

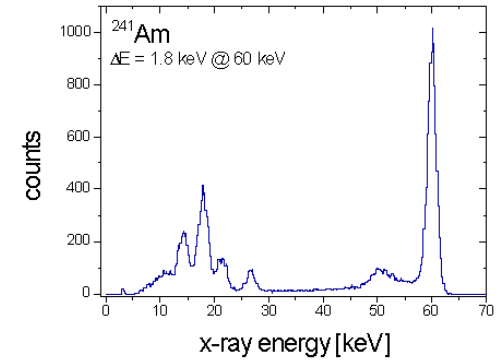
The Challenging Search for Semiconductor Detectors

Research Plan

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There is a great need for gamma ray detectors having high enough resolution to discriminate among radioactive isotopes. Applications abound in homeland security, nuclear nonproliferation, particle physics, and engineering.

The gold standard today in semiconductor radiation detectors is high-purity germanium (Ge). Because of its low bandgap, however, Ge detectors must be operated at liquid nitrogen temperatures, restricting their use in widespread nontechnical applications.



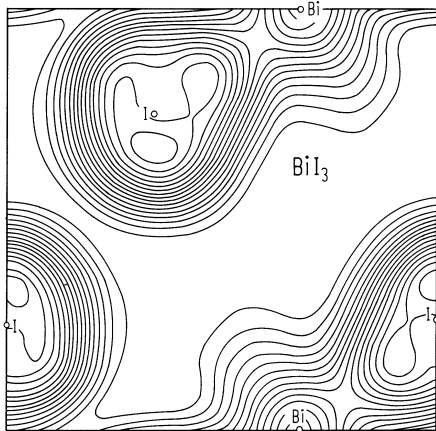
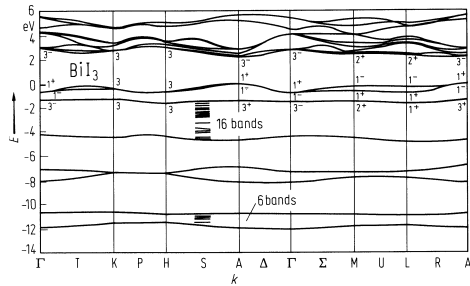
Typical spectrum obtained from a medium-quality Ge crystal

An ideal detector material would work at room temperature and yet have the same energy resolution as Ge.

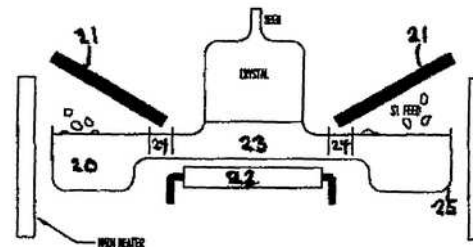
Such materials do not exist yet, because binary and ternary semiconductor compounds are hard to manufacture to the high purity standard needed to ensure long carrier lifetimes and high mobility.

My project, in cooperation with Lawrence Berkeley Lab (Stephen DeRenzo, Edith Bourret) and the UCB Department of Nuclear Engineering (Brian Wirth) aims at identifying promising compounds and studying their properties toward allowing the growth of large, ultrapure crystals suitable as detectors.

This work is in its infancy. A list of promising materials has been selected and their bandgaps, carrier mobility and lifetimes are being investigated. Crystal-growing furnaces have been ordered to start experimental work.



Band structure and charge density for a promising material, bismuth triiodide



Version of the semicontinuous Czochralski crystal growth apparatus