Lamb of the University of Illinois, Urbana-Champaign. Until scientists clear up the discrepancy, basic information such as the black hole's speed will remain unknown. All the same, Lamb says, a spinning black hole remains the most plausible explanation for what astronomers are seeing. "This is a remarkable discovery," he says.

–MARK SINCELL

Mark Sincell is a science writer in Houston.

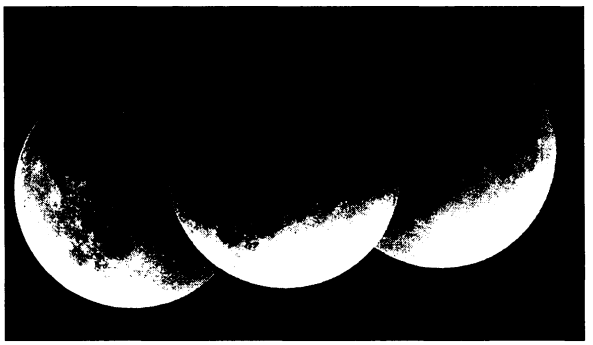
Trapping Neutrinos With Moondust

While astronomers clamor for bigger and bigger telescopes, physicists have quietly brought into play the largest instrument yet: the moon. Of course, such an enormous (and opaque) chunk of rock isn't much use for gathering light. But a 40-year-old theory has shown a way to turn it into a neutrino detector.

Neutrinos are haughty particles, so reluctant to interact with matter that they often pass right through Earth unhindered. To catch them, modern neutrino detectors rely upon a huge blob of mass, usually a tub of heavy water or a chunk of ice. When a swift neutrino interacts with the mass, it creates a cascade of particles that move too fast for the medium they're in, so they release the electromagnetic equivalent of a sonic boom—a faint glow called Čerenkov radiation.

In 1961, Soviet physicist Gurgen Askaryan suggested that if the incoming neutrino is energetic enough, the particle cascade will drag hordes of electrons from the matter along with it, generating coherent, polarized radio and microwave emissions in addition to the visible light typically associated with a Čerenkov shower. David Saltzberg, a physicist at the University of California, Los Angeles (UCLA), and his colleagues realized that this "Askaryan effect" might give them a unique opportunity to detect ultrahigh-energy neutrinos coming from outside our galaxy. If a superfast neutrino passed through the moon and then struck an atom near its surface, the cascade of particles would generate radio waves that Earth-based antennas could detect. Astrophysicists believe that such high-velocity neutrinos exist but have never identified them.

The only problem was that the Askaryan effect had never been tested in the lab in a solid medium like the moon's surface. So Saltzberg's team shot a powerful gamma ray beam at the Stanford Linear Accelerator into a three-and-a-half-ton box of moon-surface–like sand. The beam whipped up particle showers roughly as energetic as a shower created by an ultrahigh-energy neutrino—about 10^{19} electron volts. Sure enough, the scientists saw polarized, coherent pulses of radio waves, just as Askaryan predicted. "This has been talked about for more than 30 years," says team member Dawn Williams, a physicist at UCLA who described the experiment at the meeting. David Besson, a physicist at the University of Kansas, Lawrence, hails the test as "the first demonstration of the Askaryan effect in a dense medium."



CREDIT: STEPHEN BARNES/SKY OPTICS

Luna trick. Astronomers hope to detect high-energy neutrinos by listening for radio transmissions from the moon.

Encouraged by their success, Saltzberg's team turned its attention skyward. Borrowing downtime on radio antennas in the Mojave desert that NASA ordinarily uses to communicate with spacecraft, the scientists swiveled the dishes toward the moon to listen for the radio waves from high-energy neutrino strikes. After 30 hours of observations, Williams says, "we have no signals above five sigma"—in other words, no evidence of ultrahigh-energy neutrinos. But it's still early in the game, Besson says; with 120 hours still to go, he expects that something will turn up soon.

–CHARLES SEIFE

HUMAN ANTHROPOLOGY

Modern Men Trace Ancestry To African Migrants

Examination of markers on the Y chromosome add to the growing evidence that modern humans descended from people migrating out of Africa

When scientists sequenced DNA from the mitochondria of a Neandertal 4 years ago, they found that it was very different from that in living humans. The implication: We did not inherit mitochondrial DNA (mtDNA) from Neandertals. That finding provided a big boost to the leading view of human origins: the "Out of Africa model," which says that the ancestors of living humans swept out of Africa in the past 200,000 years and replaced all indigenous people they encountered (*Science*, 11 July 1997, p. 176).

But the backers of a dissident view—which holds that living humans are descended from several indigenous populations of the Old World, including Neandertals—did not give up the fight. They retreated to another fortress: Asia. A recent analysis of fossils, they argue, shows that an archaic *Homo erectus* from Java shared key features with living Asians and early modern humans in Australia. Their conclusion: Asian *H. erectus* passed on some of its DNA to modern Australians and Asians (*Science*, 12 January 2001, p. 293). Now, geneticists are storming this stronghold of multiregional evolution, as well.

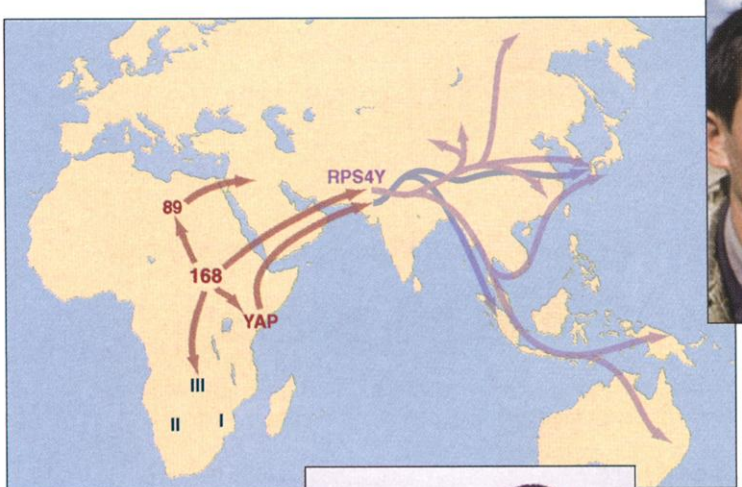
In work described on page 1151, a team of Chinese and American geneticists examined characteristic DNA sequences called markers on the Y (male) chromosome in a huge sample of men in Asia and Oceania. The Y chromosomes of every one, they found, could be traced to forefathers who lived in Africa in the past 35,000 to 89,000 years. Two other groups who have examined the geographic distribution of a large set of markers on the Y chromosome in men around the world have come to similar conclusions.

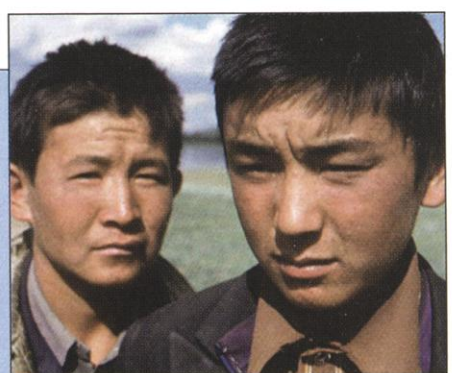
Together with a variety of studies showing that mtDNA is of recent African origins, anthropologists now have two strong lines of evidence in favor of the replacement hypothesis. Indeed, at the annual meeting of physical anthropologists in Kansas City, Missouri, last month, one self-described "dedicated multiregionalist," Vince Sarich of the University of California, Berkeley, admitted: "I have undergone a conversion—a sort of epiphany. There are no old Y chromosome lineages [in living humans]. There are no old mtDNA lineages. Period. It was a total replacement."

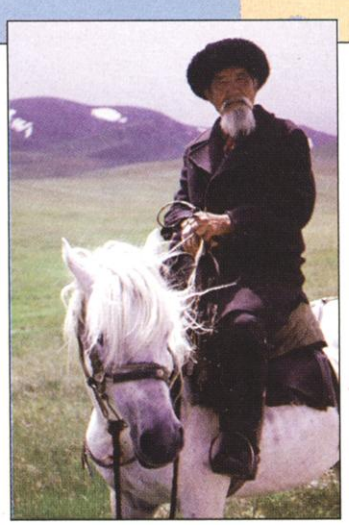
But the backers of the replacement hypothesis are not dancing on the grave of multiregional evolution. They note that evolutionary studies of nuclear DNA are just getting under way. And because human genomes are a mosaic of genetic lineages inherited from different ancestors, it is still

possible that some of our nuclear DNA came from archaic humans who were not part of the recent migration out of Africa. "You can nail it down from the perspective of the Y and mtDNA, but that still leaves us at the doorstep of the nuclear genome," cautions evolutionary geneticist Michael Hammer of the University of Arizona in Tucson.

The multiregionalists focused on Asia and Australia because they speculated that it was here that incoming Africans encountered entrenched archaic people who were the descendants of *H. erectus* in China or Java—and interbred, at least at low levels. In the work published in today's issue of *Science*, a team led by human population geneticist Li Jin of the University of Texas, Houston, and Fudan University in China concentrated on the same region.







Men's movement. Modern Asian men, including these two Kazak brothers (*above*) and this Kyrgyz horseman, carry three Y chromosome markers—89, YAP, and RPS4Y—that arose from African marker 168.

By assuming that men with the same markers are more closely related, researchers can use different methods of phylogenetic analysis, such as building ancestral trees with markers, to trace the origins and movements of different DNA variants around the globe—and, hence, the paternal ancestry of those lineages. A comprehensive study of this type published in the January issue of the *Annals of Human Genetics* points to a recent African origin for the Y chromosome in men from Africa, Europe, Asia, Australia, and the Americas.

Stanford University molecular biologist Peter Underhill and colleagues analyzed 218 markers in 1062 men from 21 populations in those regions. They saw the greatest diversity in two distinct and long-separated clusters of Y chromosomes in African men. In contrast, they found that all men outside Africa share the same mutation, called M168, which arose in an African ancestor between 35,000 and 89,000 years ago. "The M168 mutation represents the signature of the recent successful modern human migrations across Africa and beyond," says Underhill.

When Jin's group took blood samples from 12,127 men in 163 populations in Asia, including China, Southeast Asia, and Siberia, they found that every one had inherited one of three markers that arose on a Y chromosome already carrying the M168 mutation. This finding indicates that they are descendants of men carrying the African marker. "We came to a simple conclusion," says Jin. "There are no old lineages left [from archaic Asians]."

Although Jin's study looked at many Asians, it only examined one lineage on the Y chromosome, which alone would not prove that all living men inherited their Y's from an African ancestor. But another more comprehensive analysis of 43 markers on the Y chromosome in 2858 men from 50 worldwide populations has shown the same pattern of African ancestry. This study, led by Hammer, also found that after an early expansion out of sub-Saharan Africa, Asia became the staging ground for groups of men who traveled to Europe and the Americas. (The results are in press in the July issue of *Molecular Biology and Evolution*.) "It seems that Africa was the place of origin for all Y chromosome diversity, but it also seems that our gene pool has been shaped more recently by dispersals out of Asia," says Hammer.

The new findings from the Y chromosome are even more powerful when combined with studies of mtDNA. "It is a quantum leap to get strong support for an African origin" from two genetic lineages instead of one, says geneticist Svante Pääbo of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. He co-authored a report in the 7 December 2000 issue of *Nature* that described the analysis of the entire mtDNA genomes of 53 people of diverse ancestry—all of whose mtDNA could be traced to an African origin.

Even the anthropologist most identified with multiregionalism, Milford Wolpoff of the University of Michigan, Ann Arbor, now agrees that "it is not surprising" that the Y chromosome has African origins. He points out that because Africa had the largest populations for the longest times, it is only logical that Africans should be the ancestors of more gene lineages—and that larger populations of Africans would have swamped out the genes of small groups of archaic people, whose DNA could have been lost to drift. "Why should the African origin of anything be surprising?" asks Wolpoff. But he would be surprised, he adds, if all of our genetic heritage originated in Africa.

Indeed, at this time, no one can rule out the possibility that some of us could have inherited nuclear DNA from Neandertal or *H. erectus* stock. The challenge for multiregional evolutionists is to find a population carrying ancient nuclear DNA variants that are not in our ancestral African stock. Ideally such variants could be identified in the ancient DNA of a Neandertal, although so far Pääbo's group can't get enough Neandertal nuclear DNA to analyze.

Even worse, the dating of nuclear lineages is complicated because most nuclear DNA, unlike that of the mitochondria and the Y chromosome, gets scrambled when homologous chromosomes exchange their genetic material during egg and sperm formation. That makes detection of an archaic lineage so difficult that many geneticists despair that they will ever be able to prove—or disprove—that replacement was complete. Says Oxford University population geneticist Rosalind Harding: "There's no clear genetic test. We're going to have to let the fossil people answer this one."

–ANN GIBBONS

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