Introduction
April 1, 2006 – March 31, 2007

Progress in research and operations at the Texas A&M Cyclotron Institute is summarized in this report for the period April, 1, 2006 through March 31, 2007. 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 2 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 very good—we remain close to schedule as of the second quarter of FY07. During the past year the K500 cyclotron has continued to perform well. We have had increasing pressure on beam time for testing electronics components which has made juggling the schedule quite difficult.

Institute programs continue to thrive. In the fall of 2006, Dr. Rainer Fries was appointed as an Assistant Professor of Physics and became a member of the Cyclotron Institute. Dr. John Hardy was named Distinguished Professor in the spring of 2007. Also in the spring, an offer was made to Dr. Dan Melconian to join the Institute and the Physics Department as an Assistant Professor. He accepted the offer and will come in late fall of 2007.

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

Research highlights:

(1) The half-life and branching ratio of the superallowed beta-decay of ^{34}Ar have been measured for the first time with high precision (<0.1%). Combined with the previously well measured Q value, this yields a corrected $\mathcal{F}t$ value with 0.1% precision, which is also in good agreement with the world average of other superallowed decays. This result is particularly significant because ^{34}Ar has the largest calculated isospin-symmetry-breaking correction of any of the measured cases between A=10 and A=54, the region where the nuclear models used in the calculation are most trustworthy. The fact that the calculated correction leads to good agreement with the $\mathcal{F}t$-value average in this case, where the correction is large, provides strong independent validation of the calculational approach, particularly for the other cases where the corrections themselves are much smaller.

(2) The ANCs for ^{18}Ne ↔ ^{17}F + p have been determined from a study of ^{13}C(^{17}O,^{18}O)^{12}C, and used to infer the ^{17}F(p,γ)^{18}Ne astrophysical reaction rate. The results support enhanced production of ^{17}F and ^{18}F in ONe novae.

(3) Temperature and density dependent symmetry energies have been determined experimentally at nuclear densities near 0.05 $\rho(0)$ where $\rho(0)$ is the ground state density of symmetric nuclear matter. Ranging from 9.03 to 13.6 MeV, they are much larger then those derived from effective interactions in mean field models. This reflects cluster formation, primarily of alpha particles, not included in such calculations. Such clusterization plays a significant role in astrophysical environments.

(4) The beta branching ratio for the transition from ^{21}Na to the first excited state of ^{21}Ne has been measured with sub-percent precision. Previously measured values had differed from one another by more than a factor of two, and had severely limited the effectiveness of a test of the Standard Model based on a measurement of the beta-neutrino correlation in the decay of ^{21}Na.

(5) The longitudinal spin correlation, A_{LL}, has been determined via inclusive jet production, based on data recorded by STAR in 2005. The results provide significant new constraints on the gluon contribution to the proton spin.

(6) The giant monopole resonance strengths found in ^{116}Sn and ^{28}Si using inelastic ^{6}Li scattering are consistent with those extracted from inelastic α scattering, showing that GMR strengths could be extracted for unstable nuclei using a ^{6}Li target.

(7) Measurements of the β decay of ^{23}Al have confirmed that its ground state spin-parity is $5/2^+$, thus contradicting the assertion, based on results from ^{23}Al breakup, that it is $1/2^+$. The assignment of $5/2^+$ significantly lowers the rate of the ^{22}Mg(p,γ)^{23}Al reaction relative to a $1/2^+$ assignment.

(8) A reformulation of quark coalescence models has been developed at the hadron-QGP phase boundary based on a Boltzmann equation with resonant $2 \rightarrow 1$ interactions. It overcomes the problem of energy violation and the lack of a thermal equilibrium limit in earlier approaches.

(9) Heavy quarkonium correlation functions in the QGP have been calculated using a T-matrix approach with heavy-quark potentials extracted from lattice QCD. The consistent treatment of bound and scattering states is essential for a reliable interpretation of Euclidean correlation functions as directly computed in lattice QCD.

(10) New results have been obtained that give strong evidence for correlated two proton decay from a state in ^{18}Ne at 8.5 MeV. The state was populated by the ^{14}O + α resonance reaction.

(11) A new determination of the astrophysical S factor for the ^{13}C(α,n)^{16}O neutron generator reaction in the AGB stars has been done by measuring the ANC in the sub-Coulomb transfer reaction ^{13}C(^{6}Li,d)^{17}O reaction. The reaction rates determined for ^{13}C(α,n)^{16}O are 3 times lower than in previous compilations.

(12) A stripping reaction has been calculated in the genuine three-body approach using the modified Faddeev equations for the first time.

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 Canadian Penning Trap (CPT) at Argonne National Laboratory; and continued work with both the BRAHMS and STAR collaborations at RHIC.

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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