Introduction
April 1, 2011 – March 31, 2012

Progress in research and operations at the Texas A&M Cyclotron Institute is summarized in this report for the period April, 1, 2011 through March 31, 2012. The format follows that of previous years. 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 7 1/2 years of the Upgrade Project, which will give us accelerated radioactive beams at intermediate energies very soon. The K150 cyclotron is operational for both positive-ion and negative-ion beams and has been used in a number of experiments since late fall 2011. During the January, 2012 shutdown, we installed the switching magnet in the K500 axial injection line that allows us to inject beams from the ECR source or the ion-guide cave. All of the elements for the injection line from the ion-guide cave are in place and final work is being done to integrate them into the control system. We have observed charge-breeding in the ion-guide cave ECR source and work is now underway to optimize its efficiency. The high-power beam dump, which is the final element needed to begin production tests with the light-ion guide system, is being assembled in the machine shop and will be available before the end of August, 2012. A rebuild of the BigSol cryostat was completed in the spring of 2012. The new cryostat consumes liquid helium at a significantly lower rate than the previous one and shows no sign of a leak from the helium vessel into the surrounding vacuum region.

The search for faculty members to fill positions in the Nuclear Solutions Institute continued into 2012. We have active candidates for the two senior level radiochemistry positions and we hope to fill them very soon. We are still searching for a person to fill the senior-level position in the physics department and cyclotron institute.

Construction on a new floor of offices at the Institute began in March, 2012. A total of 13 months is scheduled to complete the construction. During the summer and fall of 2012, Institute faculty and staff have had to relocate offices to an adjacent building.

As in previous reports, I include here some highlights of work carried out over the past year.

- The gamma and beta branches following the decay of ^{32}Cl were measured, and led to the largest-ever observed isospin-symmetry-breaking effect seen in a superallowed transition. This result agrees with a shell-model calculation and serves as a new benchmark for other models of calculations of these corrections.

- A first experimental determination of in-medium binding energies for *d*, *t*, ^{3}He and ^{4}He clusters has been carried out for specific combinations of temperature and density in low density nuclear matter produced in collisions of 47A MeV ^{40}Ar and ^{64}Zn projectiles with ^{112}Sn and ^{124}Sn target nuclei. The experimentally derived values of the in-medium-modified binding energies confirm recent theoretical predictions based upon the implementation of Pauli blocking effects in a quantum statistical approach and extend the applicability of that method to the nuclear equation of state, which is of great interest in astrophysics.
- A new detector system based on GEM technology has been developed for proton-decay studies and used to measure beta-delayed protons in the decay of ^{23}Al and ^{27}P. The new detector substantially reduces the electron energy loss signal allowing very low-energy protons to be observed, which are the protons from resonances that are most important in the inverse (p,γ) capture reactions in stars.
- The Heavy Elements Group continued its study of "warm fusion" reactions and completed fabrication of a specially-designed "gas stopper" that will allow for the chemical study of heavy elements.
- The giant monopole resonance energies in ^{92}Zr and ^{92}Mo lead to nucleus compressibilities 27 MeV (5σ) and 56 MeV (8σ) above HF-RPA predictions, suggesting significant nuclear structure effects, which could affect conclusions about the compressibility of nuclear matter.
- Determination of experimental temperatures and densities of the fragmenting system using the quantum fluctuation method for protons.
- We obtained the first experimental evidence for non-zero gluon polarization in the proton, through measurements of the longitudinal double-spin asymmetry for inclusive jet production in 200 GeV p+p collisions with STAR.
- New generalized Faddeev equations for deuteron stripping were obtained with explicit inclusion of the Coulomb interaction and target excitation. It represents the ultimate theory of low energy transfer reactions, which takes into account all coupled channel and target excitation effects.
- The theory of deuteron stripping to resonance states has been developed in the surface integral formalism leading to the R matrix approach allowing one to parameterize the cross sections in terms of the observable resonance partial widths. The theory is free of divergences, which has been the main obstacle to understand stripping to resonance states.
- Within the framework of a multiphase transport model, we have found that including mean-field potentials in the baryon-rich hadronic matter leads to a splitting of the elliptic flows of particles and their antiparticles, thus providing a plausible explanation of the experimental observations in the Beam Energy Scan program at the Relativistic Heavy-Ion Collider.
- A thermal rate-equation approach with in-medium bottomonium spectral properties has been used to predict Upsilon observables at RHIC and LHC; initial data seem to favor a strong-binding scenario.
- Calculations of thermal photon production at RHIC suggest that the large photon elliptic flow observed by PHENIX requires the dominant emission source to radiate from around the phase transition region, rather than from the early quark-gluon plasma phases.

- It was found that for all over 16 commonly employed Skyrme interactions, the calculated HF based RPA energy of the isoscalar giant monopole resonance of ^{48}Ca is lower than that of ^{40}Ca, in disagreement with recent experimental data.

Institute scientists remain active in a number of collaborative research efforts around the world. Major programs include: mass measurements using the Penning Traps at Argonne National Laboratory and the University of Jyväskylä; continued work with the STAR collaboration at RHIC; the measurement of neutron beta decay with the UCNA collaboration; and participation in the SAMURAI collaboration at RIBF in Tokyo, Japan.

Once again, I am indebted to Dr. Y.-W. Lui for assembling this report.

R.E. Tribble
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