiting the Sun. Their size can range from the dimension of a small stone to rocks as large as mountains, or even small worlds. The largest asteroid, Ceres, has a diameter of 950-km, and is spheroid shaped, like the planets. For this reason, it was classified as a “dwarf planet”, the only one in the inner solar system, being all the other known dwarf planets, as Pluto, far away beyond the orbit of Neptune.

Ceres, like all the asteroids, has no atmosphere. As such, winds, clouds, or precipitations are completely absent on the surface. Thus, it appears to be a cratered body, like our moon, because each impact with other asteroids leaves a trace, which cannot be canceled by any atmospheric agent. Moreover, it has a very dark surface, meaning that it is composed of carbon compounds like the Carbonaceous meteorites that usually fall on the Earth.

The NASA spacecraft "Dawn" orbit Ceres since 2015. The Italian spectrometer VIR (Visual and InfraRed imaging spectrometer) onboard the spacecraft acquired the spectrum of the reflected light from the surface. With this we were able to distinguish the signatures of the minerals making up the surface.

VIR already revealed some surprises: all the surface present the ion ammonium which is a light molecule usually found in the outer solar system, thus it is curious its presence on Ceres; other minerals of the surface are found to be phyllosilicates and carbonates, their presence should be linked to a past extensive aqueous alteration; in a crater named Occator a bunch of bright spots, several square km each one, stand out against the dark soil. They were found to be composed by sodium carbonate, meaning that some liquid water should have processed the material; another spectacular feature on the surface is Ahuna Mons, a 4-km tall cryovolcano, which is a further indication of the presence of water in liquid or brine form; VIR also found a localized presence of organic material in the proximity of a crater named Ernutet, the largest amount of organic outside the Earth, whose origin is still debated; finally VIR detected patches of water ice on the surface of some crater.

All these minerals seem to be products of some geological activity. Something is going on in the interior of Ceres. Anyway, in a place like this, we did not expect to see anything changing during the time of the mission, being the geological processes much slower.

However, we observed something unexpected.

VIR detected water ice inside a mid-latitude crater, called Juling, in the southern hemisphere. The ice was found in the internal part of the rim, in an almost permanent shadow. Because it was considered an interesting target it was observed several times during a period of 6 months when Ceres was moving away from the perihelion and toward the summer. The analysis of the water ice on the wall revealed that the water ice amount increased, from 4 to 6 square km. It is difficult to explain such a phenomenon given the absence of the atmosphere. The water should come from inside the soil in liquid form, or from outside in vapor form. Both the explanations have problems: liquid water is difficult to explain by the fact that the interior of Ceres should not host temperature favorable for the water to be liquid. The vapor instead can well be formed directly from the ice, but it is difficult to find the source given the lack of ice on the surface nearby the icy-wall. It can be located under few centimeters in the subsurface of the crater floor, and sublimate from there, but in this case, it should be replenished by some geological mechanism.

The hypothesis that involves vapor implies a seasonal cycle: the increasing behavior should be followed by a decreasing one in the proximity of the perihelion, given that the warmer environment makes it sublimate from the wall itself.

We know that life, as we know it, requires the presence of organics, water, carbon and nitrogen compounds, in a geologically active environment. Well... Ceres hosts all these conditions!