tially 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.

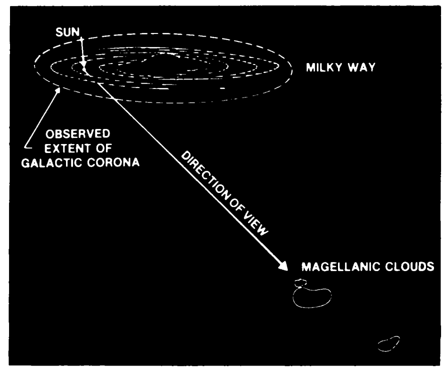
To spur such development, the Alberta Oil Sands Technology and Research Authority opened the conference with an offer to assess any country's heavy-crude or tar-sand resources free of charge provided AOSTRA can publish its findings and add them to its data bank. On June 8, Malagasy (formerly Madagascar)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

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



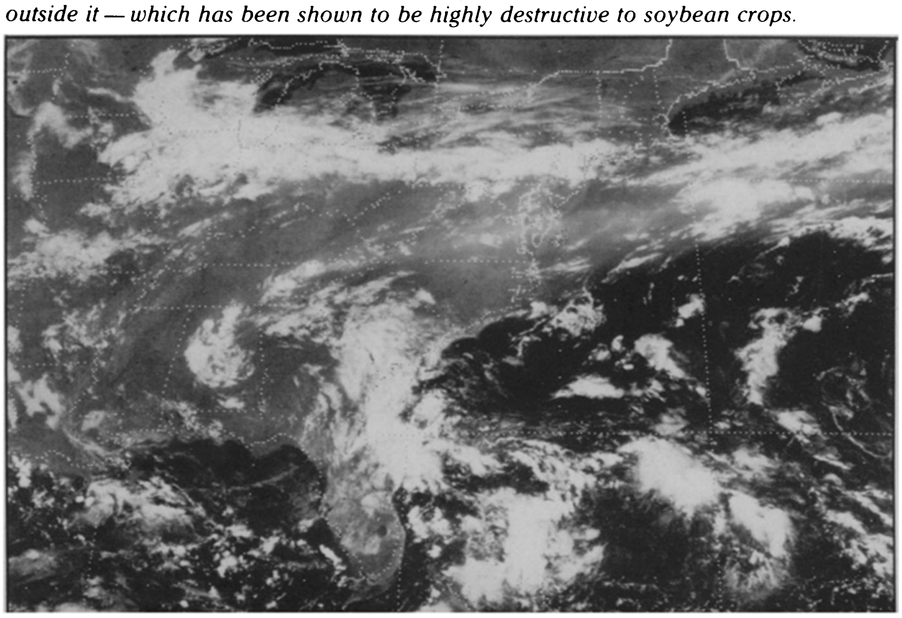
Looking through the halo toward the LMC.

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.



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