communicate with itself—that is, to transfer information back and forth. The trick, he says, is to squeeze the computer down to the most compact possible size. Lloyd shows that a computer made of the most compressed matter in the universe—a black hole—would calculate as fast as a plasma computer. It would also communicate in precisely the same time that it takes to flip a bit—the hallmark of the ideal computer. Coincidence? Perhaps not, Lloyd says: "Something really deep might be going on."

At present, scientists have no idea how to turn a laptop into a black hole (Windows 98 jokes aside). But Laflamme says that just thinking about such extreme scenarios might illuminate deep physical mysteries such as black holes. "It's not just what insight physics brings to information theory, but what information theory brings to physics," he says. "I hope that, in the next 10 or 15 years, a lot of insight into physics will be due to quantum computing."

–CHARLES SEIFE

ASTROPHYSICS

Neutron Stars Imply Relativity's a Drag

Matter warps space; space guides matter. That, in a nutshell, is Einstein's general theory of relativity. Now three astronomers in Amsterdam may have confirmed a much subtler prediction of Einstein's: warped space-time with a twist.

The general theory explains how the sun's gravity curves the surrounding space (actually space-time), bending nearby light waves and altering the orbit of Mercury. The new finding, based on x-rays from distant neutron stars, could be the first clear evidence of a weird relativistic effect called frame dragging, in which a heavy chunk of spinning matter wrenches the space-time around it like an eggbeater. "This is an extremely interesting and beautiful discovery," says Luigi Stella of the Astronomical Observatory in Rome, Italy.

Peter Jonker of the University of Amsterdam, the Netherlands, and his colleagues Mariano Méndez (now at the La Plata Observatory in Argentina) and Michiel van der Klis announced their results in the 1 September issue of *The Astrophysical Journal*. To describe such exotic behavior of space-time, Jonker goes beyond the astrophysicist's standard image of a bowling ball resting on a stiff sheet.

"Frame dragging is comparable to what happens when you cover the ball with Velcro and rotate it," Jonker says. The effect occurs only in the immediate neighborhood of very massive, swiftly rotating bodies. To study it, astronomers have to observe distant neutron stars—the extremely compact leftovers of supernova explosions, whose near-surface gravity is so strong that they make ideal testbeds for general relativity.

Using data from NASA's Rossi X-ray Timing Explorer, Jonker and his colleagues found circumstantial evidence for frame dragging in the flickering of three neutron stars in binary systems. The flickering spans a wide range of x-ray frequencies. According to theoretician Frederick Lamb of the University of Illinois, Urbana-Champaign, the most prominent "quasi-periodic oscillations" probably come from orbiting gas that a neutron star tears off its normal-star companion. The hot gas accretes into a whirling disk and gives off x-rays as it spirals toward the neutron star's surface at almost the speed of light.

The new evidence comes in the form of less prominent peaks close to one of the main frequency peaks. These so-called sidebands showed up only after the researchers carefully combined almost 5 years' worth of data. The Amsterdam astronomers say the peaks could be due to frame dragging, which would cause the accretion disk to wobble like a Frisbee. The wobble frequency would imprint itself on the main frequency peak, just as amplitude modulations do on the carrier wave of a radio broadcast.

Some physicists, however, are unconvinced. Lamb says calculations done with his Illinois colleague, Draza Markovic, show that the frequency separation between the main signal and the sidebands is probably too large for the sidebands to have been caused by frame dragging. A similar false alarm occurred 3 years ago, he says, when Stella and Mario Vietri of the Third University of Rome cited a low-frequency, 60-hertz x-ray flicker in a couple of neutron stars as evidence of frame dragging (*Science*, 7 November 1997, p. 1012). The frequency of that earlier flicker clashed with theoretical calculations by Lamb's group and others. Lamb suspects that the flicker arises from a neutron star's intense magnetic field interacting with the accretion disk. Although the sidebands aren't as far out of step with theory, he says, "it's unlikely that [they] are produced by frame dragging."

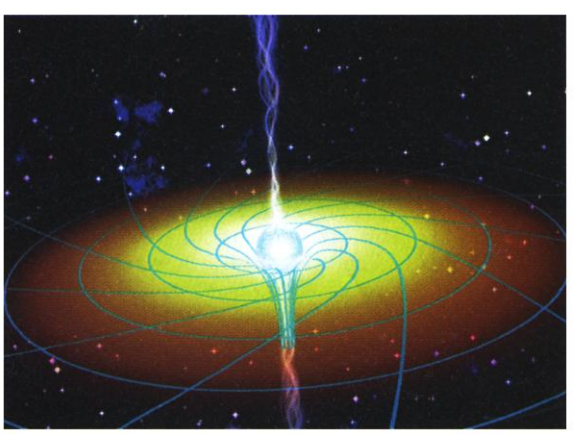
Even so, the sidebands are "a very important result," Lamb says. "The discovery of sidebands is a real breakthrough, regardless of what causes them. This may be the key to unlocking what is generating the main oscillations." They may also provide information on the mass, the radius, and the physical makeup of neutron stars.

But Stella says frame dragging can't be so lightly dismissed. Taken as a whole, he says, the sidebands and his earlier evidence "fall together in a very nice fashion. The frequency differences pose no problem at all." Indeed, in a paper submitted to *The Astrophysical Journal*, Dimitrios Psaltis of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, presents a model of a relativistically oscillating disk that overcomes the frequency problem.

The Amsterdam astronomers hope to use the Rossi satellite to study the neutron stars in more detail and look for sidebands in other sources. If the sidebands are indeed caused by frame dragging, Van der Klis explains, their frequency should shift along with that of the main oscillation in a specific way that will provide a decisive test of the hypothesis. "In principle," he says, "these kinds of observations could prove Einstein right or wrong."

–GOVERT SCHILLING

Govert Schilling is an astronomy writer in Utrecht, the Netherlands.



It's a wrap. According to general relativity, a massive neutron star (shown spinning counterclockwise) could warp and twist space-time in its near neighborhood.

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ECOLOGY

Forest Fire Plan Kindles Debate

Forest fires burning in the western United States have already scorched over 2.5 million hectares this summer. Now a federal proposal to prevent them by paying loggers to cut smaller trees is generating heat among ecologists, who say the approach may not be right for all forests—or all fires.

Leaders of western states have sharply criticized the Clinton Administration for not doing enough to prevent the blazes, the worst in nearly a century. They say that re-