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OF THE WEEK

COVER: Part of the southern hemisphere of Jupiter's moon Io (centered near 68°S, 272°) shows complex graben (fault-bounded depression) and complex scarps in this photo taken by the Voyager 1 spacecraft. Some Voyager researchers believe that some process may be eroding away the edges of the upper scarps, though evidence for such a process is scant. Such details are part of preliminary maps of the major Jovian satellites, based on Voyager 1's striking photos. See p. 396. (Photo: Jet Propulsion Laboratory/NASA)

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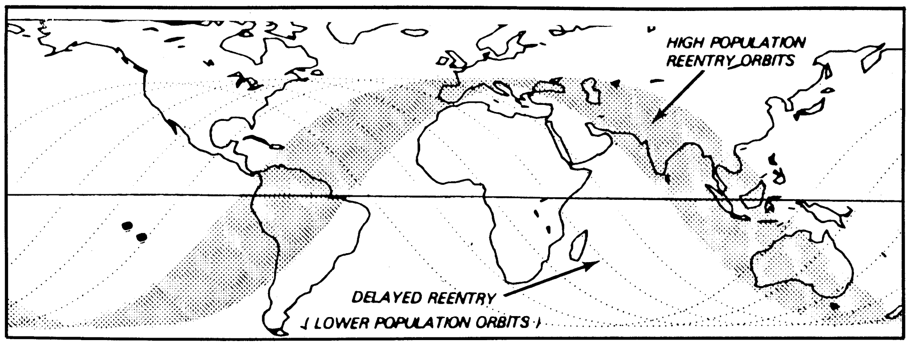
Skylab: Seeking a Handle



The population under Skylab's shifting orbit varies from 5 million to 158 million.

Each time the Skylab space station crosses the equator from north to south, it passes over a point on the earth's surface that is more than 2,600 kilometers west of the crossing point one orbit before. Successive orbits therefore cover very different territory, and with Skylab expected to crash to earth in perhaps 500 pieces next month, the difference could be very important. An "orbit risk analysis" carried out by the National Aeronautics and Space Administration has revealed that the number of people living under Skylab's orbital path at any given time varies from as few as five million to as many as 158 million. Thus the potential risk from the space station's falling parts, which may spread over a "footprint" covering more than 6,000 km along the orbit's ground track, can vary by a factor of more than 30, depending on the location of the final orbit.

It is this wide variation that has prompted NASA to plan an attempt at selecting the orbit during which Skylab finally does go down. The object's orbital motion cannot be appreciably modified, but there are slim hopes that, by reorienting the facility to increase or decrease the amount of atmospheric drag, it can be made to descend a few orbits later or earlier, should a less-populated ground track be within reach.

This week, flight controllers at NASA's Johnson Space Center in Houston were preparing for the essential first step in the agency's main plan, which one official admits is "a less than even shot." Perhaps on June 18 or 19, the controllers would attempt to maneuver Skylab into a position in which it is relatively stable against the growing aerodynamic and gravitational forces that act on it. It is also an orientation with high atmospheric drag, somewhat hastening the object's descent. The hope is that, with perhaps 12 hours remaining before the end and the final orbit reasonably predictable (though not the location of the impact footprint), it will be possible to judge whether a less-populous ground track exists one to three orbits later, and to shift Skylab back into a low-drag position that will delay its fall that long. (About two orbits in the low-drag position, officials calculate, should be worth about one orbit's additional time aloft.)

If next week's shift to the stable, high-drag position fails, NASA cites only one other hope: There is a faint chance, now being evaluated, that about 8 to 10 hours before impact, Skylab may naturally reach a stable, *low*-drag position. If time and tracking-station coverage permit, it may be possible to start the station tumbling, with resultant higher drag that might enable the final descent to be moved one or two orbits earlier. □

Tapping heavy crude: A forgotten resource

The good news is that we're really not running out of oil. The bad news is that "cheap" oil is gone forever and what is left can probably never be pumped up and refined quickly enough to "end" the energy crisis. This view is directing the research and investments of most petroleum producers and refiners. Hence their interest in the First International Conference on the Future of Heavy Crude Oil and Tar Sands, a nine-day meeting in Edmonton (Alberta), Canada, that ended this week. Sponsored by the United Nations Institute for Training and Research (UNITAR), the U.S. Department of Energy and the Province of Alberta, the meeting's 300 invited delegates represented 35 nations and roughly every major petroleum producer, including OPEC (Organization of Petroleum Exporting Countries).

Texas gushers, symbolizing the heyday of American oil exploration, contained light-crude oil. Light oil, generally thin and fluid, pours like warm maple syrup even when cold. In contrast, heavy oils are thick and viscous, with the consistency of molasses or tar, depending on their makeup and temperature. They don't gush, and many won't even pour (much less flow through pipelines) unless heated substantially and/or diluted with a lighter petroleum derivative such as naphtha.

What's more, many heavy-oil deposits contain large amounts of sulfur and heavy-metal impurities such as nickel and vanadium. Unless removed, the sulfur makes crudes unattractive as a fuel stock. And heavy metals damage traditional catalysts used in oil refining.

But the major distinguishing factor between light and heavy crudes is their carbon to hydrogen ratio. Since carbon is 12 times heavier than hydrogen, carbon-rich crudes are indeed heavier than conventional oil. More important from a refiner's viewpoint, however, carbon-rich crudes yield less of the generally preferred light-fuel derivatives, such as gasoline and kerosene. Although they can be chemically upgraded to roughly match light crudes — by adding hydrogen or withdrawing carbon — the processes are complex and add to the pre-refining cost of crude produced.

Notwithstanding, climbing oil prices in world markets now have oil companies falling all over each other in a scramble for heavy-crude leases.

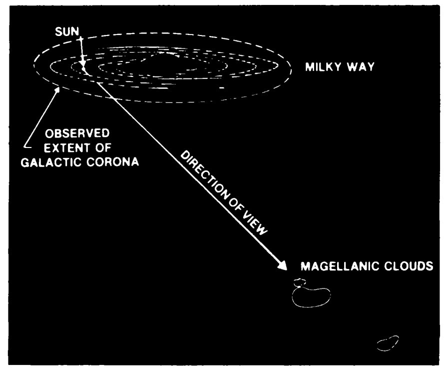
More important to Western nations, however, is the relative abundance of heavy oils and tar sands. Together they appear to dominate the oil deposits of North and South America. Data presented at the Edmonton conference indicate that Alberta has more than two trillion barrels of heavy oil in place — more oil than in the entire Middle East. Neighboring Saskatchewan is also producing heavy oil commercially. U.S. deposits could exceed 500 billion barrels. But none rival the estimated four trillion barrels in Venezuela.

Ultimate recovery of heavy oils, only about 12 percent of any deposit prior to 1960, now can reach 30 to 50 percent with new and experimental technologies described in Edmonton. And the recent world oil-price increases now make it possible even in the United States to (with oil-price decontrol and the assumption that "windfall profits" taxes won't be applied to heavy oils) profitably extract and refine heavy crude; California already produces a half-million barrels per day.

Joseph Barnea, UNITAR's energy specialist and organizer of the Edmonton meeting, sees heavy crude as a real promise for developing nations. Many that now import oil sit atop heavy-crude deposits. With technologies aired and shared at the meeting and sufficient capital (a potentially limiting factor), they may one day achieve energy independence, he says.

To spur such development, the Alberta Oil Sands Technology and Research Authority opened the conference with an offer to assess any country's heavy-crude or tar-sand resources free of charge provided AOSTRA can publish its findings and add them to its data bank. On June 8, Malagasy (formerly Madagascar) — with one of Africa's largest heavy crude and tar sands deposits — became the first country to accept AOSTRA's offer. □

Ionized coating for the Milky Way



Looking through the halo toward the LMC.

One of the more surprising things about modern astronomy, compared to the classical nineteenth-century science, is the amount of gas to be found in what was usually considered empty space. We are now used to gas between the planets, between the stars, between the galaxies, even between clusters of galaxies.

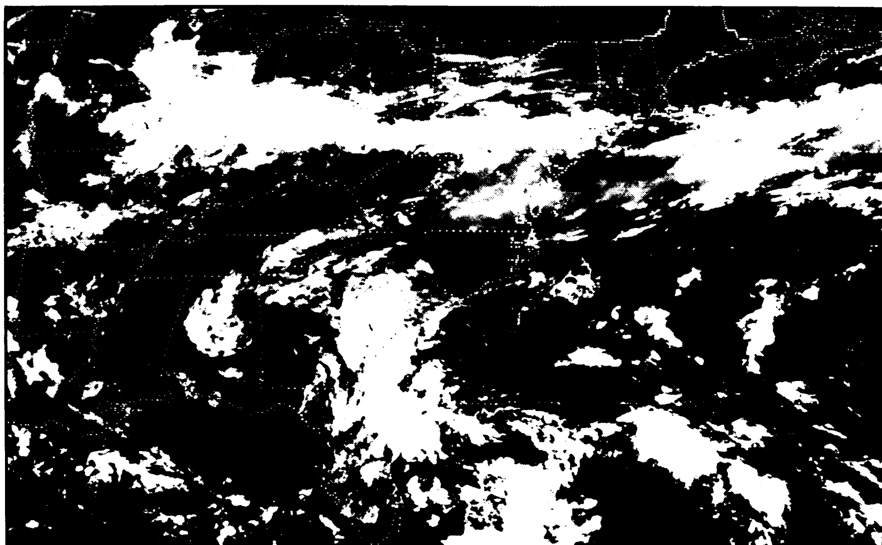
The latest bit of more or less organized gas to be found is a halo around our Milky Way galaxy. The discovery, which was made by Blair D. Savage and Klaas S. de Boer of the University of Wisconsin's Washburn Observatory, immediately raises the possibility of similar haloes around other galaxies. If the phenomenon is general it could be affecting a number of things astronomers are seeing, quite unbeknownst to them.

Savage and de Boer found evidence for the galactic halo while observing two hot stars in the Large Magellanic Cloud, a small galaxy that is very near the Milky Way. In such an observation astronomers must discount features that appear to be in the spectra of the stars, but are actually caused by material inside our galaxy or inside the LMC. In this case there remained some features, particularly absorptions by well-ionized carbon and silicon, that could not be explained away on this basis. Consideration of these lines indicated that they could be attributed to a cloud of ionized gas surrounding our galaxy and rotating with it, thus forming a halo belonging to the galaxy. The halo would be hot, about 100,000° K, tenuous (about 3 particles per 10,000 cubic centimeters at a distance of 5 kiloparsecs from us, or a million times as rare as the best vacuums ever made on earth) and would stretch to at least 15 kiloparsecs. In 1956 Lyman Spitzer had predicted the characteristics of a hypothetical halo, basing the calculation on two main assumptions: that the gas would be in hydrostatic equilibrium and gravitationally bound to the galaxy. These results fit his prediction well.

If such a halo exists in our galaxy, then it may in others, as well. Light from more distant objects (quasars, for instance) passing through such coronas could be affected by them. Such effects might be responsible for some of the mysteries in quasar spectra. □

The annual Eastern (choke) inversion

The misty stuff spreading from Kentucky through Maryland and stretching more than 800 miles into the mid-Atlantic is pollution haze, according to Chicago meteorologist Walter A. Lyons. Lyons analyzes day-time photographs taken by weather satellites 22,370 miles above the equator, tracking the summer phenomenon he calls the "blob" — a mass of turbid air thick with sulfates produced by coal-fired power plants in the Ohio River basin and in New England. Sulfates act as nuclei for water droplets, which form a haze and reduce visibility by more than half. It can be held in place for several weeks by a high-pressure front, trapping cool air under a lid of warm air and condensing the haze. Temperatures beneath it may be three to four degrees cooler, Lyons says, often causing a front of thunderstorms where the cooler air meets warmer air. Rain washes out the haze, but by doing so becomes a shower of dilute sulfuric acid, corrosive and toxic. Lyons also finds a high level of ozone in the haze — 91 ppb inside the air mass in contrast to 69 ppb outside it — which has been shown to be highly destructive to soybean crops.


NOAA