Atomic spectra for nuclear studies

The atom, through its spectrum, reveals some of the key features of its nucleus. From the earliest days of nuclear physics, high-resolution measurements of the hyperfine structure of atomic energy levels have provided reliable data on nuclear angular momenta (spins) and electric and magnetic multipole moments. Shifts in atomic energy levels from isotope to isotope—the "isotope shifts"—have given information about the change of the mean-square radius of the nuclear charge as a function of neutron number. Often the optical spectrum of bound electrons provides the only probe of these nuclear properties. Magnetic dipole moments and spins have played an important role in clarifying the individual-particle aspects of the nucleus, described by the shell model, while electric quadrupole moments and isotope shifts have dramatically demonstrated the collective nuclear degrees of freedom. To perform systematic studies of these effects over long sequences of isotopes, to shed as much light as possible on the structure of the nucleus, one must be able to make measurements with radioactive nuclei. This requirement has posed a challenge to atomic spectroscopists to develop new high-resolution techniques suitable for studies of nuclear structure with the very minute or dilute samples that can be produced with accelerators or reactors. Notable advances were made in the past thirty years in working with small samples—and particularly the small radioactive samples produced at accelerators—and by the introduction of radiofrequency and level-crossing techniques.

The next article discusses the development of these techniques and some of the recent results obtained with them. The photo below shows the ISOLDE mass separator at CERN, which has been used to obtain many of the new results in the on-line experiments that Hans Schuessler describes in the article on page 48. —*Olav Redi*