Astronomy

Dietrick E. Thomsen reports from Houston at the meeting of the American Astronomical Society

Dragging frames of relativity

Einstein's general theory of relativity makes an essential connection among the force of gravity, the curvature of space and accelerated motions. One of the consequences of this connection is that frames of reference anchored on an object in accelerated motion will appear to "drag," to lag or precess with respect to a frame fixed on bodies that are not accelerated. And this drag seriously complicates the description that a person fixed in one of these frames would make of a motion observed in the other.

The rotation of the earth is a constantly accelerated motion — physicists define "acceleration" as any change from motion in a straight line at uniform speed — and so a frame fixed on the rotating earth should drag compared with one fixed on distant stars. Detection of this drag and measurement of the amount would be a good test of the theory's accuracy.

Scientists had thought they needed to go to a fairly distant orbit to get a smooth enough motion and preserve the gyroscopes that are part of the experiment from spurious torques due to random glitches in the earth's surface motion. The advent of laser gyroscopes makes this no longer necessary, says Andrew Buffington of the University of California at San Diego. The experiment can now be done on the surface of the earth.

A laser gyroscope is a triangular arrangement of mirrors. Two laser beams — one clockwise, the other counterclockwise — are continually reflected around the triangle. After they make the circuit, the two beams are brought together, and the phase difference between them is measured by allowing them to interfere with each other. Any disturbance to the geometry of the triangle will cause the phase relation to change. Such a gyroscope, Buffington avers, is accurate enough not to be fooled by spurious torques.

Buffington would use the gyroscope to establish a direction in space, a line fixed to the rotating earth. A reference frame fixed on distant stars would be simultaneously determined by noting their passage across the meridian. Buffington intends to make the meridian measurements with a Ronchi telescope, a telescope with a grating in the eyepiece to ensure very precise determination of the instant of a given star's meridian passage. Optically or mechanically connecting the telescope and the gyroscope will allow a continuing comparison between the frames established by the two instruments, and so a calculation of any drift between them. Buffington is now looking for means to set up his Ronchi telescope.

Ghost pulsars in the sky

Turbulence in the earth's atmosphere causes multiple refractions of the light from stars, and so makes them "twinkle." Images jump around and are sometimes multiple. Turbulent electrons in interstellar space can do the same for radio waves from celestial sources. Aleksander Wolszczan of the National Astronomy and Ionosphere Center's Arecibo Observatory in Puerto Rico, and James M. Cordes of Cornell University in Ithaca, N.Y., have done year-long observations of such scintillations of pulsars. They are now convinced that such multiple refractions occur on a time scale of tens of seconds, and that "the instantaneous image of some pulsars is also sometimes multiple."

With very long baseline interferometry, which uses an array of telescopes to simulate one very large telescope, the astronomers can resolve the different images and get spectra from individual ones. Together the images can be used to build up a more accurate picture of the pulsar itself during these episodes of multiple imaging. Separately, the spectra give information about very short time changes in the pulsar's behavior. Somewhat conversely, the observations also give information about the behavior of the interstellar medium.

Biomedicine

Joanne Silberner reports from Sarasota, Fla., at the American Heart Association's Science Writers Forum

Risky business

The same type of genetic analysis that has led to a marker for Huntington's disease (SN: 11/12/83, p. 311) may someday enable doctors to pinpoint just who is at risk of heart disease, says Philippe Frossard of California Biotechnology, Inc., in Bay View. He and his colleagues have already identified 24 genetic markers associated with atherosclerosis. But more work needs to be done before the strength of the association, and thus its predictive ability, will be known, he says.

No single factor — including obesity, smoking history, positive family history or levels of cholesterol, its carriers or constituents — can predict if any one individual is likely to die of heart disease. Knowing who is at special risk would enable countermeasures, such as lifestyle change or drug treatment, before the disease has progressed.

Frossard and his colleagues started their search for genetic markers in and around genes involved with lipid metabolism and transport. They used enzymes to break the genes, and compared the fragment lengths from people with hardening of the arteries to fragment lengths from people without it.

Some of the patients with genes indicating a high-risk group had normal cholesterol levels; this contradiction, says Frossard, may help explain why serum cholesterol levels are not 100 percent accurate in predicting heart disease risk. Several of the markers are actually "protective" — people with the markers were less likely to have heart disease.

The initial study, in conjunction with Gerd Assmann of Muenster (West Germany) University Hospital, was done on the genes of 500 Germans being evaluated for atherosclerosis by coronary angiography. The California Biotechnology workers are beginning a study on 3,000 U.S. residents. "In about two years we should have a battery of markers that should be sufficient for prediction," Frossard says. He expects such a test to cost less than $50 per person.

Pictures of the heart

If Academy Awards were given for medical devices, this year's Oscar for best technical achievement might go to something called cine CT, an imaging procedure that takes stop-action photos of the beating heart.

There are already five cine CT machines operating in the United States, says cardiologist Melvin L. Marcus of the University of Iowa in Iowa City, where one of them is located. He and his colleagues have used theirs to measure blood flow through grafted coronary arteries. Such measurements cannot otherwise be obtained, except through catheterization, an expensive and invasive procedure.

By using density formulas, cardiologists can measure the actual weights of different parts of the heart with 98 percent accuracy, he says. And cine CT has also enabled surgeons to find holes in the hearts of children with congenital heart defects before surgery.

The CT stands for computed tomography, the souped-up X-ray technique that uses computer analysis to yield precise cross-sectional images. X-rays in conventional CT machines are generated by a tube that rotates around the subject, and an image requires a 1- to 2-second exposure.

The Mayo Clinic in Rochester, Minn., has also developed a machine capable of imaging the beating heart. Called the dynamic spatial reconstructor (SN: 11/1/80, p. 284), it relies on X-ray tubes placed around the body. But there are no plans to market the Mayo machine, which was designed for research purposes.

The cine CT, developed by Douglas Boyd of the University of California at San Francisco, who now heads a company called Imatron, Inc., uses a rotating electron beam to hit tungsten rings and generate X-rays.