Hidden talents: JILA's unassuming exterior houses teams of skilled technicians whose support has helped to revolutionize atomic physics.

UNIV. COLORADO, BOULDER; JILA (INSET)

Rocky Mountain high

Beneath the peaks of Colorado nestles an unusual institute that leads the world in atomic physics. Peter Aldhous visits JILA, where a culture of sharing has underpinned Nobel success.

It's always pleasing to meet an award-winning scientist who is keen to share the credit with unsung heroes. Even so, Eric Cornell's response to questions about how he came to bag a share of the 2001 Nobel physics prize comes as a breath of fresh air. I might have expected him to credit an eminent professor who first set him on a scientific path that ultimately led to the creation of a new kind of matter. Instead, Cornell singles out his technicians. "We have a very high quality of support staff," he says.

After spending a day in Boulder, Colorado, as a guest of JILA, formerly known as the Joint Institute for Laboratory Astrophysics, it's clear that Cornell's comment is not simply the product of modesty. Each of JILA's staff repeats the mantra: the institute's enviable reputation stems in large part from its outstanding mechanical and electronics workshops, and their skilled and dedicated staff.

It's not the only distinctive theme. JILA is also a place where egos and empire builders are definitely not welcome. Dana Anderson, one of the lab's optical-physicists, notes that potential recruits must have a willingness to share resources and lab space to ensure that the most promising projects can flourish. "A fair amount of attention is given to whether they'll be a good JILA citizen," he says.

World-class workshops, an open attitude to new ideas, plus stunning views of the Rocky Mountains — it sounds like a physics utopia. So how did this agreeable environment come into being? And in the cut-throat world of modern science, how does JILA's admirable ethos manage to survive?

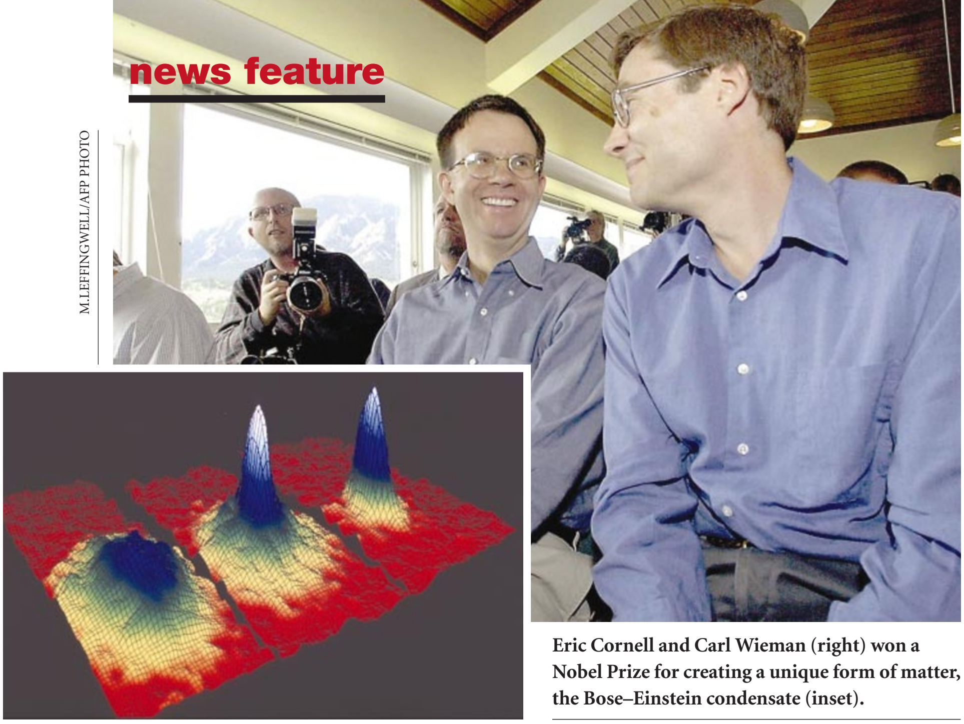
Atomic adventures

Before 1995, the lab was little known outside the fields in which it specializes: astrophysics and optics, together with atomic, chemical and materials physics, and precision measurements of phenomena, such as time and gravity. But in that year, Cornell and his colleague Carl Wieman put the lab firmly on the map of world science. By cooling a gas of rubidium atoms to within a whisker of absolute zero, they created a Bose–Einstein condensate — a state of matter whose existence had been theorized some 70 years before. This form is special because the rubidium atoms enter the same quantum-mechanical state as each other — the condensate, in effect, behaves as a single particle.

Six years later, Cornell, Wieman and Wolfgang Ketterle, whose team at the Massachusetts Institute of Technology created a condensate shortly after the JILA group, were rewarded with a Nobel prize (see *Nature* **413,** 554; 2001). This honour has linked JILA's name forever with Bose–Einstein condensates, but Cornell and Wieman's achievements were in fact just one incarnation of the lab's adventures at the forefront of atomic physics, which date back more than four decades.

JILA was established in 1962 as a joint venture between the National Institute of Standards and Technology (NIST), a federal technology agency whose work includes the development of improved techniques for measurement, and the University of Colorado at Boulder. In those days, some of the hottest action in astrophysics lay in studying the atmospheres, or coronas, of stars such as our Sun. Understanding their dynamics required detailed observations of atomic collisions under extreme conditions, and so the marriage between atomic physics and astrophysics seemed perfectly natural.

But over time, JILA's astrophysicists moved onto other problems. So, too, did the atomic physicists. "The two groups got interested in different things," says Judah Levine, who works on super-accurate atomic clocks, and is currently JILA's chair. Today, this



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Eric Cornell and Carl Wieman (right) won a Nobel Prize for creating a unique form of matter, the Bose–Einstein condensate (inset).

amicable divorce is so complete that the phrase 'laboratory astrophysics' has no bearing on JILA's activities — hence the decision in 1995 to drop the full title in favour of the acronym. While JILA's astrophysicists are now exploring exotic phenomena such as supernovae and black holes, their former partners moved first into studying atomic properties using laser spectroscopy, followed by the work on ultracold atoms that led to Cornell and Weiman's prize.

The success of JILA's atomic physics programme is in part due to the security that stems from an unusual funding stream. For three decades, the lab has held a massive 'group grant' from the National Science Foundation (NSF), which today runs to $3 million per year, about 10% of JILA's total operating budget. It's the way this money has been spent, says Wieman, that defines JILA's prevailing ethos.

Youth culture

Today, that grant is managed by Wieman, Cornell, and Carl Lineberger, a 35-year veteran of JILA who studies the structure and stability of ions. First, the principal investigators make sure that the workshops on which JILA's experimental expertise depends never have to scrimp and save — JILA spends some 10% of its budget on its workshops, about twice the sum put aside by most US academic physics departments. Second, the spending is under constant review to ensure that the most exciting projects win support. "We always give priority to new, younger people," says Wieman. "If they have new ideas, or they need some piece of equipment, we give it to them."

This sounds wonderfully altruistic, but Wieman stresses that the underlying dynamic is one of rigorous competition with the wider world of atomic physics. JILA's group grant must be renewed every five years, and this is no formality. "If they get it renewed, it's because they damned well deserve it," says NSF programme director Barry Schneider. "They are excellent at making sure that they use this money only to fund the best of the best." Ultimately, argues Lineberger, it is the lab's ability to adapt to new scientific opportunities that has kept the grant going. "The reason it is in its 30th year is the fact that the science of the grant has reinvented itself several times," he says.

The group grant currently accounts for more than 12% of the NSF's total spending on experimental atomic, molecular, optical and plasma physics. "That's very conspicuous, and you have to be absolutely above any reasonable standard," says Wieman. As a result, the principal investigators are strict in cutting funding from any projects that prove less exciting than was hoped. "We're far more ruthless than other grants like this."

For those who make the grade, the environment fostered by the NSF group grant makes JILA something of a physics playground. "It has a different feel; senior people will give up space and money," enthuses Debbie Jin, whose team is currently striving to create another new form of matter similar to a Bose–Einstein condensate, but using atoms with different quantum-mechanical properties, known as fermions (see *Nature* **417,** 892–893; 2002). "The machine shop is outstanding, and the electronics shop is something you don't find in a physics department anywhere," she adds. "Experiments can go faster here."

Given this billing, I feel that I'm entering a revered inner sanctum when I finally visit JILA's workshops. They are, indeed, impressive — as is the range of skills possessed by the technicians who work within them. Cornell, for instance, partly attributes JILA's success in being first to create a Bose–Einstein condensate to the lab's in-house expertise in working with glass. Cooling the rubidium atoms involves trapping them using lasers and magnetic fields. Thanks to JILA's technicians, Cornell and Wieman were able to conduct their experiments inside a bespoke glass vessel with the magnetic coils held outside. If Ketterle and his colleagues had a similar setup, Cornell observes, they would not have experienced the delay of several weeks that they suffered when one of their coils melted, contaminating the entire apparatus.

Paul Beckingham, a PhD in astrophysics who heads JILA's electronics shop, says that building the specialized devices required by some of the institute's physicists requires some creative thinking. Finding the right electronic component, for example, can involve scouring obscure catalogues, such as those for vehicle parts. For some, this is an alluring prospect. "People who like this kind of life tend to stick at it," he says.

Speedy pursuits

The focus on creating the right environment for technically demanding experiments also extends to JILA's arrangements for purchasing supplies. "The time it takes from ordering a widget and the widget arriving is much shorter than elsewhere," says Cornell. "We put a lot of effort into it." And as someone who knows the value of being the first to achieve a significant experimental result, Cornell is in no doubt that this effort is worthwhile. "In research, anything worth doing is worth doing quickly," he grins.

But like any successful lab, JILA can't rest on its laurels. The reinvention of the lab's experimental programme is ongoing, with one important area being ultrashort laser pulses. Jun Ye, for example, is applying cutting-edge laser technology to a wide array of projects, including the development of improved atomic clocks, the fine control of chemical reactions, efforts to develop secure communications, and the imaging of living cells.

Still, the lab has suffered some setbacks, notably NIST's withdrawl of its support for JILA's astrophysics programme in the 1990s — although the pull-out happened over a sufficiently long period for it not to pose major difficulties. And although the University of Colorado has a respectable reputation, the fact that it isn't in the same academic league as the likes of Harvard and Stanford means that senior JILA scientists are always mildly anxious about their continued ability to attract the brightest postdocs and graduate students.

But all the signs are that there's no need to worry about recruitment. "We've done pretty well and are doing better," says Cornell, who notes that Boulder has some attractions that Harvard or Stanford could never match. "It's pretty nice here, if you're a climber, a skier or a cyclist."

Empire-builders, however, need not apply. ■

Peter Aldhous is *Nature*'s chief news and features editor.

➧ **http://jilawww.colorado.edu**