Their new data indicate that the *tat* gene from HIV-1, which increases the production of viral proteins in cultured cells, may somehow trigger the growth of Kaposi's tumors. Both male and female transgenic mice that carry the HIV-1 *tat* gene mice express it in their skin cells and about 15% of the males develop Kaposi's-like tumors on their backs. Jay does not know why female mice fail to develop the tumors nor why only a small fraction of male mice do.

Jay and his collaborators interpret their new data to mean that the *tat* gene from the AIDS virus has the potential to cause cancer, in this case Kaposi's sarcoma. If this is true, it remains to be explained why all HIV-infected people do not develop Kaposi's. The researchers have not been able to show that the Kaposi's-like cells in the mice express the HIV-1 *tat* gene, nor can they detect *tat* expression in cultures of the tumors.

Both research groups propose models for the growth of Kaposi's. Gallo and Salahuddin agree with Jay that the cause of Kaposi's in HIV-infected individuals is HIV, "but it is indirect," says Gallo. When HIV infects T lymphocytes, it stimulates the cells to release the new growth factor. This factor may activate endothelial cells to become spindle-shaped cells. Once activated, Kaposi's cells make many factors, including interleukin-1, basic fibroblast growth factor, plasma-derived growth factor, chemoattractants and chemosuppressors that are not yet identified, and perhaps the new factor, says Gallo. Collectively, the factors recruit or stimulate other cells types such as granulocytes and macrophages from the blood and fibroblasts from the skin. Additionally, some of the factors may stimulate blood vessel formation. Jay thinks that growth factors may be involved in these processes but he sees a more direct role for the *tat* gene.

Many questions about Kaposi's remain to be answered. For example, no one can explain why it is predominantly a male disease. In the United States it occurs primarily in homosexual men with HIV infections. In Africa, it is widespread among young men and women, many of whom are not infected with HIV-1. Some older men in Mediterranean countries often have a milder form of Kaposi's. It is not clear what causes the disease, or if it has the same cause in these various populations.

The new work should allow researchers to study cellular and molecular mechanisms that trigger Kaposi's growth in vitro and may also help to identify its origins in vivo. "We can also ask whether other tumors are caused by chemical factors," says Salahuddin. If so, the new information may lead to different ideas about possible causes of tumor formation. ■ DEBORAH M. BARNES

Does Earth Fill Its Own Magnetosphere with Ions?

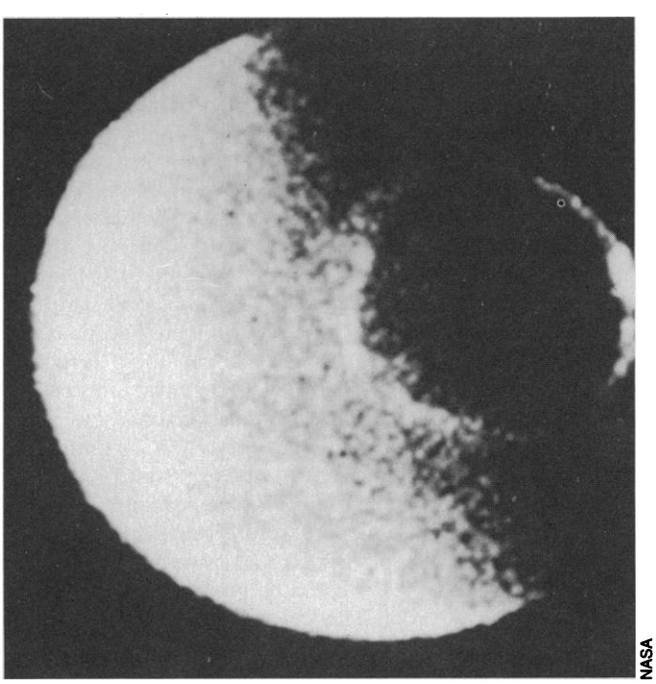
The ionosphere went from being an insignificant to a major source of magnetospheric ions; could it be the dominant source?

WHEN CHARLES CHAPPELL went to graduate school in the mid-1960s, he was taught that the ions filling the teardrop-shaped magnetic field enveloping Earth, including those trapped in the Van Allen radiation belt, came from the sun. The ions in the nearby ionosphere of the upper atmosphere, being 100 to 1000 times less energetic than those carried from the sun by the solar wind, seemed an unlikely source.

That has all changed as improved instrumentation has broadened the range of ion energies and densities that can be measured. Now Chappell, who is at the Marshall Space Flight Center in Huntsville, is arguing that the ionosphere is so leaky that it could be the sole source of observed ions found in the magnetosphere above it. If the sun also contributes a significant share, that could be a further indication that space physicists are still failing to detect a significant portion of magnetospheric ions. Because ions give the magnetosphere its physical substance and carry energy to fuel phenomena from the aurora to radio interference, sorting out ion sources is of major interest.

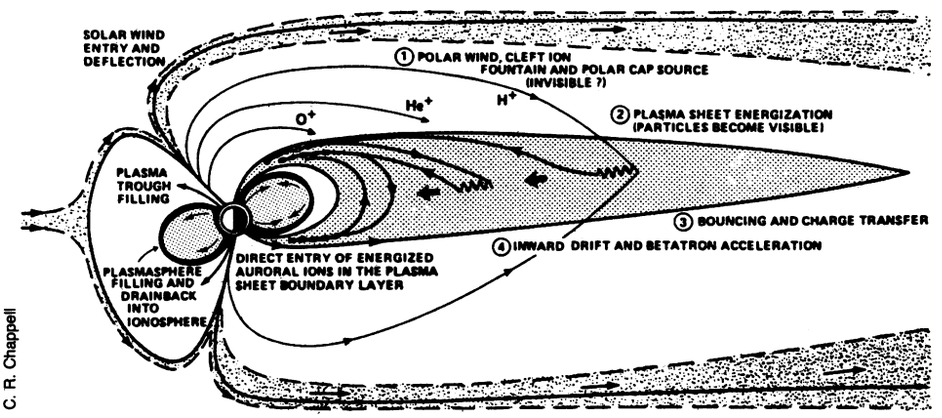
Chappell points out in a recent *Reviews of Geophysics* paper that researchers' thinking on the source of ions filling Earth's magnetic field has been shaped by the limitations of the available instrumentation. For two decades the detectors carried aloft by rockets and satellites tended to measure either high-energy charged particles high in the magnetosphere, where there are a few particles per cubic centimeter, or low-energy particles found at high densities of thousands of particles per cubic centimeter in the innermost magnetosphere and ionosphere. (Air at sea level has more than a billion molecules per cubic centimeter.) In fact, says Chappell, the innermost magnetosphere, called the plasmasphere, for years fell in a crack—it was at such a high altitude that ionospheric specialists left it to those studying the magnetosphere, but the magnetospheric community neglected it because the low energies of its ions linked it so closely to the ionosphere. Any upward flow of relatively low-energy ions went unnoticed.

Improved technology has gone far in closing this gap. Earth's ionosphere is now seen as a "multifaceted fountain," in Chappell's words, that spews low-energy ions from a



NASA

Earth in UV. *This ultraviolet image made by Dynamics Explorer 1 shows the dayglow of the dayside and the emissions of the auroral oval around the north pole. In addition to the downward flow of energy to the upper atmosphere implied by this emission, the Dynamics Explorer helped elucidate the upward flow of ions.*



C. R. Chappell

How to fill the magnetosphere. *In this cross section including Earth and its atmosphere (small concentric circles to left), ions spray out of the ionosphere of the upper atmosphere, as indicated by the arrows, to fill various regions of the magnetosphere. The solar wind, which flows from the left, distorts the magnetosphere and contributes ions as well. The relative proportions of ionospheric and solar ions remain to be determined.*

variety of leaky spots around the globe. The particular mechanisms by which electric and magnetic fields can accelerate atmospheric ions vary from place to place, but one or another is operating in the oval auroral zones encircling either magnetic pole, at the polar cusp where the divergence of magnetic field lines opens a cleft in the magnetosphere, and within and equatorward of the auroral ovals where a polar wind of ions flows outward. These flows include the ions of elements ranging from hydrogen to molecular oxygen at energies ranging from 1 to more than 10,000 electron volts. Solar wind ions have energies of about 1000 electron volts and radiation belt ions energies of a million electron volts. The best opportunity to assess the full breadth of these ionospheric flows came with the 1981 launch of the two Dynamics Explorer satellites.

In the latest such study, Chappell and colleagues at Marshall, Thomas Moore and Jack H. Waite, have used the Dynamics Explorer data, ground-based observations, and modeling to estimate the flux of ions from the ionosphere as being in the range of 3.5×10^{26} ions per second. A source of this magnitude "appears to be competitive with even the most optimistic solar wind" sources for filling the magnetosphere, says Chappell. These researchers then used their estimates of the fluxes to each region of the magnetosphere to predict the density of ions that would be there if only the ionosphere were supplying them. The predicted densities are in excellent qualitative agreement with observed densities, Chappell concludes.

If the ionosphere were to suffice as a source of magnetospheric ions, what role would be left in Chappell's scheme for solar ions? Some definitely enter the magnetosphere. If they do so in significant numbers, Chappell says, then perhaps the most reasonable conclusion is that some magnetospheric ions are still escaping detection. He argues that the problem no longer resides in any limitations of the instruments themselves but in the spacecraft carrying them.

It is well known that sunlight as well as the magnetosphere's plasma of ions and electrons tend to charge up spacecraft. The higher the spacecraft's charge, the higher the energy an ion of the same charge needs to approach the spacecraft and be sampled by its instruments. As a result, there can be a dearth of information, claims Chappell, on the composition, energy, and motions of low-energy ions, information essential to identifying their source.

Chappell is well aware that his case for an all-ionospheric source runs counter to the current mood of the space physics community; both solar and ionospheric sources are now seen as important, perhaps equally important when averaged over time and space. Chappell would not disagree too strenuously. "The final answer will probably be somewhere in between," he says. "But you shouldn't put blinders on. You should be open to the possibility that it's all ionospheric. We want to open the discussion up to its broadest possible extent."

■ RICHARD A. KERR

ADDITIONAL READING

C. R. Chappell, "The terrestrial plasma source: A new perspective in solar-terrestrial processes from Dynamics Explorer," *Rev. Geophys.* **26**, 229 (1988).

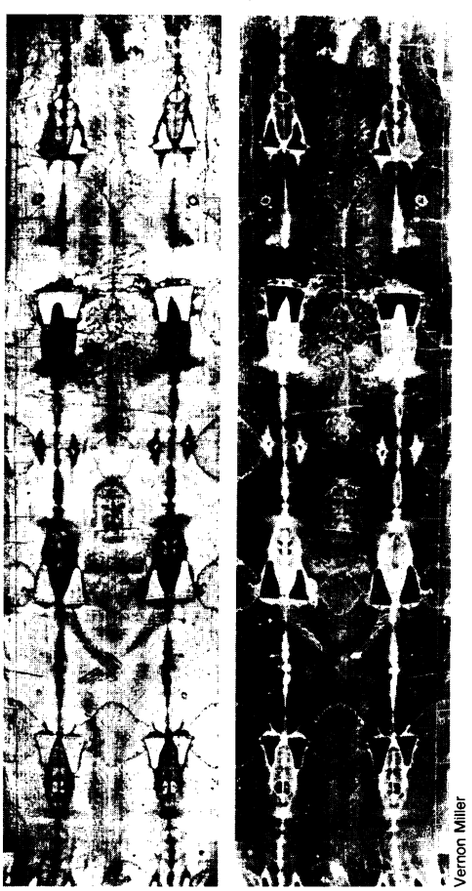
Shroud of Turin Is Medieval

After generations of controversy and months of rumors, the results are now official: the Shroud of Turin, with its haunting, faded image of a crucified man, cannot be the burial cloth of Christ. Carbon-14 dating methods give 95% certainty that the linen of the Shroud dates from between A.D. 1260 and 1390, and virtually 100% certainty that it was made later than A.D. 1200.

The tests were carried out this past spring by independent laboratories in Arizona, Zurich, and Oxford. Each group used the accelerator mass spectrometer technique, which required the sacrifice of only 2 square centimeters of the cloth. The results were announced at a news conference on 13 October by Cardinal Anastasio Ballestrero, the Archbishop of Turin, and by Luigi Gonella, his science adviser. "I see no reason for the Church to put these results in doubt," said Ballestrero, who stressed that the Roman Catholic Church has never claimed that the Shroud was anything but a "representation" of Christ's burial cloth.

Gonella, for his part, was adamant about the use of the word *forgery*. "A forgery is for the specific purpose of deceiving people," he said. "It could be possible, but there is no proof. This could be a medieval icon. We don't even know how it was made."

■ M. MITCHELL WALDROP



Vernon Miller