put, the hubcap wobbles slightly.

If space were an entirely empty place, this wouldn't matter. But in fact, it is filled with widely dispersed debris. Aside from the junk left by human space activities (See "Killer Garbage In Space," page 44, Aug. '96), the debris is mostly stardust—the remains of colliding asteroids and crumbling comets. Jupiter's strong gravitational field tends to cause stardust that would otherwise meander into the Sun to collect along the giant planet's own disc-shaped orbital plane. Muller reasoned that if the plane of Earth's orbit wobbled in a way that occasionally caused it to spend long periods of time in this stardust-rich area, the amount of solar energy reaching the surface of our planet would be correspondingly reduced.

Running through the numbers with computerized tools unimagined in Milankovitch's era, Muller found an on-the-money connection between dips into the stardust-rich areas and geologic evidence of the onset of ice ages. Muller and MacDonald published their findings in an international scientific journal. As they hoped, this encouraged other scientists to search for evidence that an increase in stardust started the 100,000-year ice-age cycle.

One of the first was Walter Alvarez, chairman of the geology department at the University of California at Berkeley. He is best known as the scientist who found evidence that an asteroid struck Earth 65 million years ago, killing the dinosaurs. Measure helium-3 in ocean sediments, Alvarez suggested. Which is precisely what Kenneth Farley of CalTech and his graduate assistant, Desmond Patterson, set out to do.

The last ice age caused a significant decline in the human population. The next one is tens of thousands of years in the future.

Why helium-3? "Most of the helium-3 in oceanic sediments comes from interplanetary dust particles," Farley explains. "Therefore, it can be used to infer the accretion rate of dust [falling] to Earth through time." Using samples from the Deep Sea Drilling project, they studied a core taken from the flank of the mid-Atlantic ridge. They found that the rate of accumulation did indeed vary in the 100,000-year cycles that mirrored the comings and goings of ice ages. Ever the cautious scientist, Farley stops short of saying that the 100,000-year cycles are caused by stardust.

Part of the reason for his caution is that the amount of stardust that falls to Earth is relatively small—no more than about 10,000 tons a year. Studies of massive releases of ash from volcanic eruptions show that even much larger releases have no appreciable effect on climate. What makes stardust different, say some experts, is that the byproducts it creates as it vaporizes upon entry into our atmosphere cause very subtle changes in the Earth's energy budget.

So far, one piece of the puzzle is missing. Interplanetary dust clouds that account for the rise and fall of helium-3 have not been found. But no major search has been undertaken either.

Beyond solving geology's last great mystery, the emergence of the stardust theory has given scientists in all disciplines a better appreciation of how delicately balanced a system Earth really is. Or, as Donald E. Brownlee, of the University of Washington's Department of Astronomy, puts it: "Farley and Patterson's results remind us once again that our planet's climate is at the mercy of its wider environment." PM