Campus physics TRIUMF

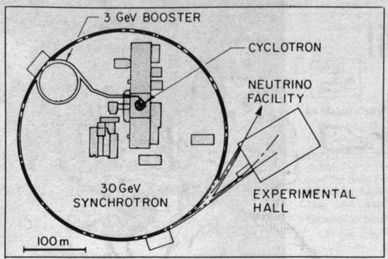
by Randy Predy

The TRIUMF accelerator located at UBC is the world's largest cyclotron (18m diameter), an accelerator that uses a magnetic field to curve the path of a beam of charged particles into a spiral trajectory.

TRIUMF is operated as a joint venture by the U of A, Simon Fraser University, U of Vic. and UBC.

The name TRIUMF is an acronym for Tri-University Meson Facility, and the U of A became the fourth partner during the intitial months of the project in 1968. Dr. Khanna (U of A Physics Department) was both patient and kind in explaining the functioning of this facility (to this biologist).

The TRIUMF cyclotron accelerates negatively charged hydrogen ions (proton plus two electrons) to energies up to 520 million electron-volts. When stripped of their electrons, protons exit the cyclotron as a high energy proton beam with a velocity up to 75 per cent of the speed of light. The functioning of this facility can perhaps best be explained by following the proton beam in its various applications.



Outlay of the proposed KAON facility

First, the proton beam itself can be used as a source of high energy projectiles to probe the structure of the atomic nucleus. Alternatively, the proton beam can be used to produce radioactive isotopes, many of which have medical applications. In addition, the proton beam can be made incident on a lithium target, resulting in the production of neutron beams which can also be used to probe the structure of the atomic nucleus, or which can be used in the rapid analysis of metals in mineral samples.

Second, the proton beam can be made incident on a carbon target and this results in the production of pi-mesons (or pions). In the current model, physicists recognise two fundamental types of particles, quarks and leptons, as the building blocks of matter. For example, the proton is envisaged as a particle composed of three quarks. Similarly, the neutron is also composed of three quarks. The electron, however, belongs to a family of particles called leptons.

Pions which can bear electrical charge (positive or negative) or be electrically neutral are composed of a pair of quarks (one quark and one anti-quark). Isolated from nuclei, pions are very short lived particles lasting only 26 nanoseconds before decaying. The application of negatively charged pions in cancer treatment deserves some elaboration.

Pion cancer treatment is conducted at the Batho Biomedical Facility at TRIUMF. Atomic nuclei, which bear positive charge, attract and absorb slowly moving negatively charged pions. Following absorption, these atomic nuclei become unstable and explode. Therefore, this therapeutic approach is based on the destruction of atomic nuclei of atoms comprising essential biological molecules, such as DNA, in the cancer cells.

Third, pions are short lived particles which decay to a mu-meson (or a muon). A negatively charged muon, for example, behaves like a heavy electron, whereas a positively charged muon behaves like a light proton. These particles can be employed in studies on condensed states of matter (crystal structure for example). Muons are themselves very short-lived particles lasting only 2.2 microseconds before decaying. It is this instability which allows muons to be used as "tagged markers" in chemical and physical studies.

What can possibly be studied at TRIUMF which can not be better addressed at the large accelerator facilities such as CERN (Geneva) and Fermilab (Illinois)? Recall that the TRIUMF cyclotron is 18m in diameter; this is small compared to the Main Accelerator at Fermilab which is 4 miles in circumference.

The answer to the question lies in the nature of the processes studied in these laboratories. The function of the large accelerator facilities is to break matter into fundamental particles (basic building blocks) and to study their behavior. However, matter exhibits properties which arise out of the interaction of particles, and it is these "many body" phenomena

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which are investigated primarily at the lower energy accelerators such as TRIUMF.

Precision experiments with the decay of muons also yield information about the fundamental particles and their interactions.

Currently before the Federal Government is a proposal to upgrade the TRIUMF Facility, requiring the construction of two new accelerator rings (or synchrotrons). The upgraded facility, or KAON Factory, would produce proton beams of 60-fold higher energy. The name KAON is an acronym for K-mesons (or kaons), Anti-protons, Other strongly interacting particles (hadrons), and Neutrinos, which represent some of the new particles which would be produced.

The current TRIUMF cyclotron would serve as the injector for the first synchrotron (214 metre circumference), which would boost the energy of the proton beam from 520 million electron-volts to 3 billion electron-volts. The first synchrotron would then pass the proton beam to the second synchrotron (1070 metre circumference) for final boosting to an energy of 30 billion electron-volts. These protons, which are travelling at a velocity of 99.8 per cent of the speed of light, would then be made incident on a target resulting in the production of these new particles.

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The KAON Factory would address fundamental questions about the structure of matter such as the mechanism of quark confinement.

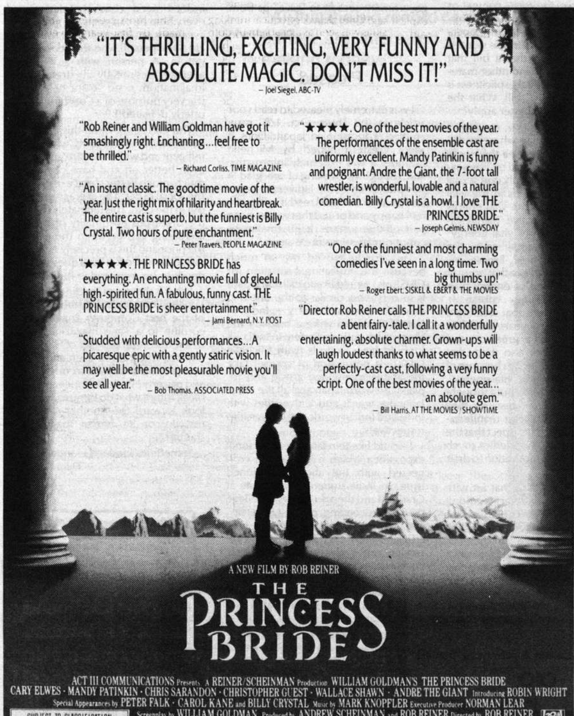
What would this upgraded facility mean to Canada? This project will cost 255 million dollars (1985 dollars) over a 6 year construction period. It is estimated that 51 per cent of the funds will be spent in B.C., and 81 per cent in Canada. All of the magnets, for example, can be manufactured in western Canada. The contracts awarded for construction of this facility will enable Canadian companies to develop new marketable skills.

During construction of the KAON Factory, it is estimated that 400-500 primary and 500-600 secondary jobs will be created. Once completed, this facility will require a permanent staff approximately twice its present size.

The Federal Government is expected to arrive at a decision on the KAON Factory Proposal by next April (end of the fiscal year). This project would be the largest ever undertaken by the scientific community in Canada, and would enable us to maintain a position of leadership in nuclear and particle physics. The benefits for the business community are obvious.

However, to arrive at a more complete assessment of this project's importance to Canada, one must consider the technological spin-offs such as pion cancer treatment and positron emission tomography (P.E.T. for brain scans) which are currently being developed at TRIUMF.

In view of these considerations, the proposed KAON Factory represents a world-class contribution to science and technology, which promises to raise the standard of living for Canadians.



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