Caustics in interstellar space

Interstellar space is nature's great chemical factory. Chemical elements — that is, atomic nuclei — are synthesized in stars, but only at some distance from stars is the ambiance cool enough for chemical compounds to persist. And compounds do form there. The branch of science known as molecular astronomy has found upwards of four dozen compounds in interstellar clouds. Now the first compound containing sodium, sodium hydroxide, is reported in the Nov. 1 ASTROPHYSICAL JOURNAL LETTERS by Jan M. Hollis of the NASA Goddard Space Flight Center in Greenbelt, Md., and Paul J. Rhodes of the National Radio Astronomy Observatory station in Tucson, Ariz. Sodium hydroxide residing in the clouds surrounding the center of our galaxy, in the radio source known as Sagittarius B2(OH), is identified by Hollis and Rhodes through two resonant radio emissions (radio spectral lines), which they attribute to two different quantum energy transitions of the molecule.

One of these lines, with a rest frequency of 100,529.11 megahertz, was studied by Hollis and Rhodes with the NRAO 11-meter telescope on Kitt Peak. The other, with a rest frequency of 75,399.2 megahertz had been recorded by W. J. Wilson and L. E. Snider as an unknown spectral feature. On the basis of their other finding Hollis and Rhodes believe that they can assign it, too, to sodium hydroxide.

Sodium is an element necessary to life, and so, Hollis and Rhodes point out, "this detection of a simple sodium compound, containing the hydroxyl radical, suggests that another hindrance to prebiotic molecular evolution in interstellar space may have been removed." Or to rephrase it in positive terms, the finding goes to support those who suggest that the basic compounds necessary to life were formed in space before life itself appeared.

How the molecules form in the rarefied reaches of interstellar space, where atoms should have a very hard time meeting each other, is also a question of much theoretical discussion. Probably the most widespread view is that the dust grains, which are also present, serve as intermediaries, capturing gas atoms and bringing them together. This finding goes to support that view too, as there is a theoretical model (attributed to W. W. Duley and T. J. Millar) for the formation of sodium hydroxide in this way. An oxide grain (in the dust) absorbs photons of 5.7 electron-volts energy from the ambient starlight. This produces chemically active negative oxygen ions and hydroxyl radicals on the surface of the grain. If the grain then picks up some sodium, reactions can follow that will produce sodium hydroxide and sodium oxide and release them in gaseous form. Subsequently sodium oxide could also react with the hydroxyl radicals to produce more sodium hydroxide and free oxygen. —*D. E. Thomsen*

Land remote sensing and the marketplace

The Land Remote Sensing Satellite Advisory Committee recommended last week that the U.S. government begin immediately to try to negotiate a contract through which private industry would assume ownership and/or operation of the land satellite system or both the land and meteorological and satellite systems.

The recommendation assumes a government commitment to the continuity of a civil land remote sensing system, whether owned or operated by the government or the private sector. Such a commitment will require supplemental federal funding, possibly to continue the present land satellite system now scheduled to end after the launching of LANDSAT D′ as early as 1983 (SN: 7/3/82, p. 4).

The committee was formed after the Office of Management and Budget in 1980 recommended that the land satellite program be terminated. The members, drawn from industry, academic and policy institutions, were unanimous in their belief that commercialization of government activities that "were not inherently governmental should enhance the economic base of the country." The government would still have access to raw unprocessed data, but would relinquish services that relate to the marketplace, such as converting raw data into computer-compatible tape and film, enhancement, processing and analysis of image data and distribution to nongovernment users. The general view is that commercialization would expand tax revenues and stimulate development of technology in response to marketplace demands.

The committee also advised that the operator, either government or private sector, be required to adhere to the "open sky" policy, guaranteeing that anyone from any country can purchase data at fair and uniform prices. France and Japan are expected to be the main foreign competitors in civil remote sensing. The committee concluded that a commercial venture would need government support if it were to compete effectively. It was recommended that the government "aggressively" support fundamental, high-risk (experimental) and long-term research in remote sensing because industry is expected to focus on low-risk, applied and short-term research to improve profits using current, proven technology.

The recommendations were forwarded to Commerce secretary Malcolm Baldridge. —*C. Simon*

Benzene begets graphite fibers

In what may prove to be a major advance in materials science, Japanese researcher Morinobu Endo has "threaded" his way through a simple industrial chemical. Endo, of Shinshu University in Nagano, has prepared graphite fibers — carbon strands found in a variety of products, including heating pads and jet engine components — from benzene. Such fibers, to be marketed soon by the Tokyo-based Showa Denko Co., are both stronger and more flexible than those now available. This development in fiber technology was announced at the recent Materials Research Society meeting in Boston.

Graphite fibers now are manufactured from such parent materials as polyacrylonitrile (PAN) and rayon. The new fibers are expected to be not only better reinforcing agents, but also cheaper to manufacture than these PAN- or rayon-derived ones. The new strands are made in a process that involves heating benzene to about 1,100°C. At this temperature, the hydrogen leaves the benzene (C_6H_6), and the remaining carbon deposits on a metal catalyst in highly ordered strands that are typically about 50 centimeters long and 10 microns in diameter. Finally, the fibers are heat-treated: exposed to temperatures as high as 3,000°C that "purify," or remove most of the impurities in, the graphite.

Fibers produced in this fashion have been subjected to a variety of analyses by Endo and colleagues Trieu C. Chieu and Mildred S. Dresselhaus, both of the Massachusetts Institute of Technology in Cambridge, Mass. For example, the three researchers have studied the carbon fibers using Raman spectroscopy — a technique in which laser light of a specific frequency is allowed to shine through the material; the resulting scattered light is collected. The frequency of that light depends on the properties of the material being analyzed. In this case, Raman scattering has revealed that benzene-derived fibers "exhibit the highest degree of ordering" thus far achieved in such graphite strands, Endo and colleagues report in the Nov. 15 PHYSICAL REVIEW B. In other words, among the graphite fibers to date, the new ones come closest to being single, perfect crystals.

In fact, the benzene-derived graphite is so highly ordered that Endo and colleagues have been able to intercalate it — that is, insert between its layers sheets of a "guest" substance — with materials such as iron chloride. In so doing, they have developed a "synthetic metal" that is lighter than copper but that, in laboratory tests, shows comparable ability to conduct electricity. This syn-metal eventually could prove useful anywhere that lighter-weight circuitry is preferred — such as in the aerospace industry. —*L. Garmon*