Astronomy

Pluto: Evidence for polar caps

In 1985, for the first time in more than a century, the tilt of the orbit of Pluto's moon Charon reached an angle, as seen from Earth, such that observers could begin to see Charon pass in front of and behind its planet. In other words, the two objects appeared alternately to eclipse each other, as they will for about three more years. Now these shadowings, called mutual occultations, have provided data that one astronomer says may represent "a direct detection" of polar caps on Pluto.

Plutonian caps have been suggested before, but they are not necessarily icy deposits on an otherwise bare surface, as in the case of Earth and Mars. Scientists detected methane in spectral measurements of Pluto more than a decade ago, and Richard P. Binzel of Massachusetts Institute of Technology in Cambridge reports in the Aug. 26 SCIENCE that the mutual eclipses may be showing signs of methane ice topping more methane ice.

But how can observations made from a planet billions of miles away, too distant to show even continent-sized features, reveal an icy cap on top of equally icy terrain? Binzel's measurements, in fact, are not photographs at all but measurements of two colors in the sunlight reflected from Pluto and Charon together.

A methane molecule consists of one atom of carbon and four of hydrogen, and if it lies exposed on Pluto long enough it is regularly bombarded by ultraviolet sunlight that can strip away the hydrogen to leave a tarry, carbon-rich residue. (Another "stripper," points out David Stephenson of California Institute of Technology in Pasadena, would be cosmic rays.)

However, one group of researchers (including Binzel) suggested last year that some of the methane ice in Pluto's polar regions may vaporize to form a short-lived atmosphere, then freeze out again as the planet's elliptical orbit carries it nearer to and farther from the sun (SN: 9/26/87, p.207). This could result in a fresh ice surface, one that has not had as long to darken in the sun.

In 1986, says Binzel, Charon's orbit carried it so that it sometimes passed over Pluto's north-polar region as seen from Earth, and sometimes Pluto itself got in the way. When Charon was hidden from view, he says, the reflected light (measured with the 2.7-meter telescope at McDonald Observatory in Texas) looked slightly redder than when the satellite was blocking the polar region. A year later, however, when the satellite's orbit took it in front of Pluto's equatorial region rather than the north pole, there the light appeared bluer.

The implication, according to Binzel, is that Charon is slightly bluer than Pluto's equatorial latitudes, but similar to the part of the surface closer to the north pole. The redder spectrum would result when Pluto's pole is hidden, as though a spectrally bluer region had been omitted from the reflected sunlight entering the telescope. Alternatively, blocking Pluto's equator would add Charon's "blueness" to the whole.

The bluer color in the measurements when Pluto's pole is visible, Binzel suggests, could be the result of methane ice that was deposited relatively recently, so that it has not had much time to darken. But how long does that take?

"There may be a significant redistribution of methane on Pluto in as little as one Pluto year [about 248 Earth years]," says David Stephenson. "The thing I don't know is whether there can be a significant amount of darkening in that year. Another factor is whether there is some way to resupply fresh, still-undarkened methane ice to the surface."

Also, methane molecules presumably can be stripped of their hydrogen atoms only once. When all are reduced to bare carbon (however long that takes – millions of years? billions?), will Pluto's polar caps, if they are indeed there now, disappear?

With future observations of the mutual eclipses, says Binzel, "we hope to get a rough map of an entire hemisphere of Pluto."

Computer Science

Christopher Vaughan reports from St. Paul, Minn., at the American Association for Artificial Intelligence conference

Old problems for testing a new math

Computers are very good at figuring out the solution to a physics problem, but the heart of intelligence lies in what physicists themselves do: look at a situation and decide what the problem is. This requires the kind of qualitative reasoning – the commonsense physics – that is so important in artificial intelligence (AI) research. The "qualitative physics" that lets us evaluate whether a bathtub with a leaky plug and the water pouring in from a spout will eventually overflow is something we learn intuitively as children, but it is hard to program into a computer.

What AI specialists need to create programs that design their own problems to solve is a new form of math – one less exact than the simple math we learn in school but not so general that all the predictive value of the equations is lost, says Brian Williams of Massachusetts Institute of Technology in Cambridge. Other researchers thought of this, but took a look at the task and decided the prospects of finding such a mathematics "didn't look promising," Williams says. However, he has succeeded in inventing just such a "new algebra," called Q1, which can work at a level better suited for posing a problem – deciding what the problem is that one needs to solve.

Q1 may allow computers not only to solve design problems, but also to suggest new designs that humans hadn't imagined. To test this, Williams is giving a computer all the knowledge available about physics and oil lamps in 300 B.C. He wants to learn whether the computer can, on its own, come up with the oil lamp design that proved a radical invention of its time: a lamp with a self-regulating oil level that Williams says represents the first example of mechanical feedback in history.

"Research suggests [the computer] can," he says.

Computer smarts changing business

Expert systems are computers that solve problems by applying simple reasoning skills to a store of knowledge. A two-year study of the use of expert systems in business reveals an explosive growth in the number of expert systems employed, and shows that companies using such systems reap tremendous gains in productivity.

In 1981, companies used only two expert systems; today about 2,000 different expert systems are used worldwide, reports one of the study's authors, computer scientist Edward Feigenbaum of Stanford University. Examples of productivity gains range from the 10-fold decrease in the time it takes to design a camera lens to a 300-fold decrease in the time it takes computer companies to organize the components of a large computer system. The time difference between walking and flying a jet also is 300-fold, Feigenbaum notes.

Time savings come, for instance, through the ability of lens designers to give the expert system a design and ask it to minimize the size of the lens. Time is money, and Feigenbaum reports that expert systems now save Digital Equipment Corp. $70 million to $100 million a year.

Furthermore, such benefits result from only the "first wave" of expert systems, using artificial intelligence technology of the 1970s and personal computers, Feigenbaum says. Far more impressive gains will come when research of the 1980s creates business applications in mainframe computers with large data bases of knowledge, he adds.

"Expert systems carry the potential for significant changes in the economy," Feigenbaum says. National wealth is tied to the nation's productivity, and the only way to increase productivity is to "work harder or work smarter," he says.

Feigenbaum, Stanford researcher H. Penny Nii and freelance writer Pamela McCorduck report the results in a book, *The Rise of the Expert Economy,* scheduled for publication in late September.