Introduction
April 1, 2012 – March 31, 2013

Progress in research and operations at the Texas A&M Cyclotron Institute is summarized in this report for the period April, 1, 2012 through March 31, 2013. The format follows that of previous years. Sections I through III contain reports from individual research projects. Operation and technical developments are given in Section IV. Section V 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 8 1/2 years of the Upgrade Project, which will give us accelerated radioactive beams at intermediate energies. The K150 cyclotron is fully operational and has been used for a number of experiments with both positive-ion and negative-ion stable beams. Recently, commissioning work on the light-ion guide system has begun with a K150 beam. The full transport system for radioactive ions and charge breeding from the charge-breeding ECR source have been tested with a 1^+ ion source. Test results show that the efficiency of accelerated beam in the K500 cyclotron exceeds that used in RIB yield estimates. The high-power beam dump was completed during this last year and is being installed for production of Light Ion Guide beams. A cryopanel for the K150 cyclotron was built and recently installed. In July, it will be tested with LN_2 cooling. Also the heavy-ion guide system was recently transported to TAMU from Argonne National Laboratory and is now being installed in the ion-guide cave.

We completed a search for a new faculty member to join the Department of Physics & Astronomy with joint appointments in the Cyclotron Institute and the Nuclear Solutions Institute when Professor Grigory Rogachev, currently at Florida State University, accepted a position with us to begin in September, 2013.

We have had a major disruption in Institute activities this past year with the on-going construction of an additional floor of offices at the Institute. The construction project was completed in mid-May, 2013. Faculty, staff, and students who had been displaced during the construction were moved back into the upgraded office building by the end of May.

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

- Recent experiments show evidence for an N/Z dependence of the nuclear caloric curve.
- After many years of incremental improvements, the group studying superallowed beta decay has successfully reached its goal of determining the branching-ratio for a superallowed beta-transition to a precision of 0.1% in the presence of other strong branches. Their proof of principle was the case of ^{38}Ca decay but this accomplishment is crucial for the characterization of all T_z = -1 parent decays,

which—unlike $T_z = 0$ decays—exhibit a number of strong Gamow-Teller branches that compete with the superallowed Fermi branch.

- A number of theoretical astrophysical EOS models have been experimentally tested by measuring cluster yields in low density nuclear matter. These new experimental data for cluster equilibrium constants provide important constraints on low density equations of state. The data strongly indicate that accounting for in-medium effects, as in the semi-empirical excluded volume approximation or a more sophisticated Quantum Statistical Model approach is required.
- Calculations based on a new theoretical approach show sensitivity to spectroscopic factors that are determined in ^{14}C+n when the asymptotic normalization coefficient is used in constraining the calculations.
- In recent work, the excitation function of the ^{154}Gd(^{48}Ca,4n)^{198}Po reaction has been measured. The results clearly demonstrate the influence on the compound nucleus survival probability of the difference in fission barrier height and neutron binding energy.
- Preliminary STAR inclusive jet A_{LL} results from 2009 were included in a global analysis of polarized parton distributions for the first time. They provide the first indication of non-zero gluon polarization within the momentum range that is sampled at RHIC.
- Based on the NJL model for the baryon-rich quark-gluon plasma produced in relativistic heavy ion collisions, we have demonstrated that the experimentally observed splitting of particle and antiparticle elliptic flows can help constrain the quark vector interaction and thus the equation of state of the baryon-rich quark-gluon plasma.
- Hartree-Fock based random-phase-approximation results for the energies of isoscalar and isovector giant resonances of multipolarities L=0-3 in ^{208}Pb, obtained for over 35 commonly used Skyrme interactions, were compared with experimental data to pin down the values of nuclear matter properties that are needed to improve the predictive power of our successful KDE0v1 energy density functional.
- A new theory of deuteron stripping reactions populating bound states and resonances based on the surface integral formalism, R matrix and CDCC was developed. A new generalized Faddeev formalism, which takes into account target excitations and explicitly includes the Coulomb interaction for deuteron stripping reactions, was developed.
- We have used multiplicity and quadrupole fluctuations from heavy ion collisions (both theory and experiment) to determine the density and temperature in fragmentation. Those quantities were determined for fermions (protons and neutrons) as well as bosons (deuterons and alpha particles). We showed that the energy density vs T scales for different particle types once Coulomb corrections are included.
- Theoretical predictions for the excitation function of low-mass dilepton spectra turn out to be in good agreement with STAR data from the RHIC beam-energy scan, from top RHIC energy down to SPS energies.
- Recent theoretical work suggests using Ds mesons (charm-strange bound states) as a unique probe of heavy-flavor dynamics in ultra-relativsitic heavy ion collisions. Comparison of Ds- to D-meson

observables can discriminate effects of heavy-quark hadronization and hadronic diffusion on transport coefficients. Preliminary data from the ALICE experiment confirm the validity of this idea.

- Commissioning has begun on the gas-filled RFQ in the Penning Trap beam line, and though no optimization has occurred yet, the efficiency is ~60%. This is already close to that obtained at other facilities now in operation.
- The characterization of the efficiency of a new gas stopper as a function of ion energy, gas flow rate, and electric field strength has been carried out.
- A forward array-quadrupole triplet spectrometer system for studying the asymmetry dependence of heavy ion breakup mechanisms in Xe and Sn + Ni reactions below the Fermi energy has been commissioned.

Institute scientists remain active in a number of collaborative research efforts around the world. Major programs include: mass measurements using the Penning Trap at the University of Jyväskylä; continued work with the STAR collaboration at RHIC; measurements of beta decays with the TRINAT collaboration at TRIUMF; 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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