dom string of ones and zeros added to a message to make it unintelligible. Before the receiver of the encrypted message can read it—by simply subtracting the key string—the key somehow has to be sent to the receiver. If it is simply sent along the same route as the message it protects, it might be intercepted. In top security situations, says Rarity, the solution "is basically a man on a motorbike"—not a very practical solution if you want to transmit messages to a satellite.

In the Los Alamos scheme, the sender of the secret information, traditionally dubbed "Alice," sends a key by dispatching a stream of single photons, whose wave orientation, or polarization, is assigned one of two values. The receiver, known as "Bob," sets out to detect the photons through a filter system that randomly switches between two other, related, polarizations. Because of the choice of polarizations used, and the vagaries of quantum mechanics, even with a perfect experimental setup Bob would only be able to detect 25% of the photons that Alice sends.

Alice and Bob can then compare notes, via a public communication channel, on which photons Bob was able to measure. It does not matter if someone eavesdrops on this conversation, because they do not reveal the polarization results, just the occasions when Alice sent a photon and Bob received one. Hence, Alice and Bob now know the sequence of polarization results that Bob detected, and this serves as the key. It won't do a potential eavesdropper any good to tune in to the quantum channel either. Quantum rules mean that anybody who attempts to listen in to the string of photons will reveal themselves, because Bob will notice a rise in his photon error rate.

Although quantum keys have previously been transmitted across labs and, 2 years ago, over 75 meters in the open, until now nobody has confronted the type of real, swirling atmosphere that would be encountered on the way up to a satellite. In the Los Alamos work, Alice is a source of laser pulses, each just a nanosecond long and so dim that the average pulse contains less than one photon. Once polarized at random in one of two ways, each pulse makes the half-kilometer journey along a disused particle accelerator cutting to a mirror and then back to Bob, a receiving telescope plus optical analyzer stationed alongside Alice.

The big problem is turbulence, says Buttler, which "causes the beam to wander" and so miss the telescope. To beat turbulence, the team spread the beam to a diameter of 5 centimeters, greatly improving the chance that the telescope will pick up at least some of the beam. The team was able to successfully transmit a key code, at a hit rate of around one key bit for every 400 laser pulses.

Transmission over a single kilometer may seem a modest achievement, given that satellites are at least 200 kilometers above Earth's surface. But in fact "the real difficulty is the first kilometers," says Gisin, because above about 3 kilometers the air becomes purer and turbulence is less of a problem. The Los Alamos team is now trying to repeat the feat over longer distances and even in daylight, when the ambient brightness confuses the receiving signal. So far, "our results are encouraging," says Buttler. The main challenge, says Rarity, will be actually hitting the satellite with enough beam to do the job. "Given that you only want a few kilobits of key, it can be done," Rarity believes.

—ANDREW WATSON

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FRANCE

Researchers Rail Against CNRS Reforms

PARIS—Geochemist Claude Allègre, France's minister of national education, research, and technology, had his hands full last week. While high school students across the country were marching in the streets for improved conditions in schools, some French scientists were threatening to stage their own protests over proposed reforms of the Centre National de la Recherche Scientifique. The CNRS, a huge public agency that employs 11,600 full-time researchers, is the bedrock of French science, and—as Allègre quickly learned—government ministers meddle with it at their peril.

Meeting resistance. French Research Minister Claude Allègre.

The controversy began on 10 October, when physicist Edouard Brézin, president of the CNRS's executive board, presented an early draft of the reforms to a board meeting. The confidential document, which Brézin had prepared in collaboration with Allègre and other ministry officials, outlined a number of proposed changes in the agency's statutes, most of which were designed to create closer ties between the CNRS and university labs. The document was quickly leaked to researchers' unions, who raised the alarm about what they saw as a threat to the independence of CNRS labs, despite the fact that most of the agency's research units are already located on university campuses. In an interview with the daily newspaper *Le Monde*, Jacques Fossey, secretary of the National Union of Scientific Researchers, accused Allègre of trying "to turn the CNRS into a granting agency for university research," which many CNRS researchers believe is inferior.

Another noteworthy feature of the reforms was a provision that would strengthen the role of the executive board and place it squarely in charge of CNRS's overall scientific direction, a responsibility it now shares with the organization's director-general. It is no secret that Brézin has not seen eye to eye with CNRS Director-General Catherine Bréchignac, who has been much more lukewarm about moves to reform the organization. Brézin says that this power struggle within the agency is of "little interest to people who don't work at the Rue Michel-Ange [CNRS's Paris headquarters] and will have no effect on the labs." Bréchignac was unavailable for comment.

Vincent Courtillot, Allègre's chief adviser, says that the unions have misunderstood the intentions behind the reforms. "We want to bring [CNRS labs] closer to university [labs], not to dissolve one or the other," he says. Courtillot also argues that 90% of CNRS labs already have the status of "associated units," meaning that they include scientists from universities, other public agencies, and industry. The remaining 10% are made up solely of CNRS researchers. However, Brézin told *Science* that a key feature of the reforms would ultimately be to give all CNRS labs associated status.

But chemist Henri-Edouard Audier of the École Polytechnique near Paris, a member of the CNRS executive board, says that protests arose because the government was trying to push the reforms through without sufficient debate. With 90% already associated, he asks, "why are they making such a big deal out of the other 10%? ... We are all for reinforcing links between the CNRS and the universities, but CNRS labs must retain their own mission."

In response to scientists' criticisms, Brézin has drawn up a second draft of the proposals, which would allow unassociated CNRS labs to be created and continue to exist for 4 years if there is no obvious partner lab for them. And as *Science* went to press, Courtillot was due to meet with researchers' unions this week to calm the waters. "We are not against reforms," says Audier. "But we must first have a discussion of the principles behind them. We need to understand where we are going."

—MICHAEL BALTER

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