

## 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.

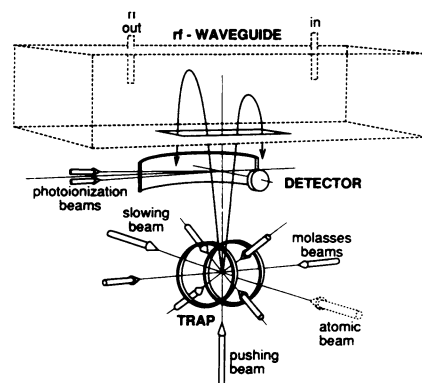
"The atomic physics community was dreaming of making [atomic fountains] in the early 1950s, but they didn't have techniques for cooling down and manipulating atoms," says Steven Chu of Stanford University. "We had to string together a lot of tricks that we have been developing in laser cooling. Once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



Chu et al./Physical Review Letters

vestigating 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.

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