INTRODUCTION
1 April 1999 - 31 March 2000

This volume presents a summary of progress in research and operations at the Texas A&M Cyclotron Institute for the period 1 April 1999- 31 March 2000. Reports on individual research projects are presented in Sections I-IV. Operation and development activities are reviewed in Section V. The last two sections summarize publications and oral presentations and present additional information on the personnel and activities of the Institute during the report period. Some of the results and conclusions presented in this report are based upon preliminary analyses of data. Until this research is published, these results and conclusions should not be cited without express consent of the investigators involved.

Again this year the Institute research groups have made considerable progress on a number of fronts. Last June the Notre Dame Town Meeting on Nuclear Astrophysics identified the indirect ANC technique, pioneered at TAMU, as an important tool for investigating astrophysical reaction rates at future radioactive beam facilities. This technique has now been applied to the ^{7}Be(p, γ)^{8}B reaction, which plays a central role in the solar neutrino question. A final value of $S_{17}(0) = 17.3 \pm 1.8$ eV·b has been obtained.

RPA-HF calculations of the isoscalar giant dipole resonance (a compression mode) have difficulty removing the spurious center of mass motion which, though ideally at $E_x \sim 0$ MeV, extends up to the $1\hbar\omega$ region, whereas strength around $E_x \sim 130/A^{1/3}$ MeV is identified as the ISGDR. The cover picture, representing work of the Giant Resonance Group, shows that in spherical nuclei such as ^{116}Sn the ISGDR strength is split into a low ($E_x \sim 75/A^{1/3}$ MeV) and a high component ($E_x \sim 115/A^{1/3}$ MeV) having comparable intensities, suggesting that at least a portion of the lower strength predicted in the calculations is not the spurious state. The origin of this splitting is not clear.

The new tape-transport system mounted at the focal plane of the MARS spectrometer has now been used for the first data-taking experiment in the new program to study superallowed 0^+ - 0^+ beta transitions at Texas A&M. The focus is on investigating experimentally the Coulomb corrections that represent one of the largest uncertainties in any determination of the vector coupling constant, G_V, from the ***Ft*** values of such transitions. The outcome will be crucial to the credibility of the test of CKM unitarity pro-vided by the superallowed beta emitters, a test that currently disagrees with unitarity by more than two standard deviations.

Isospin effects in fragmentation have been studied for excited quasi-projectiles produced in the reactions of ^{28}Si + ^{112}Sn,^{124}Sn at 30 and 50 MeV/u. If a nuclear system undergoes some differential partitioning of isospin resulting in a neutron rich gas and a more symmetric liquid - as has been theoretically predicted - this should be observable as a difference in neutron content as a function of ejectile size of. Such differences have been seen and may also be reflected in the ratio of ^{3}H/^{3}He ejectiles which is found to be very dependent on the N/Z Ratio of the fragmenting system and the beam energy. In 47A MeV collisions, multi-fragmenting nuclei with densities near $0.4\rho_o$ and temperatures near 7 MeV have been produced. These appear to be nuclei driven just to the balance point at which the nuclear expansion stalls. Results of antisym-metrized molecular dynamics model (AMD-V) calculations have been compared with experimental results for $^{64}Zn + ^{58}Ni$ collisions at energies from 35 to 95A MeV. At 49A MeV and higher incident energies, the calculations indicate that nuclear compression occurring at an early stage of the reaction plays an additional important role in the multifragmentation process.

During the last year, experiments focusing on investigation of angular momentum effects on fission fragment mass-energy distributions have been completed. For the first time a complex structure of γ-ray multiplicity as a function of excitation energy and fragment mass was observed. This structure changes with the excitation energy of compound system but remains even for $E^{*} \approx 140$MeV. Interpretation of these results is now underway.

Also during this past year the Reactions Dynamics groups and outside collaborators have employed the NIMROD detector for seven weeks of experimental investigations focused on nuclear expansion and clustering, thermal and chemical equilibration, transparency, heat capacities, isospin effects and elliptic flow. For some of these experiments the detector was augmented with discrete neutron detectors on loan from the Belgian –French DEMON collaboration which allowed simultaneous measures of neutron spectra and event by event neutron multiplicity. Analysis of the large body of experimental data obtained has begun.

In section 3 progress in the nuclear theory programs is discussed. The broad range of theoretical studies, encompassing studies of Fermi liquids, Giant resonances and compression modes, astrophysics, flow, in-medium properties at high energy density and possible signals of the quark-gluon plasma has continued. Among the many interesting results are those which indicate that the study of both in-plane and elliptic flows in intermediate energy heavy ion collisions should allow one to extract simultaneously information on the nuclear equation of state and the nucleon-nucleon scattering cross section in medium.

In the atomic physics programs (Section IV) precise determinations of inner shell vacancy distributions produced by fast heavy ions have been used to test theoretical models. Emphasis has been placed on highly asymmetric collision systems.

Institute scientists continue to collaborate in experiments at other facilities which have different or complementary capabilities. These are also reported upon in this volume. Results of measurements of charmonium production in p-A collisions at Fermilab, of multi-fragmentation in pion and anti-proton collisions at the AGS, source sizes at CERN and of β decay of ^{74}Rb at TRIUMF are reported. Preparations for measurements of the Michel parameter in normal μ decay at TRIUMF and QGP studies at RHIC continued during the year. Happily, as this volume is being printed, data taking at the RHIC facility is finally underway.

We are also pleased to note that in this report period four of our graduate students, John Blackadar, Tye Botting, Bruce Hyman and Titus Sandu received their degrees. Also, after a long delay caused by student occupation of administrative offices, Ruben Alfarro, whose research was done using the K500 Cyclotron, finally received his degree from the National Autonomous University in Mexico City.

Some notable changes in the facility are being realized with the new computerized control system which has been completed and tested on most individual components. We have scheduled two weeks in July to install it. After considerable contractor delay we received all magnets for the new, higher field hexapole magnet structure for the multiple-frequency ECR source. The full source assembly is underway and we expect first operating tests of this source to take place in September. New coils are now being wound for the upgraded MDM Spectrometer. The MDM modification will be completed in August.

The use of the Radiation Effects Line by the SEU testing community continues to increase significantly, apparently reflecting the telecommunications boom. Many groups are now using the facility regularly. We anticipate even larger demands on this facility in the next year.

Finally, over the past 1.5 years we have devoted considerable effort to exploring future directions for the TAMU Cyclotron Institute. This has included extensive in-house discussions by a "Futures Committee", a number of seminars by outside experts, a workshop in which we extended the discussions to include a broader community of experts in various aspects of nuclear research and the technical evaluation of various possible facility upgrades by our accelerator physics and operations staff. Discussions were focused on projects which could be realized in a timely fashion and would significantly extend our research capabilities as a stable beam facility with a moderate rare beam capacity.

Based on these endeavors we believe that we can accomplish a very significant upgrade of this facility by adding a fragmentation line and reactivating our 88" cyclotron for use as a stand alone facility, as a driver for production of rare isotopes for acceleration in the K500 Cyclotron and as a post accelerator for K500 created rare isotopes. The expanded range of stable beams and rare beams thus realized would create an exceptionally versatile facility for low and inter-mediate energy research. Our present plan is to prepare a " White Paper " which will present the scientific case for this project and will describe the project in sufficient detail that it can be discussed as part of the national long range planning process which will take place this fall. At the same time we will be working on a complete proposal which we expect to be ready for sub-mission next spring

J. B. Natowitz
July 2000