

ABELIAN GROUPS AT NEW MEXICO STATE UNIVERSITY

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This is a description of some of the happenings in abelian group theory at New Mexico State University (NMSU). This account is quite personal and certainly has my own personal biases in it. Some of the players may feel slighted, for which I apologize. My excuses are simply bad memory and bad judgment.

This account is supposed to explain how New Mexico State University became a center of abelian group theory. At least it will describe some of the events and circumstances that I feel contributed to its development. There will be no attempt to detail who proved what particular theorem when, or to give a complete story of which areas were being emphasized at any particular time. Over the years there were many abelian group theorists at New Mexico State University doing many different things, and such a task would be overwhelming. Please keep these things in mind while reading this account.

The flourishing of abelian group theory at New Mexico State was a product of several things. We had a sympathetic administration, both at the department level and at higher levels. Research money was readily available in the late 1950's and 1960's. And the subject was ready for development: Kaplansky's book, *Infinite Abelian Groups* appeared in 1954, and Fuchs' book, *Abelian Groups* appeared in 1958 and were tremendous catalysts. These circumstances and some good luck enabled us to attract some truly talented people.

But how did this all get started, and how did New Mexico State continue to develop as a center of abelian groups? It could be said that it was due to Professor W.R. Scott at the University of Kansas. At least four of his students came to NMSU after finishing at Kansas: Ralph Crouch, Delmar Boyer, me and John Irwin, in that order. Boyer and I were recruited by Crouch, and I think John Irwin came because he wanted to go somewhere where there was another abelian group

Received by the editors on September 5, 2001, and in revised form on October 15, 2001.

theorist, and Professor Scott knew us. I came to NMSU in 1957, and Irwin in 1960. John was a very special person. He was intense and totally devoted to the subject. He and I worked together for several years, at first on his topic of high subgroups. I think John had as much to do with New Mexico State University becoming a center of abelian groups as anyone. It was John who suggested that we apply for National Science Foundation (NSF) support. And, from that beginning, the Mathematics Department had at least one NSF research grant in abelian groups every year from 1961 through 1985. The biggest single event that put us on the abelian group theory map was also due to John. He suggested that we apply to NSF for support for a conference in abelian groups. There had never been one in the U.S. Fuchs was spending the year at Tulane, and he was “Mr. Abelian Group Theory”. We submitted a proposal to NSF featuring Fuchs as the main speaker. The proposal was funded, and the first New Mexico State University abelian group theory conference was held in June 1962. The “major participants” are listed below.

Major participants at the first NMSU conference

James Armstrong	University of Illinois
Ross Beaumont	University of Washington
Gilbert Baumslag	New York University
Delmar Boyer	University of Idaho
Stephen Chase	Princeton University
Paul Conrad	Tulane University
Spencer Dickson	New Mexico State
Donald Dubois	University of New Mexico
Laszlo Fuchs	Tulane University
David Harrison	New Mexico State
Franklin Haimo	Washington University
Thomas Head	University of Kansas
Paul Hill	Auburn University
John Irwin	New Mexico State
Samir Khabbaz	Lehigh University
George Kolettis	Notre Dame
Nancy Lakey	University of Maryland
Horst Leptin	Tulane University
Ronald Nunke	University of Washington

Carol Peercy	New Mexico State
Richard Pierce	University of Washington
James Reid	Yale University
Joseph Rotman	University of Illinois
Ti Yen	Michigan State University
Elbert Walker	New Mexico State
Robert Wisner	Michigan State University

With the singular exception of Kaplansky, this list includes every prominent abelian group theorist in the United States at that time. This conference certainly spotlighted New Mexico State University in the abelian group theory world. The publication of the proceedings of the conference [1] was another major step in our recognition. That proceedings sold out.

At the time of the 1962 conference, homological methods had already begun to play an important role in the theory, and that was amply reflected at the conference and in the proceedings. And there were papers on torsion-free groups and various aspects of p -groups and endomorphism rings. It is interesting to compare the table of contents of that volume with the proceedings of a recent conference. Here is the list of papers appearing in the 1962 proceedings.

1. L. Fuchs, *Recent results and problems on abelian groups*
2. R.A. Beaumont, *A survey of torsion free groups*
3. J. Reid, *On the ring of quasi-endomorphisms of a torsion-free group*
4. J. Irwin, C. Walker and E. Walker, *On p^α -pure sequences of abelian groups,*
5. R. Nunke, *Purity and subfunctors of the identity*
6. S. Chase, *On group extensions and a problem of J.H.C. Whitehead*
7. D. Harrison, *On the structure of Ext*
8. J. Rotman, *The Grothendieck group of torsion-free abelian groups of finite rank*
9. R. Pierce, *Homomorphisms of primary abelian groups*
10. P. Hill, *Certain pure subgroups of primary groups*

11. J. Armstrong, *On p -pure subgroups of the p -adic integers*
12. D. Boyer, *On the theory of p -basic subgroups of abelian groups*
13. G. Baumslag, *Hopficity and abelian groups*
14. F. Haimo, *Image-sharing endomorphisms and linear equations*
15. T. Head, *An application of abelian groups to geometries with a transitive set of translations*
16. *The status of Fuchs' 86 problems*
17. *Problems on abelian groups*

In any case, a major step in the establishment of New Mexico State University as a center of abelian group theory was that conference and the publication of its proceedings. Credit must be given to the National Science Foundation for funding the conference, and to our administration for additional funding and encouragement. The importance of the support that our Department of Mathematical Sciences and the higher administration gave us cannot be stressed enough. Particular credit must go to Ralph Crouch, the chairman in some of those early years. And, in the higher administration, Earl Walden was not only a strong supporter of our effort, but a constant source of inspiration. Those who knew him understand what I am saying.

The funding of our research proposal to NSF was truly a major step. It included not only summer faculty support but quite generous student support. We were in fortunate times in that regard. Sputnik had spurred the funding of science in the US, and financial support was then rather easy to get. Graduate students were plentiful and the quality was high. Some of those early students were Doyle Cutler, Spencer Dickson, Adolf Mader and Carol Peercy, now Carol Walker. It's impossible to comment on all our students, but mention must be made of Lee Lady, who finished in the early 1970's and for many years has been a faculty member at the University of Hawaii. Suffice it to say that he has done some very significant work in abelian group theory. I had the privilege of having him in an abelian groups course, but he was Fred Richman's student. And in the early 1980's, there was Ulrich Albrecht, who was a student of Dave Arnold. Ulrich is now chairman at Auburn, and many of you are familiar with his work. I think Ruediger Goebel sent him to us.

In 1962–63 David Harrison was a visiting professor at NMSU. This turned out to have a giant influence on abelian groups at NMSU. Homological algebra was being applied, and Harrison had already published his work on cotorsion groups, exploiting relative homological algebra. But he also pushed the categorical point of view, gave a course in category theory, and had a big influence on me, and of course on his student Carol Peercy. And Spencer Dickson, the inventor of “torsion theories” was in that course. One thing I readily take credit for is persuading David Harrison to come to New Mexico State. None of us could persuade him to stay, however. His main interests no longer included abelian groups. He went to the University of Oregon in 1963.

A giant step in our development as a center for abelian groups occurred in 1963–64. A new Ph.D. in commutative ring theory from the University of Chicago was hired: Fred Richman. Ralph Crouch did that. I was on sabbatical leave that year. When I returned in the Fall of 1964, Fred Richman had become an abelian group theorist. This was the doing of John Irwin, and John did it while directing to completion five Ph.D. theses that year. With John Irwin around, Fred had to learn abelian group theory out of self-defense. As we all know, Fred Richman became one of the world’s foremost workers in the subject, spanning many topics, and is still active as we see at this conference. I had the honor of working with him for over 20 years and was astonished almost daily with his mathematical knowledge, insights and creativity. He retired from NMSU after 25 years and is now professor at Florida Atlantic University. John Irwin left New Mexico State to go to Wayne State in 1965, where he spawned another crop of Ph.D. students.

Carol (Peercy) Walker, a student of David Harrison, joined the faculty at NMSU in 1964, after spending a year at the Institute of Advanced Study as an NSF postdoc. She was an active researcher in abelian groups, interested mainly in the homological and categorical aspect of the theory. She was lost to active research in 1979, when she became chairman of the Department of Mathematical Sciences, a position she held for 14 years. From 1993 to 1996, she was Associate Dean of the College of Arts and Sciences, and Director of that College’s Research Center, after which she became Professor Emeritus. So, from 1979 to 1996, she was another strong supporter of abelian group theory in the administration of the university.

Wolfgang Liebert came to NMSU in 1966 and remained for eight years, after which he went back to Germany. Liebert is well known for this work on endomorphism rings and automorphism groups of p -groups. It is a pleasure to see him at this conference. He is now retired from his position in Munich.

In mid 1960's the Department of Mathematical Sciences received an NSF Science Development Grant. This provided money over the span of five years for the development of the department. We expanded greatly, and in several fields. There was funding for visitors and postdocs. A list of visitors in abelian groups and related topics appears in a table below. That table does not include those who later became regular faculty. Among the visitors in the late 1960's were Reinhold Baer, Dick Pierce and Otto Kegel, and several postdocs (who were called "research associates"), included Arnold, Warfield, Hausen and Mines. Arnold came in 1968 and became a regular faculty member. He became one of the world's foremost authorities on torsion free groups and was at New Mexico State for 22 years, after which he was named to a chair at Baylor University. Ray Mines also became a member of the regular faculty and is well known for his application of topological methods, functorial topologies, and the like.

Among the postdocs who did not stay, special mention must go to Bob Warfield whose contributions are very well-known indeed.

Visitors in abelian group theory and related topics

Reinhold Baer	Tom Head
Donna Beers	Otto Kegel
Frank Castagna	Otto Mutzbauer
Bernard Charles	Michel LeBorgne
Carl Faith	Richard Pierce
Ted Faticoni	Ulrich Schoenwalder
Temple Fay	Phillip Schultz
Ruediger Goebel	Charles Vinsonhaler
David Harrison	Robert Warfield
Jutta Hausen	

The last addition to the regular abelian groups faculty was Roger Hunter in the Spring of 1976. That happened as follows. Hunter

was a student of Rangaswamy at the Australian National University. Rangaswamy's advisor was M. Venkataraman at the University of Madras, an analyst. So Ranga was in effect his own advisor. I had been Rangaswamy's outside thesis examiner when Rangaswamy got his degree in 1963 or 1964. Hunter subsequently received an Australian fellowship to come to the US for a year. He asked Warfield where he should go and Warfield said that wherever he went he should spend some time at New Mexico State University. So he came to NMSU for the Spring semester of 1976 on this fellowship and didn't leave until he resigned in 1993 to devote full time to software development. Richman and I had begun studying valuated groups about a year before Hunter arrived, and Roger joined in the effort, to put it mildly.

Regular abelian group theory faculty at NMSU

Faculty Member	Advisor
David Arnold	Rotman
Delmar Boyer	Scott
Roger Hunter	Rangaswamy
John Irwin	Scott
Wolfgang Liebert	Baer
Ray Mines	Nunke
Fred Richman	Kaplansky
Carol Walker	Harrison
Elbert Walker	Scott
John Werth	Pierce
Robert Wisner	Beaumont

In contrast to the 1962 conference, the NMSU conference in 1976 had 72 participants of whom 57 were from other universities. And the proceedings of that conference shows the growth of the subject since 1962. That conference was another New Mexico State University abelian group theory landmark. The proceedings were published by Springer [2].

Alphabetical listing of abelian group theory Ph.D.'s at NMSU

Ulrich Albrecht Ed Howard Jim Peake

Dennis Bertholf	Larry Hughes	Eugene Poluianov
Donald Cook	Lee Lady	Laurel Rogers
Yonina Cooper	Wu-Yen Lee	Annemarie Schlette
Doyle Cutler	Milton Legg	Robert Stanton
Spencer Dickson	Adolf Mader	Joerg Stelzer
Bruce Edington	Judy Moore	David Tabor
Ronald Ensey	Christine Merrin	Carol Walker
Sharon Feuchter	Alfred Mitchell	Randall Walters
Tony Giovannitti	Roger Mitchell	Frank Williams
Ralph Gramaldi	Edwin Oxford	
Neal Hart	Larry Parker	

I want to say a little bit about what kinds of abelian group theory were done at New Mexico State University over the years. This will be very general. If the reader is interested in specifics, I suggest that the appropriate web pages be consulted.

In the very early years, John Irwin and I worked on his topic of high subgroups. But soon, homological things came to the fore and of course never left. So applications of homological algebra to abelian group problems were prevalent, and categorical ideas and settings were becoming common. A number of Ph.D. students had theses with a categorical or homological flavor.

Fred Richman and others gave constructive developments of some abelian group topics. David Arnold and coauthors did fundamental work on torsion free groups. Ray Mines and coauthors did some topological applications. There were a number of papers produced about endomorphism rings, especially about groups as modules over their endomorphism rings. And I must mention some work on Ulm's theorem, including Larry Parker's thesis in which Ulm's theorem was extended to totally projective groups of length $< \Omega\omega$. In the late 1970's Fred Richman and I begin working on valuated groups, and this was a topic of concentration for the next ten years or so. It involved several faculty, including Arnold and Hunter. One result of note is an "Ulm's theorem" for simply presented valuated p -groups.

On July 1 of this year, Ray Mines retired from New Mexico State. This is the last of abelian group theorists in the department. It is the end of an era, a little bit sad, but abelian group theory goes on, as

evidenced so admirably at this conference.

REFERENCES

1. J.M. Irwin and E.A. Walker, *Topics in abelian groups*, Scott Foresman and Co., Chicago, 1963.
2. D.M. Arnold, R.H. Hunter and E.A. Walker, *Abelian group theory*, Proc. of Second New Mexico State University Abelian Group Theory Conf., Lecture Notes in Math., vol. 616, Springer-Verlag, Berlin, 1976.

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