# Atomic fountain springs from a light touch

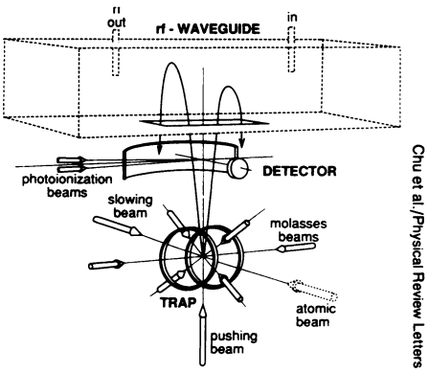
Using pulses of laser light, a team of physicists has succeeded in creating an atomic fountain. The laser pulses push the atoms up; gravity brings them down. During the descent, scientists can probe the freely falling atoms with microwaves, obtaining extremely precise measurements of transitions from one atomic energy level to another. Such a scheme may form the basis of an atomic clock for establishing a time standard.

"The atomic physics community was dreaming of making [atomic fountains] in the early 1950s, but they didn't have techniques for cooling down and manipulating atoms," says Steven Chu of Stanford University. "We had to string together a lot of tricks that we have been developing in laser cooling. Once we had those tricks, it was actually fairly easy."

To create an atomic fountain, Chu and his colleagues first use a laser beam to slow a stream of sodium atoms moving toward the laser (see illustration). They then store the slowed atoms in a special trap created by a combination of magnetic fields and three laser beams positioned at right angles to each other (SN: 7/23/89, p.52). After a final cooling stage, during which the atoms reach a temperature of roughly 50 microkelvins (a tiny fraction of a degree above absolute zero), the trap is turned off and laser pulses from beneath launch the atoms upward. Following a ballistic trajectory, the atoms soar into a microwave waveguide, where the transition from one energy level to another occurs.

Such a fountain makes it possible to measure atomic properties very precisely. According to the Heisenberg uncertainty principle, the longer an atom can be observed, the more precisely researchers can determine the frequency of an energy-level transition. Chu's fountain allows a 0.25-second measurement time, when the atoms are free of any perturbing electric and magnetic fields that would otherwise affect the measurements. The relatively long time the atoms spend freely falling allows the team to measure the frequency of a microwave transition in the sodium atom to within 2 hertz, better than the 26-hertz precision of the present U.S. time standard.

The atomic fountain is only one of several possible ways to build a precise atomic clock. Other researchers are investigating the use of single ions, which can be stored for long periods of time in magnetic traps (SN: 8/12/89, p.103), or designing traps with specially shaped magnetic fields to hold neutral atoms without unduly perturbing them. Which approach works best for making a practical atomic clock remains to be seen.



Chu et al./Physical Review Letters

Meanwhile, Chu and his colleagues, who report their achievement in the Aug. 7 PHYSICAL REVIEW LETTERS, are in the middle of deciding whether to perform the same experiment with cesium atoms —which ought to yield even more precise measurements — or to try building an apparatus to measure optical rather than microwave frequencies. — *I. Peterson*

# Teenagers reap broad benefits from 'authoritative' parents

Attention, harried parents: Supportive control gets the nod over permissiveness if you want to nurture a psychologically healthy teenager, according to an ongoing study directed by psychologist Diana Baumrind of the University of California, Berkeley.

Parents who consistently set down clear standards for conduct and offer freedom within specific limits produce teenagers who perform better on academic tests, are more emotionally and socially stable, and use alcohol and illicit drugs substantially less than youngsters from other types of families, Baumrind reported last week at the annual meeting of the American Psychological Association in New Orleans.

"The study demonstrates the problems with parental leniency," she says. "We expected that at puberty, some imbalance in favor of freedom over control would have become desirable, but that did not happen."

Many traditional theories of psychological development, based on the work of Sigmund Freud and Swiss psychologist Jean Piaget, encourage a more lenient parental style with adolescents, emphasizing freedom over control. Such theories hold that an individual's prime task during the teen years is to separate emotionally from the parents and achieve a sense of his or her own identity.

The traditional approach may be appropriate in a stable social environment, Baumrind asserts. But in today's climate of social instability — marked by many mothers entering the work force, a high divorce rate and readily available illicit drugs — adolescents function best when parents are highly demanding as well as sensitive to a child's emerging needs for autonomy, she says.

In fact, Baumrind notes, this style of parenting, which she calls "authoritative," even confers advantages on adolescents who use alcohol and drugs heavily. In her study, she defines heavy users as teenagers who reported getting high on alcohol or drugs several times a month. The few heavy users from authoritative families and those from "democratic" families — where parents stress permissiveness somewhat more than setting down limits — did much better on academic achievement tests and showed more emotional stability than heavy users from the five other family types.

The 124 youngsters in the Berkeley study were born in the mid-1960s and their parents were born in the 1930s. The researchers studied families when the children were 3 years old, and then twice more, when the children were about 10 and 15 years old. Most participants were white, middle class and well educated.

At each point in the investigation, one team of observers spent at least 20 hours with each child and a different team spent about 30 hours with the parents, compiling a wide range of data on their behavior and emotional functioning. Researchers interviewed each parent separately and videotaped both parents during interactions with the child at home.

Baumrind and her co-workers divided the sample into seven parenting styles: 21 families were authoritative, 25 were democratic, 21 were "authoritarian" (extremely restrictive and demanding but providing little emotional support or consideration), 7 were "directive" (obedience-oriented and moderately supportive), 7 were "nondirective" (setting no limits and moderately supportive), 30 were "unengaged" (providing neither control nor support) and 13 were "good enough" (adequate, but not outstanding, in control and support).

Adolescents from authoritative and democratic families showed by far the most social competence, maturity and optimism, Baumrind says. They also scored the highest on verbal and mathematical achievement tests. However, significantly more heavy drug users and "dependent" drug users, characterized by daily use, came from democratic homes than from authoritative homes.

"Authoritative parents are not bossy," Baumrind says. "They make it their business to know their children, how they're doing in school and who their friends are. Their control reflects a high level of commitment to the child, and they are not afraid to confront the child."

The lowest drug use appeared among

teenagers from both authoritative and authoritarian families. But the researchers found that youngsters in the authoritarian families, particularly daughters, were more unhappy, had more emotional problems and scored lower on achievement tests than their peers.

Reports of sexual activity and heavy or dependent drug use came most often from adolescents with unengaged parents, followed closely by adolescents from nondirective families.

Teenagers from good-enough homes displayed no serious problems and did fairly well on achievement tests. Daughters in these homes reported extremely low self-esteem, however. This finding is difficult to explain, Baumrind says. "These girls may need something more from their parents, perhaps a sense of being special," she suggests.

Although the authoritative parenting style proved most successful in this sample, Baumrind notes that well-functioning children also came from other types of homes, especially democratic ones.

Divorce was most frequent among authoritarian and unengaged parents, she adds. But single parents who used the authoritative style had teenagers who were just as competent and well adjusted as teenagers from intact authoritative families. *– B. Bower*

# A snake-in-the-ring keeps spins aligned

Using a Soviet-conceived device known as a Siberian snake, U.S. physicists have wormed their way out of a tricky technical problem encountered in accelerating elementary particles.

The problem arises in trying to keep the spin of subatomic particles aligned, or polarized, as they whiz around an accelerator. Particles that maintain such alignment during high-energy collisions give scientists a window on the strength of the spin-dependent portion of the strong force, which holds nuclear particles together. Although the magnetic field that keeps a charged particle circling through the accelerator changes the direction of spin with each lap, at most energies these effects tend to cancel each other out after successive laps around the ring.

But at certain energies, called depolarizing resonances, the changes in spin direction become additive, throwing the spin orientation of such particles as protons out of alignment. While misalignment at a particular energy can be overcome electromagnetically, says physicist Alan D. Krisch of the University of Michigan at Ann Arbor, high-energy accelerators have thousands of resonances. Correcting for each misalignment then becomes impractical, if not impossible.

Enter the Siberian snake.

Although the device was first proposed in 1974 by Soviet theorists Yaroslav S. Derbenev and Anatoly M. Kondratenko of the Novosibirsk Laboratory, researchers were unable to build it because none of the world's existing high-energy accelerators had enough room in their beam pipes for the 19-foot-long electromagnet. The snake produces a magnetic field that reverses the spin of every proton in a particle beam each time the particle travels around the accelerator ring. As a result of the spin flip, unwanted magnetic disturbance that redirects a proton's spin after one lap has the opposite effect the next time around. Thus, the two effects cancel each other out and the particle beam remains polarized.

"It's a cute idea and it works for all resonances at once," says Krisch, who collaborated with scientists from the University of Michigan, Indiana University in Bloomington and the Brookhaven National Laboratory in Upton, N.Y., to build and insert the device inside the cooler-ring accelerator of Indiana University's cyclotron.

During the weekend of Aug. 5, the researchers put the snake through its paces. First, with the Siberian snake switched off, they accelerated protons in the cooler ring to an energy of 108.45 million electron-volts – one of two depolarizing resonances at the Indiana facility. A polarimeter measured the fraction of protons spinning in each direction. At resonance, the fraction of protons with aligned spins decreased from 70 to 20 percent. But after the investigators turned on the snake electromagnet, spin alignment remained at 70 percent despite the resonance. Krisch says he sent a telegram to the Novosibirsk Laboratory informing the director of the results.

Perhaps fittingly, Krisch says, one of the first high-energy accelerators to exploit the snake concept will be UNK, the Soviet Union's 3-trillion-electron-volt accelerator, located about 70 miles south of Moscow. *– R. Cowen*

# Tracking down the neurons of perception

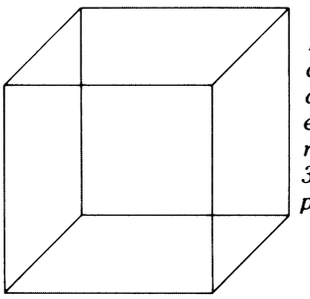
A simple sketch of a cube can prompt two rivalrous perceptions: A person might see the cube extending forward at one moment and backward the next, switching perceptions with each new glance.

By presenting rivalrous visual stimuli to rhesus monkeys and monitoring the monkeys' silent, inner perceptions – through behavioral clues and the responses of brain cells known to process visual motion – two neurophysiologists think they may have observed the cellular activity of perception.

"This is one of the first demonstrations of the activity of single neurons corresponding to a monkey's perceptual state," says Jeffrey D. Schall of Vanderbilt University in Nashville, who works on the ongoing project with Nikos K. Logothetis of the Massachusetts Institute of Technology in Cambridge. They report their progress in the Aug. 18 SCIENCE. "It's the best attempt I know of to look at the neurophysiology underlying rivalrous perception," notes neuroscientist William T. Newsome of Stanford University.

The stimuli in the experiments come from vertically moving gratings of horizontal bars, each visible to one eye through a viewer that fuses the gratings into a composite stimulus. In half the trials, the gratings move in the same direction and the monkey can perceive only up or down motion. In the other half, the gratings move in opposite directions, eliciting rivalrous perceptions of upward and downward movement.

Since monkeys can't describe their perceptions verbally, the scientists



*Line drawing of a cube elicits rivalrous 3-D perceptions.*

trained them to make quick eye movements to the right (signaling upward motion) or left (signaling downward motion) of a central fixation point presented after each trial. And *during* each trial, researchers tracked vertical movements of each monkey's eyes for a check on the animal's subsequent report of its perception.

At the same time, they used electrodes to study how 59 single neurons in the superior temporal sulcus – a brain groove roughly located behind each ear – responded in the different trials. As expected, most of these neurons fired fastest in response to exclusively upward or exclusively downward movement of the gratings. The response of many of the cells didn't change even during trials presenting rivalrous stimuli. That means they responded only to the visual stimulus and did not reflect the internal perception of the monkey. Yet with the same rivalrous stimuli, 13 of the neurons did change their firing behavior. These cells, therefore, could be related to the internal perceptual state of the monkeys, and not merely to some physical feature of the stimuli, Schall and Logothetis argue. *– I. Amato*