Introduction
April 1, 2007 – March 31, 2008

Progress in research and operations at the Texas A&M Cyclotron Institute is summarized in this report for the period April, 1, 2007 through March 31, 2008. Sections I through IV contain reports from individual research projects. Operation and technical developments are given in Section V. Section VI lists the publications with Cyclotron Institute authors and the Appendix gives additional information including talks presented by members of the Institute during the past year. Once again, the full volume of this year's Progress in Research is available only on our web site (http://cyclotron.tamu.edu). *Since most of the contributions presented here are truly reports on progress in research, results and conclusions should not be quoted from the report without the consent of the authors.*

We have now completed 3 1/2 years of the Upgrade Project which ultimately will give us accelerated radioactive beams at intermediate energies. The progress on the project continues to be good—we remain close to schedule as of the second quarter of FY08. Last fall, we accelerated a beam in the K150 cyclotron for the first time in 20 years. Beam lines for the refurbished machine are now being installed. During the past year, we had some operational problems with the helium liquifier for the K500 cyclotron that caused some unscheduled maintenance downtime for the program. We have been working hard to catch up with experiments and electronics testing that did not get done during that period.

Institute programs continue to thrive. In the late fall of 2007, Dr. Dan Melconian joined us as an Assistant Professor of Physics and a member of the Cyclotron Institute. Dr. Melconian is developing a new program in experimental physics. In August, 2008, Dr. Cody Folden will join us as a new Assistant Professor of Nuclear Chemistry. He is planning to develop a program in heavy-element research.

Some highlights of work over the past year are given below.

Research highlights:

(1) Prompted by an anomalous new result for the superallowed decay of ^{46}V, we have significantly improved our calculations of the nuclear-structure-dependent corrections to all $0^+ \rightarrow 0^+$ superallowed beta transitions. The validity of these improved corrections has been re-enforced by Penning-trap measurements of the Q-values for the superallowed transitions from ^{50}Mn and ^{54}Co (experiment performed in collaboration with the University of Jyvaskyla).

(2) A new detector system has been used to measure the beta-delayed proton decay of ^{23}Al and ^{31}Cl. The results provide new information about resonance states that contribute to the proton capture reactions ^{22}Na(p,γ)^{23}Mg and ^{30}P(p,γ)^{31}S.

(3) Investigations of quantum phase changes in nuclear systems show that near the critical temperature for a second-order phase transition, the quantity I/A=(N-Z)/A behaves as an

order parameter and the difference in chemical potential between the neutrons and protons is its conjugate variable.

(4) We have measured the half-life of ^{198}Au at 20K and at room temperature. The results are the same within 0.04%, in strong contradiction to a published report claiming a 4% difference. Having tested a beta-minus decay, we are now making a similar measurement on ^{97}Ru, which decays by electron capture.

(5) The transverse collective flow of light particles emitted during the reactions of ^{58}Fe and ^{58}Ni with ^{58}Fe and ^{58}Ni at 35 and 45 MeV/nucleon has been shown to depend on the neutron to proton ratio of the reacting system. Additionally the magnitude of the flow depends on the N/Z ratio of the emitted particle.

(6) High resolution measurements of the spectra of Kα x rays originating from excited state configurations having single- and double- K vacancies plus additional L vacancies, produced in heavy ion collisions with argon atoms, have provided a quantitative measure of the effect of inter-atomic transitions on the average fraction of L vacancies remaining at the time of x-ray emission and revealed that they play in increasingly significant role as the number of L vacancies increases.

(7) In the past year, the first measurement of the direct photon-associated jet yields (the "golden probe of energy loss") was performed for heavy-ion collisions at RHIC. The results were presented for the STAR Collaboration at Quark Matter 2008.

(8) The STAR collaboration released new results for the longitudinal double-spin asymmetry, A_{LL}, for inclusive jet production in *pp* collisions that provide significant new constraints on the contribution that polarized gluons make to the spin of the proton. These results were identified as one of the highlights of the past five years in the 2007 NSAC Long-Range Plan for Nuclear Science.

(9) The cross section of photon production in deep-inelastic scattering off large nuclei has been calculated in perturbative QCD, re-summing multiple re-scatterings in nuclear matter. This is an important step towards understanding the production of photons from jets in cold nuclear matter and has potential applications at CEBAF and RHIC.

(10) Heavy-quark transport properties have been computed in a Quark-Gluon Plasma (QGP) employing a T-matrix approach based on potentials estimated from lattice QCD. The calculations suggest an intimate connection between a strongly coupled QGP and quark coalescence processes near the phase transition, which is supported by applications to heavy-quark observables at RHIC.

(11) New calculations have constrained the parameters of relativistic mean-field models using the density dependence of nuclear symmetry energy extracted from analyses of experimental

data on isospin diffusion and isotope scaling in intermediate energy heavy ion collisions as well as measured isotope dependence of the giant resonances in even-A Sn isotopes.

(12) Significant advances have been achieved in the theory of the indirect methods in nuclear astrophysics. A new method to estimate direct (n,γ) cross sections via (d,p) reactions has been developed. The half-off-shell R matrix theory of the Trojan Horse method for resonant reactions has been developed and has been applied to measurements in order to obtain information about important CNO cycle reactions.

(13) Results have been finalized for measurements of giant resonance strength in ^{24}Mg and ^{28}Si from ^{6}Li scattering. The results indicate that a ^{6}Li target will work well to explore giant resonance yields from radioactive beams at K500 energies.

(14) A new energy density functional, which can be consistently employed in calculations of properties of ground states and giant resonances of nuclei within the Hartree-Fock random phase approximation, was developed.

As in the past, Institute scientists remain active in a number of collaborative research efforts around the world. Major programs include: a measurement of Michel parameters in normal μ^+ decay at TRIUMF in Vancouver, B.C.; mass measurements using the Penning Traps at Argonne National Laboratory and the University of Jyvaskyla; continued work with STAR collaboration at RHIC; and the measurement of neutron beta decay with the UCNA collaboration.

Once again, I am indebted to Dr. Y.-W. Lui who has managed to assemble this report in a very prompt and efficient manner.

R.E. Tribble
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