detect because at a great distance from Earth, even a speedy galaxy appears to cross the sky at a snail's pace. In their study, the astronomers compared photographs, taken 15 years apart at the Cerro Tololo Inter-American Observatory in La Serena, Chile, of a star-packed region at the LMC's northeastern edge.

Using an electronic scanner, they could discern the slight shifts in position, relative to a fixed background of distant galaxies, of 250 LMC stars during those 15 years. Based on this analysis, the researchers report that the satellite galaxy moves across the sky at a brisk 220 kilometers per second. To keep the LMC gravitationally bound to the Milky Way despite this transverse velocity, the team calculates, our galaxy must contain at least as much mass as 600 billion suns — about five times as much mass as the visible galaxy.

Deriving the shape of the proposed halo of dark matter surrounding the Milky Way requires further knowledge of the LMC's orbit. Lin's team reconstructed the galaxy's likely path by examining a huge comet-like stream of hydrogen gas that astronomers believe was torn from the LMC by the Milky Way's gravity. Lin suggests that the stream trails the LMC and marks the galaxy's path at the time of its previous revolution around the Milky Way, about 2.5 billion years ago. "The stream provides a tracer, just as a jet [contrail] shows where a jet used to be," he notes.

Lin notes that segments of the hydrogen stream have a large radial velocity. Since this velocity had to have originated from the stream's parent galaxy, the LMC, this indicates that the galaxy takes a highly elliptical, rather than circular, path around the Milky Way.

A distribution of dark matter that extends far beyond the LMC best explains the galaxy's elliptical path. The LMC lies about 170,000 light-years from the center of the Milky Way. In comparison, the Milky Way's halo of dark matter may have a minimum radius of 300,000 light-years, Lin says, and could extend as far as 800,000 light-years.

Scott D. Tremaine of the University of Toronto says the study is important but that its implications for measuring dark matter are far from clear-cut. "Most people will probably be a little cautious in applying this; it's easy to underestimate [errors] in determining dark matter. It's not like [measuring] the orbit of a planet, which we can study as it goes around many times. Here you have just one snapshot."

Lin says the study indicates that the LMC and perhaps other satellite galaxies of the Milky Way are about 1 to 2 billion years younger than the oldest stars in our galaxy. Bit by bit, the Milky Way's gravity is tearing apart the LMC and will gobble it up entirely in about 20 billion years, he adds. *— R. Cowen*

Lipoprotein link to heart disease revealed

High concentrations of the cholesterol carrier lipoprotein(a) in the blood are a known risk factor for heart disease. Indeed, cardiologists estimate that Lp(a) — a close cousin of low-density lipoprotein, itself a heart threat — may be responsible for up to 25 percent of heart attacks that strike relatively early in life. The trouble is, scientists don't understand the mechanism underlying this molecule's role in the drama of heart disease.

Now, an international scientific team suggests that elevated concentrations of Lp(a) in the bloodstream may cause smooth muscle cells within the artery wall to proliferate. As a cholesterol carrier, Lp(a) also deposits cholesterol and other fatty debris on the vessel's inner wall. The thickening of the blood vessel that results is a hallmark of atherosclerosis.

Biochemist David J. Grainger of the University of Cambridge in England and molecular biologist Richard M. Lawn at the Stanford University School of Medicine grew smooth muscle cells taken from healthy human arteries in laboratory dishes. When the team exposed those cultured cells to Lp(a), the cells began to divide more rapidly than usual. The researchers report their findings in the June 11 SCIENCE.

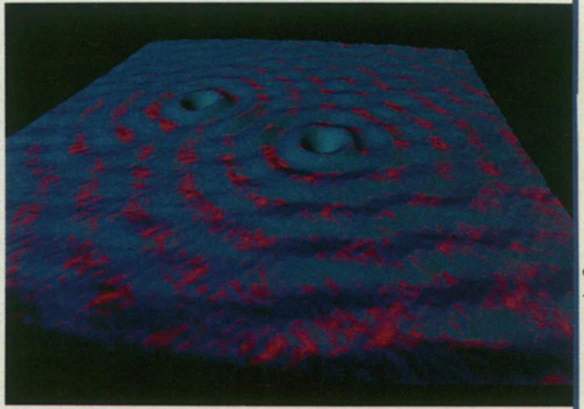
The new study suggests that Lp(a) interferes with a natural growth-restraining system that operates in human arteries. The group showed that Lp(a) inhibited the activation of an antiproliferative substance called transforming growth factor-β. Without enough of this activated factor, smooth muscle cells continue their division unchecked, an insidious process that could lead to clogged arteries, Lawn says.

People with high concentrations of Lp(a) in their blood may suffer the double whammy of too much arterial muscle cell proliferation plus large deposits of cholesterol inside their artery walls. Such a mechanism may explain the elevated risk of heart attack for such people, Lawn adds.

However, both Lawn and Grainger warn that their study only looked at this cholesterol carrier's impact on smooth muscle cells grown in laboratory dishes. The team has yet to determine whether such proliferation takes place in humans.

If it does, cardiologists may one day be able to stave off atherosclerosis in people who produce too much Lp(a), says Grainger. One approach would be to use drugs that block the excess proliferation of smooth arterial muscle cells, he speculates. *— K.A. Fackelmann*

Rippling the surface of an electron sea


Eigler/IBM Research

If it weren't for the unnaturally luminous colors, you might think you were looking at ripples centered around a pair of barely submerged rocks in a pool of water. But this is a new kind of waterscape — one that originates in the realm of atoms, electrons, and quantum physics.

Metal atoms readily lose one or more electrons, and these electrons roam freely within the metal crystal to form a pervasive "electron sea." At the surface of a metal crystal, however, the loose electrons usually are confined to a thin layer. Free to move only in two dimensions, these particles also behave like waves.

Donald M. Eigler and his co-workers at the IBM Almaden Research Center in San Jose, Calif., used a scanning tunneling microscope at 4 kelvins to detect tiny variations in the concentration of electrons across the surface of a copper crystal. They observed distinctive patterns of electron density corresponding to standing waves, in which the locations of the peaks and troughs of the electron waves remain fixed.

In the image shown, a pair of imperfections on the surface of a copper crystal deflects electrons in such a way that the incoming and scattered electron waves overlap to create concentric ripples at each defect. The electron layer responsible for generating this standing-wave pattern is just 0.02 angstrom deep.

Eigler and his colleagues describe their technique for imaging electron waves in the June 10 NATURE. Researchers at the IBM Thomas J. Watson Research Center in Yorktown Heights, N.Y., have recently obtained similar images of standing electron waves on a gold surface at room temperature.