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Cyclotrons: From Science to Human Health

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Lawrence's invention of the cyclotron, whose 80th anniversary we have just celebrated, not only revolutionized nuclear physics, but proved the starting point for a whole variety of recirculating accelerators, from the smallest microtron to the largest synchrotron, that have had an enormous impact in almost every branch of science and in several areas of medicine and industry. Cyclotrons themselves have proved remarkably adaptable, incorporating a variety of new ideas and technologies over the years: frequency modulation, edge focusing, AG focusing, separate magnet sectors, axial and azimuthal injection, ring geometries, stripping extraction, superconducting magnets and rf..... Even FFAGs, those most complex members of the cyclotron (fixed-magnetic-field) family, are making a comeback. Currently there are more than 50 medium or large cyclotrons around the world devoted to research. These provide intense primary beams of protons or stable ions, and correspondingly intense secondary beams of neutrons, pions, muons and radioactive ions, for experiments in nuclear, particle and condensed-matter physics, and in the materials and life sciences. Far outnumbering these, however, are the 800 or so small and medium cyclotrons used to produce radioisotopes for medical and other purposes. In addition, a rapidly growing number of 230-MeV proton cyclotrons are being built for cancer therapy - 12 brought into operation since 1998 and as many more in the works. Altogether, cyclotrons are flourishing!