Superconductor Patents: Four Groups Duke It Out

With millions of dollars at stake, the question of who discovered high-temperature superconductors becomes more than just a matter of assigning scientific credit

WHEN DU PONT paid $1.5 million last year for patent rights to superconductivity discoveries made at the University of Houston, the company was betting on more than the commercial potential of the technology. It was also gambling that Houston's patent claims would stand up against an assault from at least three other major competitors.

AT&T Bell Labs, IBM, and the Naval Research Laboratory have all filed patent applications on the same superconductor discovery as the University of Houston. Even a team from the University of Alabama at Huntsville, which collaborated with the Houston group, has a entered a rival claim.

Now the U.S. Patent and Trademark Office is struggling to sort out which of these contenders should get the prize, and it could be years before it reaches a decision. The final award, which could be worth millions of dollars to the winner, will likely hinge on the Patent Office's determination of what constitutes a true invention, as opposed to an obvious extension of existing work.

Underlying this patent fight is a vexing issue for scientists: The longer a researcher holds off announcing a discovery in order to flesh out his work, the stronger the patent claim is likely to be. Indeed, patent experts say that if Paul Chu at the University of Houston had not announced the discovery of his potentially revolutionary material before he knew exactly what he had, Houston's patent claims would be unassailable. But this type of secrecy is antithetical to the normal way that scientists operate, and many researchers resist it even at the cost of a weaker patent position.

In February 1987, Chu's team found they could mix yttrium, barium, copper, and oxygen to create a compound that lost its resistance to electricity at 90 K, a previously unheard of temperature for a superconductor. But they knew neither the chemical composition nor the crystalline structure of the material, and they were unsure what part of the mixture was responsible for the superconductivity. Nevertheless, feeling that several groups were right behind him, Chu went public with the discovery. After having filed a patent application and submitted a paper on the results, he held a press conference and the race was on.

By the second week of March, several groups had reproduced Chu's results and gone one step further, figuring out exactly what the superconducting material was. Four of them—including the University of Houston, which had also determined the structure by that time—filed patent applications on this new work.

Although the Patent Office will not comment on specific applications, the parties involved acknowledge that the office has declared an "interference" among the University of Houston, Bell Labs, IBM, and the Naval Research Laboratory over the manufacture and characterization of the Y-Ba-Cu-O superconductor. In layman's terms, this means the four parties have filed applications on the same invention and the patent examiner must decide which was the first "true and original inventor."

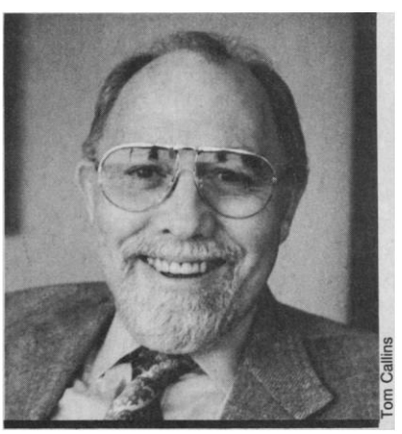
The United States is the only industrialized country whose patent system allows such complications. Most others use a first-to-file system, where the first applicant to file is the only one who can receive a patent, even if someone else made the discovery earlier. U.S. law instead gives the patent to the first to discover.

But determining who was first can be a complicated matter. To begin with, the Patent Office must decide what the invention was, and in this case much of the argument centers around that question.

"The language of the count as it is finally constituted is critical," says Charles Cox, a patent attorney for the University of Houston. The "count" is the precise definition of the invention, and different counts can favor different parties in an interference. In the case of the Y-Ba-Cu-O superconductor, the Patent Office has made an initial ruling that the invention consists of five parts: the manufacture of the material; the proof that it is a superconductor; the analysis of the chemical composition of the compound; the determination of its crystal structure; and the preparation of a sample that is at least 90% pure. Under patent law, whichever party can show it was the first to achieve all five would be awarded the patent.

At first glance, this count looks like bad news for the University of Houston. The samples made by Chu's team were not 90% pure at the time the different groups wrote their papers and filed their patents. Judging from the published papers, Bell Labs may have been the first of the four contenders to get a 90% pure sample—and it can clearly satisfy the other four prerequisites.

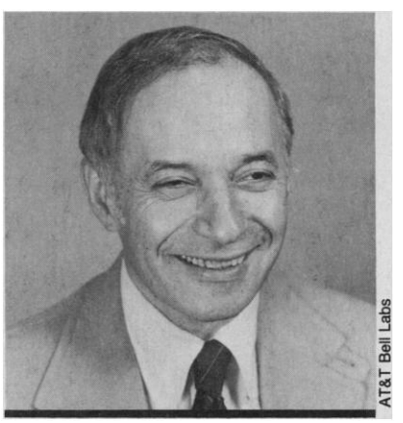
Still, Bell Labs may not have a clear shot, for the contenders are fighting to change the precise wording of the count. "Each side has probably filed four or five different motions to amend the count," says James Gambrell, lead patent attorney for the University of



Tom Callins

"Since four or five people did [the follow-up work] within a month, it's clear it wasn't hard."

—James Gambrell, UH attorney



AT&T Bell Labs

"We're looking at [the initial superconductor discovery] as entailing two inventions."

—George Indig, Bell Labs attorney

Houston. "Everybody is jockeying around to try to get the claims in the count to correspond to their own work." The examiner will take these motions into consideration before determining the final count.

Houston would like to convince the patent examiner that the real invention was making the new material and showing it was superconducting and that the steps of determining the chemical and crystalline structures and making a 90% pure sample were obvious extensions of that original work. "Since four or five people did it [the follow-up steps] within a month, it's clear it wasn't hard," Gambrell says.

Indeed, at least one laboratory involved in the initial superconductor rush seems to agree with Gambrell. Researchers from Bell Communications Research, the research arm of the seven Bell companies after the breakup of AT&T, reproduced the Houston work and found the material's chemical composition and crystalline structure at about the same time as the other four contenders but did not file for a patent. "Our patent people felt there wasn't anything to file," says Jack Wernick, associate division manager of chemistry and materials science research at Bellcore.

AT&T Bell Labs sees it differently. "We're looking at this thing as entailing two inventions," says George Indig, general attorney for intellectual property matters for Bell Labs. "Paul Chu is entitled to credit [for discovering the material] and will probably receive it in the form of a patent." However, Bell Labs contends that identifying the material and showing how to make it in pure form is worth a second patent—an option open to the patent examiner. "There was room for the description of a process that would reliably make a single-phase material," Indig says.

The Naval Research Laboratory is making a similar pitch. "Our patent claim is based on the fact that we were among the first to properly identify the stoichiometric composition and the crystal structure," says Donald Gubser, superintendent of NRL's Materials Science and Technology Division. "Paul Chu discovered a material that goes superconducting at around 90 degrees. We're claiming that we were the first to show how to make 90% pure samples."

IBM attorneys would not comment on the case, but its publications indicate it will probably base its case on similar claims. IBM scientists submitted research characterizing the Y-Ba-Cu-O material to a scientific journal at approximately the same time as the other three labs.

Thus, the outcome of the interference may depend on what the patent examiner decides should qualify as an "invention." Everyone agrees that the first work done by Chu's team was inventive, but what about the subsequent work? Was it obvious?

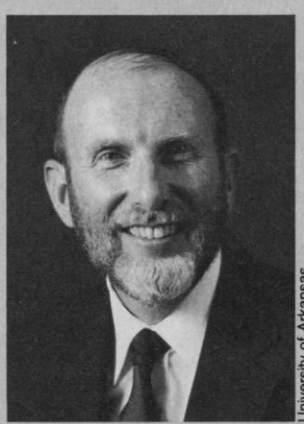
Here the debate gets rather technical, but again, the battle revolves around the preliminary nature of Chu's announcement. Bell Labs' Indig offers one solid argument as to why the later work was inventive. He points out that the original paper from the University of Houston and the University of Alabama in Huntsville, published in *Physical Review Letters*, shows that Chu's team had not isolated the superconducting phase and, even more importantly, was confused as to what created the superconductivity. The paper suggests that "interfacial effects" between the different phases in their samples could have caused the superconductivity. This indicates that at the time the paper was written, Chu's team did not even know they were looking for a single compound. Besides discovering that the superconductivity arose from one phase of the mixture, the Bell Labs team isolated and identified that compound. All this constitutes a patentable invention, Indig contends.

No matter how this interference turns out, the betting is that the University of Houston will come away with something for its original discovery. Gambrell, the Houston attorney, predicts that at the very least the university may end up with a patent on the material itself, while a second subsidiary patent would cover its structure and the manufacture of pure samples.

That outcome would be quite satisfactory to William Brinkman, executive director of physics research at Bell Labs—assuming, of course, that AT&T ended up with the second patent. Then, Brinkman notes, anyone wishing to manufacture something out of the Y-Ba-Cu-O material would have to get licenses from both AT&T and Du Pont, the latter having bought the exclusive license rights to Chu's work. In this case, the two companies would probably end up signing a cross-licensing agreement, giving each other rights to both patents. AT&T's patent philosophy, Brinkman says, is to use patents not to make money but to guarantee itself access to technology by cross-licensing with other patent holders. The electronics industry, for example, is crisscrossed with licensing agreements among the holders of patents on various bits of the semiconductor technology. "Patenting only makes you a

A Costly Lesson in Patent Law

Allen Hermann has some heartfelt advice about patent disputes. "When an interference is filed, you should always fight it," he says. Hermann figures he lost millions of dollars by not fighting a patent interference on a discovery he made in the mid-1960s.



Allen Hermann

Hermann, now a professor of physics at the University of Arkansas and a leading researcher in high-temperature superconductivity, was working at the Jet Propulsion Laboratory in 1966 when he and coworkers invented a new type of solid-state battery. The battery had great promise for use in space—it packed a lot of energy into a small volume, it contained no messy liquids, and it had a long life—but its most valuable potential use was not obvious at the time. Hermann's group filed a patent application on the invention before announcing it in the literature.

Three years later, a company named Catalyst Research Corporation filed a patent application on a lithium/iodine solid-state battery that was very similar to his invention, Hermann recalls. Hermann's patent application was for a rather broad, generic class of batteries while the Catalyst Research application was for a specific composition, but "scientifically it was the same battery," Hermann says. He and his colleagues subsequently received word that the Patent Office had declared an interference between the two patent applications. But Hermann declined to fight the interference because it applied to only a small corner of his broader invention. "I was on to something else at the time," Hermann says, "and I didn't realize the significance [of the specific battery in the interference]."

Unfortunately for Hermann, the particular battery patented by Catalyst Research turned out to be the best choice to power cardiac pacemakers, an application that has earned a lot of money in the years since the patent was granted. "I lost many millions of dollars in royalties," Hermann says. ■ R.P.

member of the club," Brinkman says.

Indeed, Du Pont's payments to the University of Houston, which could reach $5.5 million if the Y-Ba-Cu-O material proves valuable, are little more than entrance fees to that club. Ed Mead, Du Pont's manager of business development, explained that the company had not done any of the early work on the superconductor and it was worried about being blocked from commercial applications by companies such as AT&T and IBM, which would hold many of the important patents.

The fight over patent rights to the Y-Ba-Cu-O superconductor may not be over with the settlement of this interference, for there is at least one more controversy on the horizon. The University of Alabama in Huntsville collaborated with the University of Houston in the search for the superconductor, and it was Maw-Kuen Wu and coworkers at the Alabama school who first synthesized the material and found it to be superconducting at 90 K. But when the University of Houston filed its patent application, it ignored the other school's contribution, and Alabama later filed a separate patent application. Bob Rieder, counsel for the University of Alabama in Huntsville, says, "We expect the interference to be declared any day."

Are there any lessons in this for scientists who make patentable discoveries? One thing is clear from the University of Houston's experience with the patent interference: Commercial interests often clash with the desire of scientists to announce results as quickly as possible. "If Paul Chu hadn't published this, he could have filed a second application 6 months later when it was completely characterized," says Chuck Guenzer, a patent attorney for Bellcore. "The typical patent attorney would prefer no publication at all." In reality, most superconductivity researchers agree that if Chu had not announced his discovery, someone else would have discovered the same material within a matter of weeks. But Guenzer's point is still valid: In terms of patents, the smartest thing to do with a major discovery is to hold off announcing it for as long as possible while doing further research.

If for some reason the Patent Office does not give the University of Houston the proper credit for its work, it could be "chilling to open and free scientific discussion," says Bob Hazen, the Carnegie Institution researcher who determined the structure of the Y-Ba-Cu-O material for Chu. Already there are some industrial labs where the company's patent office will sit on an invention for years, and no one wants to see that attitude move into universities.

■ **ROBERT POOL**

A Surprise Near Virgo

In a supposedly blank part of the sky south of the cluster of galaxies in the constellation Virgo, astronomers have found a giant, rotating hydrogen gas cloud—possibly an embryonic galaxy that may even now be coalescing to form stars and planets.

Cornell University astronomers Riccardo Giovanelli and Martha Haynes discovered the cloud using the 1000-foot radio telescope at the National Astronomy and Ionosphere Center in Arecibo, Puerto Rico. Their finding will appear in a future issue of *The Astrophysical Journal (Letters)*. Nearly all known galaxies formed within the first billion years of the existence of the universe—most within the first 100 million years. This means that to catch a glimpse of an evolving galaxy, astronomers have been looking at very distant objects—so far away that their light has taken nearly the age of the universe to reach Earth.

What makes the cloud discovered by Giovanelli and Haynes so remarkable is that it is almost next door in intergalactic terms: just 20 megaparsecs (or 65 million light-years) away.

"It is an exceedingly fascinating object," says astrophysicist James Gunn of Princeton University, "because it looks like the first bona fide, galaxy-sized thing that is just now collapsing out of the expansion [of the universe]."

The newly discovered gas cloud has a mass about one tenth that of the Milky Way, but is about ten times larger—some 200 kiloparsecs in diameter. The cloud is elliptical in shape, with two large clumps of gas that may be merging, but there is no evidence that stars have already formed. It is rotating extremely slowly—one revolution would take approximately 10 billion years—which gives a clue to its age.

"For something that is going that slowly, it either has to have taken that long to form," says Gunn, "or you require some kind of deus ex machina to have put the thing down originally in this state rotating just right." He says that most galaxy formation theories predict that gas clouds will start rotating slowly and speed up as they shrink to the point where the centrifugal force is large enough to overcome gravity. "To collapse to that state and 'spin them up' takes at least as long as the rotation time, and sometimes longer," he says. "So it says that this thing that they have found has not even finished yet . . . it's just getting itself together."

Many astronomers—including Giovanelli and Haynes—have been skeptical about the existence of intergalactic clouds. About 15 years ago, radio astronomers made a systematic search for such optically invisible clouds after theorists speculated that they might account for the missing mass of the universe. But the search proved fruitless and the theory fell out of favor.

"I spent my Ph.D. thesis looking for these and I never found anything," Haynes says. So when she and Giovanelli picked up a strange signal coming from a supposedly empty part of the sky, they thought it was spurious. "We thought 'something is wrong, we looked in the wrong position.' It happens so often that [a peculiar signal] is just interference or something has gone wrong or you've made a mistake. You don't get too excited about it until you see it again."

A second look convinced them something was there, but what? "Riccardo said, 'Ah, it's an intergalactic cloud,' " Haynes recalls, "and I said, 'No, I don't believe in them. They can't exist. It's against my religion. How can you do this to me?' "

Haynes says that although the space where the cloud was found is locally isolated, "if you look on a larger scale, around 10 or 20 megaparsecs, there is a higher concentration of galaxies along what we call the supergalactic plane. And this looks like it's in a little pocket of nothingness in the clustering of galaxies in the supergalactic plane."

Giovanelli and Haynes plan further radio astronomy observations of the cloud this year and optical observations next winter and spring when Virgo rises into the nighttime sky. They will also search for more such clouds to get a better idea of how important a role they play in the evolving universe. "They seem to be telling us something about the fact that the galaxy formation process, especially for rotating disks, is a process that can occur over a long interval of time in the history of the universe, not necessarily at one magic time," says Giovanelli.

"I'm very excited about it," says Gunn. "It is going to be a kind of Rosetta stone for galaxy formation."

■ **JOSEPH PALCA**