Microwaves accelerate chemical extractions

Microwave ovens can do more than reheat a leftover casserole. A Canadian chemist has harnessed them to selectively remove one or more chemicals from a material for analysis. Sometimes the new technology can achieve in 30 seconds what conventional extraction chemistry now requires 24 hours to do.

In announcing a licensing agreement negotiated with Hewlett-Packard Co. of Palo Alto, Calif., Environment Canada, that nation's environmental agency, briefly described the ability of its patented process to dramatically reduce the time, energy, process steps — and costs — associated with solvent extractions. In a few months, says J.R. Jocelyn Paré, the technology's developer, Environment Canada will describe a second major application: the process' ability to selectively vaporize desired chemicals out of materials — such as organic pollutants contaminating water or soils.

"Right now, the holdup on a lot of analytical testing at hazardous waste sites is how long it takes to extract [compounds]," says Philip R. Campagna, a chemist with the EPA Environmental Response Team in Edison, N.J. If this new technology lives up to its promise, "it will become the procedure of use because it's so much faster and has the potential for automation," he adds.

The technique may also facilitate testing of animal tissue. Humayoun Akhtar of Agriculture Canada in Ottawa found that microwave extraction sped his search for growth hormone residues in pig tissue. "It's very promising," he says.

Solvent extraction, a workhorse of process chemistry, diffuses one chemical through some material — a sample of contaminated soil, for example, or an herb from which essential oils will be harvested. As the solvent slowly passes through the target material, it picks up and carries away any soluble chemicals it encounters. After leaving that target — the soil or leaf, say — the solvent will be analyzed to identify what it acquired in transit.

While effective, this process has inherent inefficiencies, notes Paré, head of analytical programs at Environment Canada's Environmental Technology Center in Ottawa. First, the diffusion takes a lot of time — typically hours to a day. And because heat drives the diffusion, energy must be applied throughout the process. But lacking a way to selectively heat only the target, the process unnecessarily heats up the solvent and its container.

Microwaves heat something when a material stops or slows the radiation, causing it to deposit some of its energy. The new process involves immersing a target material in a solvent that is relatively "transparent" to microwaves. The result: Only the target heats up.

Moreover, because microwaves tend to heat quickly and from the inside of the target, energy builds up dramatically, Paré says. When applied to a mint leaf, for instance, the microwaves expel any oil bound in the plant's cells into the solvent bath within seconds.

Conventional solvent extraction also tends to extract more than the desired compound. This often requires repeated cleanup steps to separate out only the desired extract. With Paré's new process, chemists set how much energy they deposit to the target so that only the desired extract emerges.

Since some extract is lost during each cleanup step, eliminating the need for such procedures can reduce dramatically the sample size needed for analysis — in some cases, from 250 grams down to just 10 grams, Paré notes.

In recent years, a high-pressure separation technique that uses supercritical-fluid carbon dioxide (CO_2) as its solvent has become quite popular. This process is relatively fast and can also extract lipids and fats without leaving solvent residues. But the new microwave process can extract in a minute or so what supercritical CO_2 takes an hour to do — without the need for high-pressure equipment and compressors. And because CO_2 is transparent to microwaves, it can offer the same residue-free extractions. Indeed, Paré told SCIENCE NEWS, the marriage of his process and CO_2 as a solvent seems "almost too good to be true."

To carry out selective vaporization, chemists traditionally heat drinking water to below its boiling point and measure the volatile gases that emerge. The process can scout for toxic volatile organics — such as benzene and toluene.

However, water dissipates heat rapidly. Paré reasoned that if he microwaved a beaker of water briefly — raising its overall temperature just a few degrees — the water molecules would immediately transfer their heat to anything nearby. And that proved to be the volatile organic contaminants — chemicals themselves transparent to microwaves.

Because so much water shed heat and so few contaminant molecules picked it up, the organics "felt" as though they were boiling and vaporized. Paré could easily suck them off for analysis.

The microwave process is so rapid it may even allow, for the first time, the online quality analysis of products during manufacturing, he says.

Paré expects to report on these and related experiments early next year at the Pittsburgh Conference, a major analytical chemistry meeting. — *J. Raloff*

Milky Way starbirth: Some far-out action

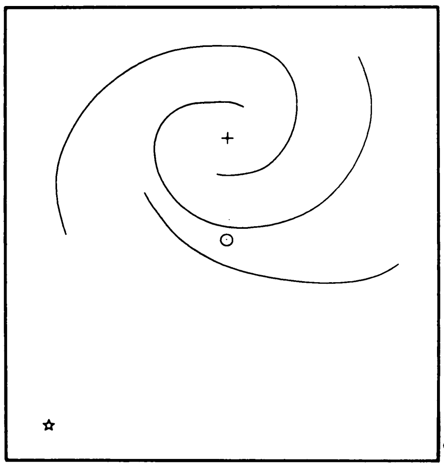
Astronomers have identified the first young star known to hover at the fringe of our galaxy. The finding surprised some researchers, who thought such a remote part of the Milky Way could not harbor young stars because the region now contains relatively little gas and dust — the raw materials needed to form them.

In challenging that notion, the new finding should shed light on the nature of starbirth in an environment drastically different from that in the star-producing regions near the sun, says Stuart N. Vogel of the University of Maryland at College Park. Vogel, Eugene J. de Geus, now at the California Institute of Technology in Pasadena, Robert A. Gruendl of the University of Maryland, and Seth W. Digel of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., report their work in the Aug. 20 ASTROPHYSICAL JOURNAL LETTERS.

The youthful star lies perhaps 90,000 light-years from the Milky Way's center — some 25,000 light-years beyond the visible spiral arms of the galaxy. In contrast, the sun lies well within the visible disk, about 27,000 light-years from the center.

Vogel notes that before he and his colleagues conducted their study, only elderly stars were known to reside at the Milky Way's periphery. Indeed, it seemed unlikely that the small amounts of gas and dust at the galaxy's edge could congregate into clouds of material dense enough for starbirth. In addition, Vogel says, outlying regions of the galaxy contain much lower abundances of elements heavier than helium and much less radiation — conditions common to star formation in the sun's vicinity.

Stephen E. Strom of the University of Massachusetts at Amherst calls the study significant. He notes, however, that it's not surprising to find a young star at the edge of our galaxy. Astronomers have



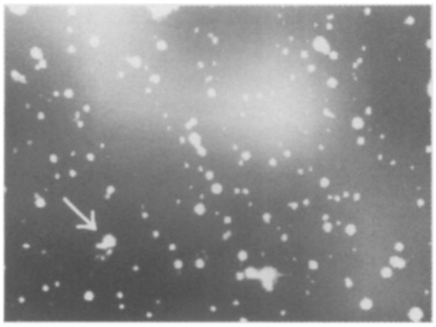
Vogel

The Milky Way, from above galaxy's disk, shows the galactic center (plus sign), the sun (small circle), and the newly discovered young star (bottom left).

observed young stars in the low-density outskirts of nearby galaxies, including a satellite of the Milky Way known as the Small Magellanic Cloud.

"The potential of this discovery is that by studying star formation in the outer galaxy, where there is a lower abundance of heavy elements, we can learn about starbirth under very different physical conditions than in the solar neighborhood," he says. Finding youthful stars at the edge of our galaxy should allow researchers to study this population up close and in greater detail.

An intriguing finding prompted Vogel and his colleagues to begin their study. Digel and his Harvard-Smithsonian colleague Patrick Thaddeus last year reported evidence for a molecular cloud—a stellar nursery—at the extreme fringes of the Milky Way (SN: 7/4/92, p.13). Figuring that where there's a star-making cloud, there should be stars, Vogel and his colleagues examined the region near the cloud last December using the 1.5-meter telescope on California's Palomar Mountain.



Vogel, de Geus, Gruendl, Digel

The distant star (arrow) sits at Milky Way's edge. Diffuse glow indicates radiation emitted by hydrogen atoms, believed recently ionized by the star.

Rather than looking for a young star directly, the team searched for evidence of its presence: red light emitted by surrounding hydrogen atoms. Hot, young stars ionize hydrogen gas, and the gas radiates red light when its electrons and protons recombine into atoms. After pinpointing this telltale radiation, the team searched for a likely stellar source. They report that a blue supergiant first detected some 20 years ago fits the bill.

Vogel notes that the distance to this hot, young star (no more than a few million years old) had been undetermined when other astronomers first catalogued it in 1974. His team now estimates that the star lies in the plane of the galaxy beyond the visible disk, between 77,000 and 155,000 light-years from the Milky Way's center. The most likely distance is 90,000 light-years.

The study could only detect the most luminous young stars at the galaxy's edge, Vogel says, but more sensitive surveys should find fainter newborns there because a single molecular cloud gives birth to many stars. — *R. Cowen*

Concern grows over expansion of earmarking

In 1985, John Silber, the president of Boston University, justified universities going directly to Congress for financial support by arguing that peer review functioned as an "old-boy" network that deserved to be bypassed because it put most federal support for research into the hands of about 20 institutions (SN: 8/3/85, p.71).

Back then, the practice seemed exceptional. But not anymore. In 1980, Congress earmarked less than $11 million for specific academic projects and set aside none the next year. But in fiscal year (FY) 1992, Congress approved almost $708 million to support 499 such projects. During the past decade, almost $2.5 billion in federal support for academia has skirted traditional merit review, says Rep. George E. Brown Jr. (D-Calif.), chairman of the House Committee on Science, Space, and Technology.

At one time, most earmarks set aside funds for buildings. "But there are more and more instances where [they're] going for research," says Joel Widder, director of legislative affairs for the National Science Foundation. According to Brown's committee, 42 percent of the $708 million earmarked in 1992 supported research and development.

Moreover, it seems these decisions are slipping through the fingers of science's old-boy network into the hands of a different closed circle, that of a few lobbyists and powerful legislators. As a result, just a few institutions reap the rewards of these changes. Out of some 3,600 U.S. colleges and universities, only 170 received these direct federal appropriations in 1992, Brown says.

Early last week, Brown's committee released an interim report on academic earmarks and urged Congress to take steps to prevent the continued expansion of this practice. The committee based its report on figures compiled by the Congressional Research Service and on responses by 50 universities to letters sent by Brown about earmarked projects awarded those institutions.

Several of the institutions receiving large appropriations in fiscal 1992 (see chart) also rank among the top 25 all-time recipients of earmarks. They vary from small schools such as the 1,000-student Wheeling Jesuit College in West Virginia, awarded a total of $29 million, to large universities such as Iowa State University, the leading overall recipient with $91.6 million.

The 170 institutions do not always represent "outsiders" shorted by science's old-boy system, Brown notes. Half of the top 20 recipients of competitively awarded federal research money also have gotten earmarks.

Many of these institutions do so well because "they all have friends in high places," Brown writes.

Two kinds of legislation, and two sets of congressional committees, guide the allocation of funds. Periodically, Congress passes laws proposed by so-called authorizing committees that set budget ceilings for each federal agency. Each year, appropriations committees recommend specific funding amounts — up to that authorized — that Congress then accepts, rejects, or alters.

"The authorizers tend to think that the appropriators have overstepped their bounds," Widder says. The report notes that in FY 1992, 20 states got almost 79 percent of the academic earmarks and that these states have 12 senators and 34 representatives on appropriations committees.

Those individuals can slip unauthorized earmarks into any agency's budget — such as for new hospital buildings in legislation funding the Department of Energy — at the last minute or bury them in reports that accompany a bill. As a result, little discussion about these allocations goes on, says Brown, who urges that site-specific earmarks be banned and that agencies be able to ignore earmarks without fear of political reprisal. — *E. Pennisi*

Top 10 Recipients in FY 1992

Schools	Overall Rank*	Dollars
1. University of Alaska	2	$45,063,000
2. Boston University	10	$29,000,000
3. Michigan State University	13	$23,172,000
4. University of Maryland	23	$22,770,000
5. Wheeling Jesuit College	21	$21,000,000
6. University of Rochester	7	$20,300,000
7. University of West Virginia	5	$19,625,000
8. University of Hawaii	6	$16,941,000
9. Indiana University	17	$13,688,000
10. University of North Dakota	12	$13,681,000

*Rank based on total earmark funding from FY 1980-1992

Chart adapted from Congressional Research Service data