

THE MICHIGAN CENTER FOR THEORETICAL PHYSICS*

MCTP



PAST, PRESENT, AND FUTURE

Written by:

M. Duff, Director Emeritus

G. Kane, Interim Director

L. Sander, Associate Director for Research

J. Liu, Associate Director for Budget/Executive Committee

K. Freese, Associate Director for Outreach

A. Bloch, Executive Committee

G. Evrard, Executive Committee

F. Nori, Executive Committee

A. Milliken, Research Secretary

* <http://www.umich.edu/~mctp/>

SUMMARY

The missions of The Michigan Center for Theoretical Physics (MCTP) are to carry out quality research, to educate, and to perform service. It is meant to focus particularly on promoting interdisciplinary explorations in theoretical physics and related mathematical sciences through a program of individual and collaborative research, seminars, workshops, and conferences.

In the time since its inception in 2001 the MCTP has already gained a strong international reputation for its intellectual and organizational activities, and it is now poised to have an even larger impact as the world of theoretical and mathematical sciences increasingly takes advantage of the MCTP infrastructure to focus national and international activities at the MCTP. External fund raising began in fall 2004 and is showing signs of success. This report documents the structure and achievements of MCTP, and its goals for the future.

Basically, within certain guidelines, the MCTP functions by responding to proposals from full members (perhaps with internal or external colleagues) for Workshops, Conferences, Visitors, and students support. Typically two postdocs have also been hired, and support provided for graduate and undergraduate students.

This report documents the past activities of MCTP, and forms the foundation for urging the Department of Physics, the College of LS&A, and the University of Michigan to renew their support for an extended period in such a way that total resources are at least as large as they have been. Appendix 8.3 contains a proposed budget based on past ones.

The present (Interim) Director of the MCTP is Gordon Kane. There are three Associate Directors (Len Sander, Research; Jim Liu, Budget; and Katie Freese, Outreach). The present executive committee is Jim Liu (particle physics), Franco Nori (condensed matter physics), Gus Evrard (astrophysics and cosmology), and Anthony Bloch (mathematics). The MCTP, and all of theoretical physics, is extremely grateful to Director Emeritus Michael Duff for taking the MCTP from its beginnings to its present form as a mature, well-known center with many accomplishments. The present report/proposal is based on Duff's report covering MCTP's establishment and first four years, which can be obtained from him or the center's secretary, Angela Milliken.

With this report and proposal we request that the College recognize the success and value of the MCTP by continuing its support. Appendix 8.3 contains a budget for 2006-2008 to show how such funds might be used.

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1 The Michigan Center for Theoretical Physics

“Things are happening rapidly and Michigan’s Center will have lots to do”

Sheldon Glashow, Boston University, Nobel Laureate

“I have fond memories of the annual summer schools in theoretical physics at the University of Michigan. I am glad that your Center will, in a way, resume these summer schools.”

Hans Bethe, Cornell University, Nobel Laureate

1.1 Theoretical Physics at Michigan

Theoretical physicists like to ask big questions: When and how did the universe begin? What are its basic constituents and the laws of nature that govern them? How do effective laws of nature emerge and evolve from scale to scale, from the subatomic level to the size of the universe? How will these fundamental discoveries benefit humanity? The practice of theoretical physics is a process of entering vast and uncharted territory, mapping unknown domains, and probing some of the biggest yet most intensely relevant mysteries of creation. It is a quest for knowledge that began centuries ago with extraordinary and courageous thinkers such as Sir Isaac Newton and one that continues to the present day, strengthened by the work of James Clerk Maxwell, Albert Einstein, Stephen Hawking, and scores of other gifted theorists. Relativity, quantum mechanics, the Big Bang, black holes, the statistical theory of phase transitions, and the standard model of subatomic particles are all examples of theoretical concepts that have now been experimentally established.

Although theoretical physics is inherently abstract, based on invention, imagination, and mathematical formulae, many of its outcomes are relevant, in highly significant ways, to everyday life. The methods and approaches of theoretical physics are remarkably relevant to areas outside of the traditional concerns of physics. For example, physicists are playing a central role in bringing mathematical techniques to bear in life sciences.

For over a century, the University of Michigan Department of Physics has made seminal contributions to the ongoing process of exploration and discovery. Among the many intellectual pioneers who gained international prominence as UM faculty are Samuel Goudsmit and George Uhlenbeck, discoverers of electron spin; David Dennison, whose work revealed the proton spin; Otto Laporte, who discovered the concept of parity; Joachim Luttinger, discoverer of the Luttinger liquid and Oskar Klein, creator of the Klein-Gordon equation and the Kaluza-Klein theory of extra dimensions of space. See Figure 1:



Figure 1: *“Returning to my Ann Arbor attempts, I became immediately very eager to see how far the mentioned analogy reached, first trying to find out whether the Maxwell equations for the electromagnetic field together with Einstein’s gravitational equations would fit into a formalism of five-dimensional Riemann geometry.”* Oskar Klein, “From My Life in Physics”

The idea for a fifth dimension came to Klein during his stay as an assistant professor at the University of Michigan, 1923-25. He was hired by H. M. Randall on the recommendation of the father of quantum theory, Niels Bohr, with whom he had been working in Copenhagen. He was a contemporary of two other famous Michigan faculty members, George Uhlenbeck and Samuel Goudsmit, discoverers of electron spin*. See Figure 2:



Figure 2: Left to right: Oskar Klein, George Uhlenbeck and Samuel Goudsmit (American Institute of Physics)

The most influential founder of theoretical physics at Michigan was Uhlenbeck, who did seminal work in statistical physics and the theory of stochastic processes during his long stay in Ann Arbor. In fact, two of his distinguished students, theorists G. W. Ford and R. L. Lewis (both now emeritus professors) were long-time

* Visitors to the Michigan Center for Theoretical Physics (<http://www.umich.edu/~mctp/>) are invited to view a collection of memorabilia and photographs of Klein (with Bohr, Goudsmit, Uhlenbeck and others) in the Oskar Klein Conference Room, 3481 Randall Laboratory.

members of our faculty. Uhlenbeck's last student, Robert Ziff (who received his Ph.D. at Rockefeller after Uhlenbeck left Michigan) is now a professor of Chemical Engineering at Michigan and an active member of the Center.

Under the leadership of Uhlenbeck, David Dennison and others, our department became world famous for the Ann Arbor summer schools in theoretical physics which ran from the 1930's to the 1950's. It is fair to say that many of the European developments in physics, such as quantum mechanics, were introduced in this country by the Ann Arbor schools.



Figure 3: A photo at the Ann Arbor summer school. Two future Nobel prize winners are in this picture, Maria Goeppert Mayer (far left) and Lars Onsager (far right). Others are Joseph Mayer, Robert Atkinson, and Paul Ehrenfest.

The University of Michigan is, in many respects, an ideal venue for interdisciplinary research. Long considered one of America's leading public universities, the UM actively promotes collaboration among its highly ranked colleges, departments, specialized laboratories, and centers of excellence.

1.2 The Creation of the MCTP

In 2000, the physics department presented a Long Range Plan for 2000-2004 and Beyond. It identified two important priorities for the department.

- To increase the emphasis on theoretical physics
- To increase the emphasis on interdisciplinary activities

For a few years physics department theorists had been discussing with University administrators the possibility of creating a theoretical physics center. Moreover, since most of the top physics departments in the nation already had such theory centers, this seemed to be more of a necessity than a luxury if Michigan is to fulfill its goal of competing with the best. (Michigan's Center has evolved toward being, to a significant extent, an international facility, which also enhances local benefits, while most other centers are mainly for the use of local theorists. Appendix 8.4 is a list of U.S. Centers for Theoretical Physics.)

Stimulated by Veltman's Nobel Prize this effort gained momentum. Then Chair Ctirad Uher appointed a Committee to Propose a Center for Theoretical Physics at the University of Michigan: Fred Adams, Paul Berman, Michael Duff (Chair), Len Sander and Bob Savit. The Proposal may be found on the web: <http://www.umich.edu/%7Emctp/membership.html>

We were pleased to learn on September 19, 2000, that Dean Neuman had approved the Center under the conditions set out in a letter to Chair Ctirad Uher shown in Appendix 8.1.

We were further pleased to learn on May 14 2001 that, as a result of the early successes of the MCTP, the Dean extended the period of seed funding for a further 18 months, totaling five years from January 2001, as set out in the letter to the Director shown in Appendix 8.2.

The Michigan Center for Theoretical Physics was officially launched in 2001. Its mission is to seek to build on the current strengths of the Department, continue Michigan's long tradition of leadership in theoretical physics, and make significant contributions to theoretical and mathematical science and the larger world. Leveraging the University of Michigan's breadth and depth of academic excellence, the research emphasis of the Center is interdisciplinary and non-traditional.

At present, the MCTP has 61 Full Members drawn from faculty in the University of Michigan departments of Aerospace Engineering, Astronomy, Biology, Biophysics, Chemical Engineering, Complex Systems, Electrical Engineering, Materials Science, Mathematics, and Physics. It includes a number of experimentalists who take an active interest in theory. In addition, the Center has attracted 58 Associate Members from numerous UM departments and the wider community. In addition to facilitating research and collaboration, the MCTP offers programs of study, research positions, and other academic opportunities for graduate and undergraduate students in theoretical physics. It also maintains a program of community outreach.

The MCTP has a three-fold mission of research, education, and service. However, as its primary objective, the Center strives to promote interdisciplinary explorations in theoretical physics and related mathematical sciences through a program of individual and collaborative research, seminars, workshops, and conferences. As an interdisciplinary center for theoretical science, the MCTP enables the UM Department of Physics to meet the two major strategic challenges mentioned above: increasing the emphasis on theoretical physics and expanding interdisciplinary

activities. The Center also helps to assure that Michigan will continue to play a leadership role in this important field by remaining in the vanguard of discovery.

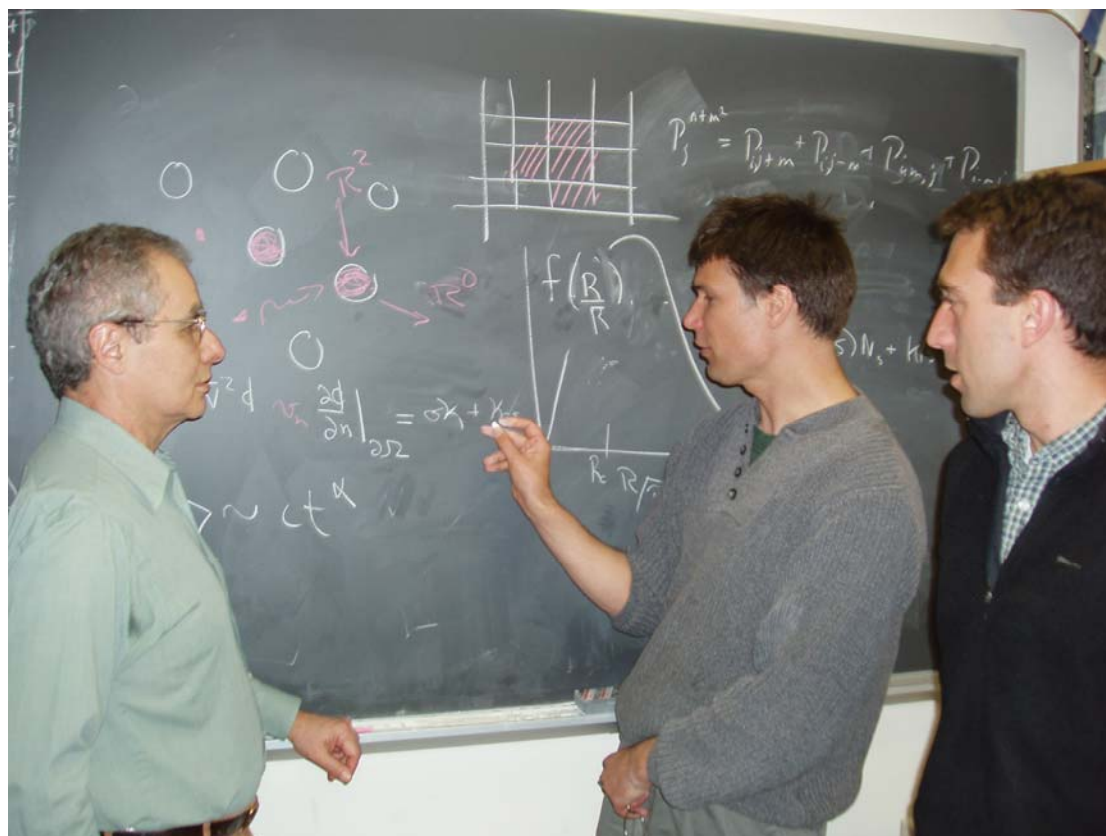


Figure 4: Professor Len Sander (Physics) and Peter Smereka (Mathematics) collaborating with physics graduate student Jason Devita.

1.3 Governance

One immediate challenge for the MCTP was to fulfill its interdisciplinary mission while at the same time recognizing the exclusive role played by the Physics Department in the funding arrangements. The way we attempted to achieve this is set out in the MCTP bylaws, a complete text which may be found on the web at <http://www.umich.edu/%7Emctp/membership.html>

The bylaws called for the Director to be elected and to serve for the initial funding period, ending July 2004 and a four person Executive Committee to be elected each representing one of the following four areas: (1) Particle Theory, (2) Condensed Matter, Atomic and Molecular Physics and Optics and Biophysics, (3) Astrophysics, Cosmology and Relativity, (4) Interdisciplinary. Conditions of term limits are set out in the bylaws.

The bylaws, Director and Executive Committee were officially approved by the Physics Department on 17 November 2000 at which time the MCTP effectively began. Its funding began officially on 1 January 2001.

As mentioned above, the Dean extended the initial funding period an extra 18 months taking us to the end of 2005. At the Winter General Meeting 2004, the MCTP Bylaws were amended (under the two-thirds vote rule) to enable the current Director to serve until the end of that fiscal year, June 30 2006. The results of the elections from 2000 to 2004 were:

Michigan Center for Theoretical Physics

Director:	M. Duff 00-06
Particle Theory:	R. Akhoury 01-03 J. T. Liu 03-05
Condensed Matter/AMO/Biophysics:	L. Sander 01-01 R. Savit 02-04 F. Nori 04-06
Astrophysics/Cosmology/Relativity:	K. Freese 01-03 G. Evrard 03-05
Interdisciplinary:	P. Berman 01-02 C. Doering 02-04 A. Bloch 04-06

The Interim Director has now appointed Associate Directors to strengthen various activities. The present MCTP leadership is:

Interim Director:	Gordon Kane
Associate Director for Research:	Len Sander
Associate Director for Budget:	Jim Liu
Associate Director for Outreach:	Katherine Freese
Executive Committee:	A. Bloch, G. Evrard, J. Liu, F. Nori

The make-up of other MCTP committees may be found in Appendix 8.5. It is worth mentioning that MCTP administration is very efficient and cost-effective. For example, a number of other centers release the Director and sometimes also the Deputy Director from other responsibilities, but here the Director and the Associate Directors currently carry out all their normal duties and are otherwise uncompensated. Most centers that arrange workshops and conferences have several staff while the MCTP has effectively one.

1.4 Facilities

In order to create space for the MCTP within the Physics Department, the Executive Committee and the Department jointly approved:

1. The conversion of 3424 Randall (previously Keith Riles's Lab) into 3 faculty offices (cost: \$61,000).
2. The addition of two smaller offices on either side of 3246 (the fishbowl) New Randall (cost: \$50,000).

Since one of the main purposes of the MCTP is to host visitors, conferences and workshops, there is clearly the need for much more space and this will continue to be a priority. The original proposal submitted to the Dean called for 10-15 offices or equivalent to be allocated to the MCTP. As MCTP looks toward the future, it will be important to develop a plan to add some offices in order to have an optimum situation for the very successful workshops.



Figure 5: Professor Gus Evrard (Astrophysics/Theory) working with graduate students.

2 Research

“The MCTP excels at research on particle physics both from a purely mathematical and more phenomenological point of view”

Martinus Veltman, University of Michigan, Nobel Laureate

2.1 Proposals

Within qualitative guidelines, basically the MCTP functions by responding to proposals from members, perhaps with internal or external colleagues. Each winter the Executive Committee invites proposals for programs for the next fiscal year 1 July – 30 June. Any of the Center’s activities may be considered: conferences, workshops, visitors, postdoctoral fellowships, graduate student fellowships, undergraduate research studentships, outreach etc. Additional weight is attached to proposals that fulfill the Center’s interdisciplinary mission of being “more than the sum of its parts”. More weight is attached also to proposals than can offer some degree of cost sharing. Members are encouraged to make external grant proposals submitted under the aegis of the MCTP, which would then be eligible for MCTP cost sharing. MCTP proposals need only be brief (one or two pages), plus vitae in the case of visitors, postdocs and students. Full guidelines are available on <http://www.umich.edu/%7Emctp/>

The research activities of the MCTP may be thought of as divided roughly into two broad categories. As a guideline the two categories each receive about half the MCTP funding. On one side there is astronomy, astrophysics, relativity, particle physics, string/M-theory and pure mathematics. On the other side there is condensed matter physics, atomic, molecular and optical physics, biophysics, complex systems, dynamical systems theory, and non-traditional applications such as sociology, economics and medicine.

2.2 Publications

Thanks in part to the structure and support provided by the Michigan Center for Theoretical Physics members have produced 340 publications, each carrying the MCTP byline. They span subjects that include high energy physics; string theory and M-theory; condensed matter physics; atomic, molecular and optical physics; relativity and cosmology; astrophysics; and biophysics. The publications are distributed by year as follows:

2000: 24 (partial year)
2001: 65
2002: 72
2003: 62
2004: 74
2005: 43 (to 28 February)

Of these, 200 papers were authored or co-authored by MCTP visitors, postdocs and students. A complete publications list may be found in the Appendix 8.10.

3 Conferences

“MCTP has enabled truly interdisciplinary work at Michigan... I hope that MCTP can continue to play the kind of galvanizing role that it so effectively has in recent years.”

Charles Doering, Professor of Mathematics, University of Michigan

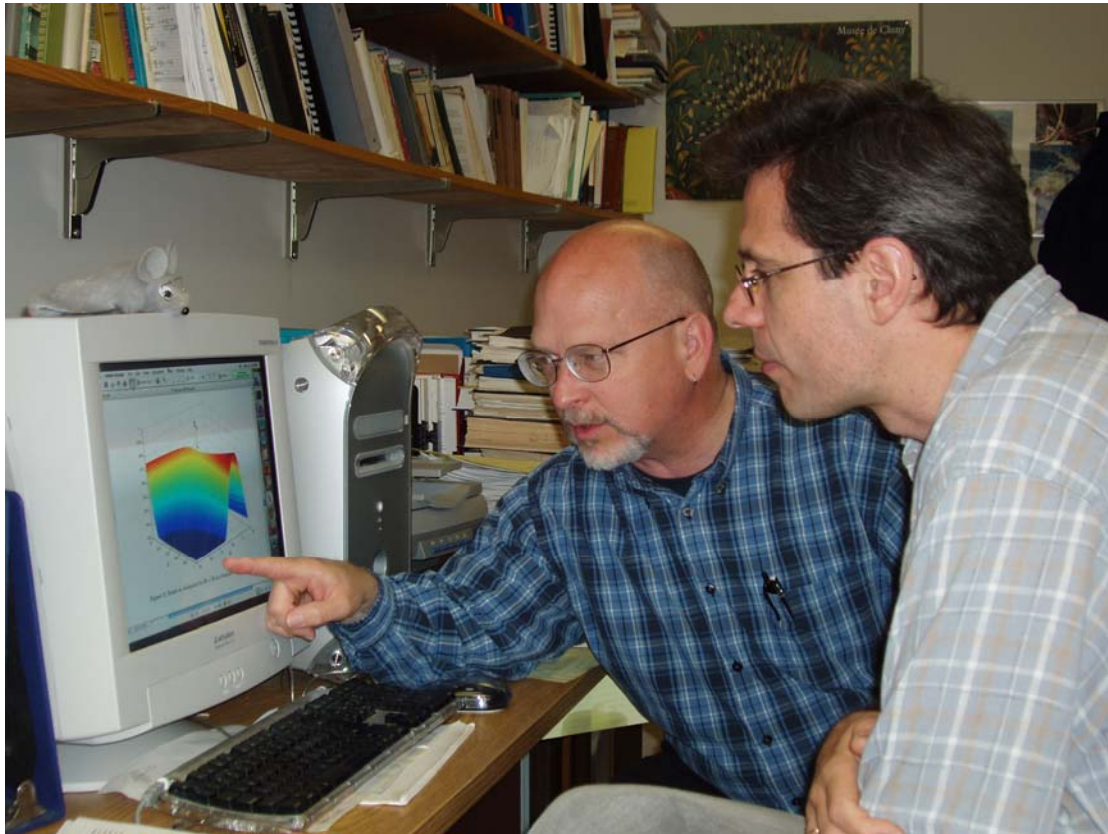


Figure 6: Professor Charlie Doering (Mathematics) is talking with MCTP postdoc Nikola Petrov.

“During the last few years, there has been tremendous progress in the search for the deepest laws governing the universe. The MCTP has been instrumental to these developments through critical discoveries made by the center’s scientists and also through its hosting of lively conferences that have facilitated key scientific interactions. The next decade will be a formative time and holds the promise of fundamental breakthroughs in our understanding of the cosmos. The MCTP will play a vital role in our achieving these advances.”

Brian Greene, Professor of Physics, Columbia University, author of “The Elegant Universe” and “The Fabric of the Cosmos”.

3.1 Inaugural conference: 2001 A Spacetime Odyssey

Hosting national and international conferences is a central function of the MCTP. These events, which draw hundreds of participants each year, attract leading theorists to Ann Arbor and bring together some of the ablest minds in science. They also provide rich learning opportunities for students and serve as a catalyst for new ideas and directions.

In view of the mission of the Michigan Center for Theoretical Physics to

provide a venue for interdisciplinary studies in the mathematical sciences, the Inaugural Conference *2001: A Spacetime Odyssey* brought together Astronomers, Cosmologists, Particle Physicists and Mathematicians to share their different perspectives on the 21st century view of spacetime. The conference was held May 21–25 and featured around 25 talks by prominent researchers in the field.

The purpose of the conference was to communicate the latest developments in these diverse fields to a wider community and to foster ongoing and new research collaborations. The talks were to be aimed at a scientific audience but, bearing in mind the interdisciplinary nature of the conference, they were less technical than those aimed at specialists. They served the purpose of allowing the fruitful exchange of ideas among researchers that may ordinarily not have the chance to meet.

An important benefit of having major conferences at our university is that it provided a means for graduate students, postdocs and junior faculty to interact with and learn from more established members of the communities, people they might not normally meet.



Figure 7: Katherine Freese, Marty Einhorn, Michael Turner and Gloria Lubkin chat during the Inaugural Conference May 2001.

3.2 *List of conferences and workshops 01-05*

Similar descriptions hold for a number of conferences in several MCTP areas. A complete list of MCTP conferences and workshops, and their organizers, is given below:

- *2001: A Spacetime Odyssey Inaugural Conference* – May 2001 (Adams, Akhoury, Burns, Duff, Freese, Kane, Liu)
- *Quantum Applications Symposium* – July 2001 (Augustyn, Monroe)
- *Pattern Formation and Diffusion-Limited Growth Workshop* – August 2001 (Macintosh, Sander, Savit, Ziff)
- *CP Violation Workshop* – November 2001 (Akhoury, Chupp, Einhorn, Kane, Yao)
- *Mathematics and Physics of Extra Dimensions Workshop* – April 2002 (Doering, Dolachev, Duff, Freese, Larsen, Liu Pando Zayas)
- *Fronts, Fluctuations and Growth Workshop* – May 2002 (Doering, Sander, Smereka, Ziff)
- *Perspectives in Decoherence Control and Quantum Computing Workshop* – August 2002 (Berman, Bloch, Geva, Monroe, Nori, Rangan)
- *Time-Dependent Backgrounds in String Theory Workshop* – March 2003 (Buchel, Einhorn, Larsen, McNees)
- *QCD and Strings Workshop* – April 2003 (Akhoury, Pando Zayas)
- *Great Lakes Cosmology Workshop* – May 2003 (Adams, Akerlof, Evrard, Freese, McKay, Riles, Tarle, G. Bernstein, R. Bernstein, Bregman, Mateo, Richstone, Somerville)
- *Baryogenesis Workshop* – June 2002 (Einhorn, Freese, Kane)
- *Deserfest Conference* – April 2004 (Duff, Liu, Stelle, Woodard)
- *Status of M-Theory Workshop* – April 2004 (Duff, Larsen, Liu, Pando Zayas, Stelle, Woodard)
- *The Dark Side of the Universe* – May 2004 (Evrard, Freese, McKay, Tarle)
- *Ion Trap Quantum Computing Workshop* – May 2004 (Monroe, Wineland)
- *Building Computational Devices using Coherent Control Workshop* – June 2004 (Bucksbaum, Guest, V. Malinovsky, Rangan, Shapiro)
- *String Phenomenology 2004 International Conference* – August 2004 (Kane, Wells)
- *The Future of Cosmology with Clusters of Galaxies Workshop* – February 2005 (Arnaud, Carlstrom, Ebeling, Ellingson, Evrard, Frenk, Henry, Kaiser, Luppino, Szapudi, White)
- *MCTP Spring Symposium: The Top Quark* – April 2005 (Wells, Gerdes, Juste, Ramond)
- *Dynamics of Cancer: Modeling and Experiment* – May 2005 (Sander, Jackson)
- *100th Anniversary Celebration of the Birth of John von Neuman* – September 2005 (Simon, Whitman, Newman)

4 Collaborations

“One of the most exciting intellectual explorations of our time concerns the mathematical structure underlying our physical universe. The Michigan Center for Theoretical Physics is a focal point in this activity, and attracts many of the outstanding mathematicians and physicists working in this area. It deserves the support of all who value intellectual discovery at the highest level.”

Sir Michael Atiyah, University of Edinburgh, Fields Medalist, former President of the Royal Society, former Master of Trinity College, Cambridge

“The very successful activities of the Center put it on a par with such world-renowned programs as the KITP at Santa Barbara, the Newton Institute at Cambridge, and the Yukawa Institute for Theoretical Physics in Kyoto.”

Professor Baruch Meerson, Racah Institute, Hebrew University of Jerusalem

4.1 Membership

The bylaws state that there are two grades of membership: Full Members and Associate Members. The initial Full Membership was all of the Theoretical Physics faculty, with the intention that Full Members from other departments would be elected beginning with the first Fall General Meeting on December 18, 2000. New members from Aerospace Engineering, Astronomy, Biology, Biophysics, Chemical Engineering, Complex Systems, Electrical Engineering, Materials Science and Mathematics were duly elected at that and subsequent general meetings. We are happy to note that the Full Membership includes several experimental colleagues who take an active interest in theory.

Associate Membership is open to all with a current or past affiliation with the University of Michigan and there are now representatives from an even more diverse list of departments as well as outside of the University.

There are currently 61 Full Members and 58 Associate Members. The membership lists may be found in Appendices 8.7 and 8.8.

4.2 Visitor programs

The MCTP provides an attractive venue for visiting academics. Guest faculty and researchers engage in individual and collaborative research, interact with undergraduate and graduate students, and share their expertise with the wider community through public lectures and other activities. Some of the highlights were:

- “Young String Theorists” visitor program, July 2002-June 2005 (Larsen, Liu, Pando Zayas)
- “Condensed Matter, AMO and Interdisciplinary” visitor program, July 2003-June 2004 (Doering, Savit)
- Cost Sharing on “ADVANCE: Young String Theorists” visitor program, July 2004-June 2007 (Larsen, Liu, Pando Zayas)
- Visit and Public Lectures by Fields Medalists Sir Michael Atiyah, April – May 2002
- Visit and Public Lectures by physicist and author Paul Davies, April – May 2004

- Visit and Public Lectures by Nobel Laureate Martinus Veltman, jointly with Physics Department and Provost: 3 annual visits each of one month 2005-2008

4.3 Long term visitors

The MCTP has played host to about 150 short term visitors. Theoretical physics is a very interactive, collaborative activity. As one Full Member said, “We’ll see how important this work finally is, but it is clear the work could not have been done without the extended visits made possible by MCTP.” Among the long term visitors (hosts) were:

R. Guven, *Bogazici University* (Duff)
G. Russo, *Universita di Catania, Italy* (Sander, Smereka)
C. Grojean, *Saclay* (Wells)
M. Perry, *University of Cambridge* (Kane)
J. X. Lu, (Duff)
I. Sokolov, *Humboldt Universitat, Germany* (Sander)
P. Davies, *Macquarie University* (Duff)
G. Servant, *University of Chicago* (Wells)
C. Terrero, *Instituto de Fisica, UNAM, Mexico* (Freese)
M. Pinard, *Laboratoire Kastler-Brosswl, France* (Berman)
A. Dantan, *Universite Pierre et Marie Curie* (Berman)
C. Cattuto, *University of Perugia, Italy* (Nori)
F. Marchesoni, *University of Perugia, Italy* (Nori)
P. Candelas, *Oxford University* (Duff)
L-A Wu, *University of Toronto* (Duan)
B. Meerson, *Hebrew University* (Sander)
C.W. Zhang, *University of Texas at Austin* (Duan)
P. Ko, *KAIST* (Yao)
J.-P. Hu, *Purdue University* (Duan)
N. Petrov, *University of Texas at Austin* (Doering),
Z. Chen, *LSEC, Beijing* (Duan)
E. Moro, *Universidad Carlos III de Madrid* (Doering)
M. Atiyah, *University of Edinburgh* (Duff)
L. Okun, *Institute for High Energy Physics, Moscow* (Duff)

4.4 MCTP colloquia

In keeping with its interdisciplinary mission, the MCTP sponsors non-technical colloquia designed to help members and scientists in general learn more about the work of their colleagues in other fields. Presentations are made by scientists from the UM and other universities. Recent topics have included:

- “Unveiling the Universe” Joseph Silk (Oxford University), Tuesday, May 25, 2004.
- “The New Cosmology and its Challenge to Fundamental Physics” Mark Trodden (Syracuse University), Tuesday, May 18, 2004.
- “CORE: Frustrated Magnets, Charge Fractionalization and QCD” Marvin Weinstein (SLAC), Tuesday, March 16, 2004.
- “Exploring Young Brown Dwarfs” Ray Jayawardhana (University of

Michigan), Tuesday, February 3, 2004.

- “Puzzle of Charge and Mass” Stuart Raby (Ohio State University), Monday, January 19, 2004.
- “Black Holes for the Curious Physicist” Malcolm Perry (University of Cambridge), Tuesday, September 30, 2004.
- “Exactly Solvable Models of Networks and their Applications” Mark Newman (Department of Physics and Center for the Study of Complex Systems), Tuesday, November 12, 2002.
- “A Physicist’s Quest for the Secrets of Stradivari: William F. Fry” Kameshwar Wali (Syracuse University), Tuesday, March 8, 2005.

4.5 Outreach

In a world that relies increasingly on science and technology, and one in which important decisions affecting all of our lives frequently require some level of scientific expertise, it is vital that the general public have a fundamental understanding of current trends and issues in theoretical physics. To meet that need, the MCTP offers an ongoing series of public lectures and other outreach activities. All events are designed to generate both understanding and support of work now underway in theoretical physics. MCTP members are actively involved in public outreach: writing books for the popular market, publishing magazine and newspaper articles, making television and radio appearances, and interacting with local schools.



Figure 8: Graduate student talking with Michael Turner after presenting his public lecture during the Great Lakes Cosmology workshop in May 2003.

4.6 Arts/science collaboration

During the inaugural conference of the Center, “2001: A Space-time Odyssey” members of MCTP developed a collaboration with the School of Art and Design as part of our outreach mission. The collaboration involved creative works related to the activities of the new center. The works were collaboratively developed by faculty from both the Physics Department and the School of Art and Design. Research scientists, postdocs, graduate students, and staff from both units, mathematicians, and other Ann Arbor artists were also invited to participate.

Ten works were commissioned for exhibition in conjunction with the conference. The School of Art and Design made available a stipend of \$1,000 for each project to defray expenses. A committee of faculty from both physics and art and design selected work from proposals.

Initial development of the space-time art concept came from Lois and Gordon Kane. Important support for the collaboration was provided by Prof. Bryan Rogers, Dean, School of Art and Design, and by Prof. Sherri Smith of the School of Art and Design. In addition, Lois Kane acted as coordinator between the Department of Physics and the School of Art and Design. Further collaborative interactions of physicists with Art and Design faculty are underway, and the Art and Design school has appointed Gordon Kane an Adjunct Professor.



Figure 9: This weaving by Prof. Sherri Smith (College of Art and Design) and Prof. Dante Amidei (Physics) depicts an event in a collider in which two top quarks decay into anti leptons.

5 Training

5.1 *Postdoctoral fellowships*

It is not unusual for some of the freshest and most original ideas to come from the youngest and newest physicists. Newly minted PhDs can be a source of inspiration for colleagues and students alike. The MCTP funds a vigorous postdoctoral program that attracts top candidates from the U.S. and abroad. Every two years, two or three MCTP Postdoctoral Fellows are selected from applications that we receive. The typical pool is about 500 applications. The Fellows for 00-04 were:

LS&A:

Brent Nelson, Berkeley (particle phenomenology and astrophysics)
Vladimir Malinovsky, U Florida (coherent control of quantum dynamics)
Jason Kumar, UC San Diego (high energy and string theory)
Dejan Stojkovic, U Alberta (astroparticles and cosmology)
Evgeniy Khain, Racah Institute (cancer modeling)
Nikola Petrov, U Michigan (nonlinear dynamics)
Shi Liang Zhu, ISI Institute, 50% FOCUS (coherent control, quantum computing)

TASK T (postdocs brought with the DOE matching funds. see section 6.3):

Bob McNees, U Texas (string theory)
Diana Vaman, Princeton (string theory)
Paul de Medeiros, Queen Mary College (string theory)
Manuel Toharia, UC Davis (particle phenomenology)
Asesh Datta, U Florida (collider physics)

5.2 *Graduate student fellowships*

To further the education of graduate students in theoretical physics and related mathematical sciences, the Michigan Center for Theoretical Physics provides fellowships designed to augment funding from federal and university sources. In a typical semester, approximately eight MCTP-funded graduate students are engaged in research activities within the Department of Physics. (The name of their faculty advisors are in parentheses). At most top universities, once past their coursework graduate students can immerse themselves in research and make the transition to becoming a productive researcher. This funding allows the best students to do that.

LS&A:

M. Busha (Adams, Evrard, Bloch)
P. McRobbie (Moukouri)
E. Quintana (Adams)
J. Park (Tkachenko)
S. Olsen, (Raithel)
T. Wang (Kane)
J. Bourjaily (Wells)
M. Fisher (Wells)

T. Bodiya (Wells)
A. Eppig (Mrenna)
N. H. Lee (Liu)
Y. Li (Savit)
M. Lewis (Freese)
S. Chivoret (Doering, Nori)
J. Davis (Larsen)
J. DeVita (Sander)
R. Zhang (Berman)

TASK T:

T. Wang (Kane)
J. Davis (Larsen)
A. Batrachenko (Duff)
M. Lewis (Freese)
M. Mahato (Einhorn)
H. Sati (Duff)
W-Y. Wen (Liu)
D. Oros (Pando Zayas)

COST SHARING:

In addition the MCTP has provided \$160,000 in the form of graduate student support to the NSF grant “Fronts, fluctuations and growth 2003-2006 (Doering, Conlan, Sander, Smereka, Ziff) and \$63,000 in the form of graduate student support to the NASA grant “Habitable planets” 2004-2007 (Adams).

5.3 Undergraduate research studentships

“MCTP has provided me with many valuable experiences in regards to my undergraduate research. Summer funding has allowed me to continue my research on Galaxy Cluster Morphology from Hubble Volume Simulations, which will result in a senior thesis and a published paper. MCTP-sponsored workshops have allowed me to gain experience in presenting my research and in networking with potential graduate school advisors. The workshops have also exposed me to cutting-edge physics research too new to make it into textbooks.”

Sara Kasun, University of Michigan, Class of 2004



Figure 10: (left to right) Sara Kasun and Sara Scanlon attending a MCTP lecture.

Research experience at the undergraduate level is crucial to the education of young physicists, but relatively few universities are willing or able to assume the challenge of developing undergraduate research opportunities that are both appropriate and substantive. With undergraduate education as one of its priorities, the MCTP offers a range of research opportunities in theoretical physics for UM physics majors and students from other units participating in the National Science Foundation's Research Experience for Undergraduates summer program. Participating students can choose from a variety of ten-week summer internships or, in the case of UM physics majors, a one-term independent research project. Students supported for the period 2001-2004 were (the name of the faculty advisors is in parentheses):

J. Paul (Tomozawa)
S. Walavalkar (Krisch/Neal)
J. Bourjaily (Krisch/Neal)
M. Borysow (Krisch/Neal)
C. Hayward (Krisch/Neal)

S. Kasun (Evrard)
E. Lau (McKay)
K. Alatalo (Akerlof)
K. Beverlein (Tarle)
K. Edwards (McKay)
S. Kasun (Evrard)
A. Povilus (Raithel)
R. Schabinger (Wells)
R. Wilson (Gerdes)
R. Vega-Morales (Geva)
G. Ghoshal (Sander)
A. Kimball (McKay)
B. Kelly (McKay)
J. Racusin (McKay)
M. Lamarca (Riles)
A. Kimball (McKay)
J. Efrom (Sander)
D. Paolotti (Nori)

No discussion of undergraduate success at Michigan would be complete without mentioning the achievements of Jacob Bourjaily who is working on Dark Matter with Gordy Kane. While still an undergraduate, he earned the top prizes at the International Summer School on Sub-nuclear Physics, Erice, Sicily: Best Student, P. A. M. Dirac Scholar, Best Theory Presentation (MCTP provided travel funds for Bourjaily to visit Erice.) All other students there were postdocs or graduate students finishing their PhD. He has also been awarded a Marshall Scholarship to visit Cambridge University (the first student from Michigan in seven years).

6 Funding

“I am very pleased to be a member of the MCTP Director’s Council.”

Sam Ting, MIT, Nobel Laureate

6.1 Annual income

The basic support for the MCTP is provided by seed-funding from the College of Literature, Science, and the Arts, \$400,000, plus \$50,000 from the Physics Department. Sources of external funding are described below.

Other sources of significant external funding include MCTP sponsored proposals to AFOSR for “Quantum Computing with Superconducting Qubits”, to NSF for “Fronts, Fluctuations and Growth” and to NASA for “Solar Systems with Habitable Planets”. See section 6.4 below.

6.2 Expenditures

A summary of the MCTP expenditures of LS&A and department funds for 2000–2004 is given in the pie-chart of Figure 11:

MCTP FY01-05 expenditures

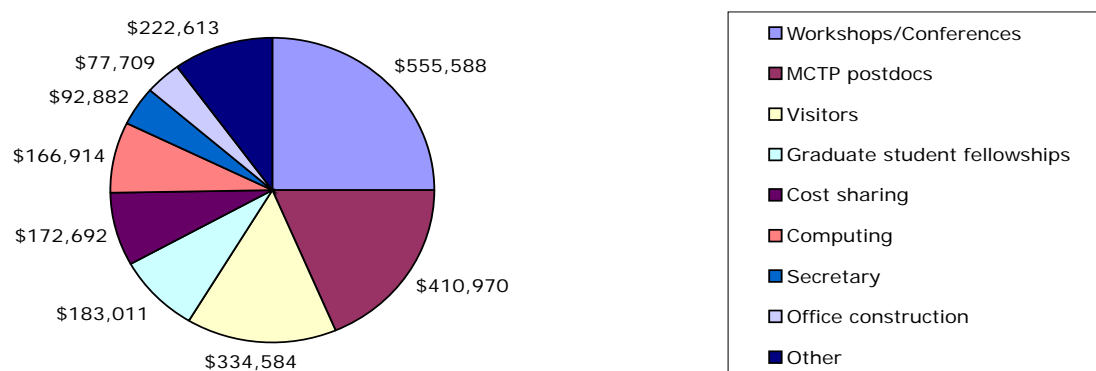


Figure 11: MCTP Expenditures, FY01-05

6.3 Matching funds from the DOE

Major external funding for the MCTP is provided by a \$900,000 Matching Funds Grant for High Energy Theory 2001–2005 from the DOE (PIs Michael Duff, Gordon Kane and Myron Campbell). These MCTP matching funds (denoted Task T) are separate from, and in addition to, the regular high energy theory DOE grant (denoted Task G). Task T PIs have complete autonomy on Task T expenditures which are independent of the MCTP Executive Committee.

Task T matching funds are quite interdisciplinary, covering those subjects of

interest to the DOE High Energy Physics Program: particle physics, string/M theory, stringy mathematics, astrophysics, cosmology, and relativity.

Some of the benefits of Task T include:

1. More graduate student time spent on research
2. Improvement in quality of MCTP postdocs (e. g. by offering a third year to supplement two year appointments, Michigan can compete for the best candidates).
3. Otherwise unaffordable visitors and quick, flexible response.
4. Strengthening the MCTP workshop and visitor programs.
5. Benefits entire US high energy community via workshops and visitor programs.

The Department of Energy has emphasized explicitly that any reduction in the University funding for MCTP will be accompanied by an associated reduction in the Task T grant.

6.4 External funding

- \$10,000 Clay Foundation “Inaugural conference” 2001 (Duff,Liu)
- \$10,000 DOE “Inaugural conference” 2001 (Duff,Liu)
- \$7,500 OVPR “Inaugural conference” 2001 (Duff,Liu)
- \$12,500 NASA “Inaugural conference” 2001 (Freese)
- \$15,000 NASA “DLA workshop” 2001 (Sander)
- \$5,000 Schlumberger “DLA workshop” 2001 (Sander)
- \$10,000 Complex systems “DLA workshop” 2001 (Sander)
- \$3,000 Murray Deutsch Gift 2001
- \$5,000 Veridian Gift 2001
- \$900,000 DOE “Michigan Center for Theoretical Physics Matching Funds” 2002-2005 (Duff, Kane, Campbell),
- \$300,000 AFOSR “Quantum Computing with Superconducting Qubits” 2001-2004 (Nori), MCTP Cost Sharing \$10,000 in the form of graduate student support.
- \$216,000 NSF “Fronts Fluctuations and Growth” 2003-6 (Doering, Conlon, Sander, Smereka, Ziff) 2003-2006, MCTP Cost Sharing \$160,000 in the form of graduate student support.
- \$165,000 NASA “Solar Systems with Habitable Planets” 2003-2006 (Adams), MCTP Cost Sharing \$63,000 in the form of graduate student support.
- \$15,000 FOCUS “Workshop on Decoherence Control and Quantum Computing” 2002 (Berman and Monroe)
- \$30,000 ADVANCE “Young string theorists” 2004-2007 (Larsen, Liu, Pando Zayas), MCTP cost sharing \$5,000
- \$100,000 FOCUS “Joint MCTP/FOCUS postdocs” 2003-2005
- \$60,000 Office of the Provost “ Distinguished visitors” 2005-2008
- \$15,000 Physics Department “ Distinguished visitors” 2005-2008
- \$7,000 Complex systems “Von Neumann workshop” 2005
- \$1,500 Lynn and Kenneth Marko Gift 2005
- \$10,000 Stan and Iris Ovshinsky Gift, 2005

TOTAL: \$1,907,500

6.5 *NSF Roaming Postdocs*

Recently an opportunity may have arisen that will broaden the intellectual strength of MCTP, increase its national visibility, and bring some financial support. The National Science Foundation – Theoretical Division is interested in funding two postdocs who work in Lattice Gauge Theory, in such a way that the postdocs, selected by a national search, could “roam”, i.e. work at whatever national center of activity they choose. NSF is interested in having the funding for the postdoc administered by MCTP. The associated Indirect Costs would come to the University of Michigan. NSF has indicated an interest in extending this model to three postdocs in LHC physics, and if it works out well it could move into other areas of physics. Such roaming is intrinsically appropriate to theoretical physics, which is more movable than an experimental program. Typical postdoc funding would cover salary, fringe benefits, and some operating and computing money, ranging from 60K – 80K. Until such a program is in place the funds that would accrue to the University are uncertain, but could be significant.

6.6 *Funding opportunities*

During its relatively short history, the Michigan Center for Theoretical Physics has amassed an impressive list of accomplishments. In the process, the Center is becoming a major force in shaping our understanding of the physical world, and the implications and opportunities provided by that undoubtedly. While a great deal has already been achieved, much more remains to be done. Some of the possible funding opportunities for donors are:

1. Two - four week workshops convened by experts from around the world, \$20,000–40,000
2. Postdoctoral fellowships, 2-3 @\$65,000 each
3. Graduate student fellowships, 2-3 @ \$12,000 each
4. Undergraduate research scholars, 6 @ \$2,000 each
5. Support of a larger conference, \$100,000
6. Visiting Faculty who are typically paid \$5,000–12,000 for one month; they visit for 1–3 mos, \$5,000–36,000 (This would also be a great endowment opportunity for \$720,000)
7. Outreach, \$10,000
8. Endow the Michigan Center for Theoretical Physics, \$10,000,000 - \$20,000,000.
9. We welcome outside interest and support. To learn more about contributing to the work of the MCTP, we invite you to contact Sheila Cumberworth, Major Gift Officer, LSA Development, 524 Main St, Ann Arbor, sheilac@umich.edu, 734-9980-6253, or Gordon Kane.

6.7 *The MCTP Director’s Council*

Efforts to raise funds from private sources began in earnest in 2004 with the involvement of the LS&A Development Office and the publication of a brochure outlining the activities of the center aimed at Alumni and the general public. It is available electronically on the MCTP website or in hardcopy from Angela Milliken amillik@umich.edu.

One initiative is the appointment of a “Director’s Council” composed of influential members of the business, media and scientific communities, whose job will be to spread the word on the Center’s activities and provide leadership in the development campaign. Interim President Emeritus Homer Neal has kindly lent his support.

GOALS: Volunteer members of the MCTP Director’s Council will help position the Center for success by providing feedback to the Director, maximizing community relations, and helping raise funds to support the Center financially. A minimum of \$10,000,000 needs to be secured to fulfill the vision of endowing the Center and ensuring it is among the finest in the country.

COMMITMENT: Members will participate in one or more formal meetings per year on campus – working sessions perhaps held in conjunction with an MCTP public lecture. They will be in contact via e-mail and telephone throughout the year. Members will be actively engaged with the Center, its scientists, and other distinguished visitors. By being leaders in giving and helping to identify potential donors, members set the stage for other alumni and friends to show their support.

STRUCTURE: Volunteers will include prominent community members with an interest in cutting-edge science, influential correspondents/science writers, and highly accomplished scientists. Members will serve an initial term of approximately three years.

CURRENT MEMBERS:

- Stephen D’Arcy, Vice Chairman, PricewaterhouseCoopers, Detroit, MI
- Stanford and Iris Ovshinsky, Founders, Chief Scientist, and Vice President of Energy Conversion Devices, INC, Troy, MI (Stan was named ‘Hero for the Planet’ by Time Magazine in 1999)
- Irving T. Salmeen, Manager, e-Technology Research, Ford Motor Company, Dearborn, MI
- Samuel C. Ting, Thomas Dudley Cabot Professor of Physics at MIT (1976 Nobel Laureate and Michigan Alumnus)

Appendix 8.2 contains two letters that document the significant progress toward achieving fundraising goals.

7 Taking Stock: Current State & the Future

7.1 *The current state of the Center*

The Michigan Center for Theoretical Physics has begun to take a leadership role in the search for answers to a broad range of important questions. It is a focal point for some of the most exciting and productive research and thinking being done in theoretical physics.

We are quite pleased that the Center has, in a very few years, established an international reputation as a useful and distinguished venue for interaction. In fact, this distinguishes the MCTP from many of the other theoretical physics centers in the country. In most such centers, the main activities are internal to the host university, and, in fact, mostly internal to the host physics department. Our view of our mission has been much more ambitious, in that we seek to be of service to the theoretical science community as a whole. (Of course, this kind of service is of inestimable value to our department and the University!) In this respect, the best comparison to the MCTP is the well-known Kavli Institute for Theoretical Physics in Santa Barbara, or the Newton Institute at the University of Cambridge.

In order to assess the impact that we have made, we sought the opinions of scientists from outside of Michigan who have participated in our activities. We include these as an appendix, below. We were very pleased by the warmth of the reactions to our activities.

Another thing that distinguishes us from other centers is our interdisciplinary emphasis. This aspect of our work has involved, as well as outside researchers, many faculties from other LSA departments, and other Colleges. We are particularly encouraged by the strong ties that we have established with Mathematics, which includes a joint NSF grant directly inspired by the existence of the MCTP. We include in an appendix, below, a set of statements from the Michigan faculty, outside of Physics. We think that we have made a significant impact on the intellectual environment of the University.

The Members of the MCTP (and the international theoretical physics community) are very grateful to Interim President Emeritus Homer Neal, Provost Paul Courant, Deans Shirley Neuman and Terry MacDonald, and Chairs Ctirad Uher and Myron Campbell for their support and encouragement.

The founding director of the center, Professor Michael Duff, unfortunately will be leaving Michigan soon. Duff wrote:

On a sadder personal note, my time at the University of Michigan is drawing to a close. I have accepted the position of Professor of Physics and Principal of the Faculty of Physics Sciences at Imperial College, London. In order to effect a smooth transition, I stepped down as Director at the end of 2004. From January 1, 2005, the new (Interim) Director is Gordon Kane. In addition there will be three Associate Directors: Katie Freese (Outreach), Jim Liu (Budget), and Len Sander (Research). I wish Gordy and his colleagues every success.

7.2 *The Future*

Crucial to the center's continuation will be an assessment by the Dean of LS&A as to the success with which the MCTP has fulfilled the conditions set out in the Dean's founding letter (Appendix 8.6). In this report, authored by the old and new Directors, the new Associate Directors and the MCTP Executive Committee, we have attempted to take stock of what we have accomplished.

In the future we hope to continue and strengthen our core activities, and to carefully consider stimulating activities in new interdisciplinary areas. For example, theoretical physicists are taking a leading role in the life sciences throughout the world. This introduction of the methods of theoretical statistical physics into the life sciences is an extraordinarily promising area. We think that the MCTP can play a creative role in bringing together the expertise in this new area that is present at Michigan, but scattered among departments and colleges.

We have made a promising start in fund-raising. We are particularly pleased by the response to the formation of the Director's Council, and we think that we have a realistic chance to eventually become self-supporting.

We urge that the College support the MCTP at least at the level it has, so that its impact and productivity is not reduced. Since the MCTP has had and will have more significant reach not only in other departments but in other Colleges, perhaps some funds could be brought in from the Office of the Provost, effectively reducing the College's commitment. Perhaps some money from fundraising could also go to reducing the College's commitment, but some fundraising might be endangered if the donors thought their support was not adding value.

Our hopes for this enterprise are very high. The enthusiasm of the Michigan community for our work is widespread. We think that our future prospects are bright, and that we can make an important and lasting contribution to the university community.



Figure 12: (From left to right) Previous Director Michael Duff, colleague Bruno Zumino, and Interim Director Gordon Kane

8 Appendices

8.1 Endorsements

In order to assess our impact, we collected endorsements for MCTP and its activities. One email message was sent to Members and to Workshop participants (not Conference participants), and the following responses arrived. All were positive. They came from other departments and colleges in the University, nationally, and internationally. The full text of the endorsements is available at the following site: <http://www.umich.edu/~mctp/reports/>

8.1.1 Sample quotes from endorsements received

‘I’m happy to reply in detail, for my own experience is that MCTP has been a remarkably stimulating force for interdepartmental activities here at Michigan. ... I hope that MCTP can continue to play the kind of galvanizing role that it so effectively has in recent years.’

Charlie Doering

Professor of Mathematics, University of Michigan

‘MCTP has stimulated interdisciplinary cooperation within the university. It certainly has helped me- a rather traditionally minded pure mathematician- appreciate and benefit from the ideas and insights of my more applied colleagues within the university...’

Joe Conlon,

Professor of Mathematics, University of Michigan

‘For me, it has been a great source of help in having interdisciplinary interactions with members of the physics department and has given me a reason to come to central campus on a regular basis from the engineering college.’

Robert M. Ziff

Professor of Chemical Engineering, Univ. of Michigan

‘The MCTP is an exciting and stimulating resource for physics, Mathematics and science in general at the University of Michigan that greatly Benefits students and faculty ... I have found that in visits to other universities people really know about MCTP and that this has Michigan put theoretical science on the map in a way that individual departments here cannot do...’

Anthony Bloch,

Professor of Mathematics, University of Michigan

‘To summarize, from many decades’ experience in our field, MCTP has brought back the glory days of UM Physics and I fervently hope that this initial period’s success will be continued in the next cycle you so richly deserve.’

Stanley Deser

Ancell Professor of Physics, Brandeis University, Fellow, National Academy of Sciences

‘As far as I can see, the very successful activities of the Center put it on a par with

such world renowned programs as the KITP at Santa Barbara, the Newton Institute at Cambridge and the Yukawa Institute for Theoretical Physics in Kyoto.'

Baruch Meerson

Professor of Physics, Racah Institute, Hebrew University of Jerusalem

'I sincerely hope that the MCTP funding can continue or hopefully even be enhanced. Such funding enables international research to flourish, and collaborations to be maintained across international boundaries, resulting in high quality research to be performed that would not otherwise be possible.'

S.F.King,

Professor, Department of Physics and Astronomy, University of Southampton, UK

'It was really a great thing to open the Michigan Center for Theoretical Physics. As a person from abroad, I must state, that the Center has brought a lot for the visibility of the whole your University from the outside: I still remember a nice posters which I have seen in Freiburg (where I was at that time) when the Center was opened. This poster immediately attracted my attention, ...'

Igor M. Sokolov

Statistische Physik und Nichtlineare Dynamik Institut fuer Physik

Humboldt-Universitaet zu Berlin

'Funding of the MCTP not only demonstrates the Univ of Michigan's commitment to excellence in Physics research but it also puts the international spotlight on U. Mich. in our field.'

R. N. Mohapatra

Professor of Physics, University of Maryland

'The University of Michigan has played an important role in the History of High Energy Physics. MCTP gives the University the opportunity to become one the leading actor of this new century in the race to discover the ultimate secrets of matter at the tiniest scales ever explored. Let us make MCTP that exciting place where everybody wants to visit.'

Christophe Grojean.

Staff Scientist, Theoretical Physics Division, French Atomic Energy Commission, Saclay

8.1.2 List of all endorsements received

University of Michigan

- Charlie Doering Professor of Mathematics, University of Michigan
- Fred Adams Professor of Physics, University of Michigan
- Joe Conlon Professor of Mathematics, University of Michigan
- Jason Kumar Postdoctoral fellow, Physics, University of Michigan
- Rachel Goldman Associate Professor Depts. of Materials Science & Engineering and Electrical Engineering & Computer Science, University of Michigan
- Philip Hughes Research Scientist, Astronomy, University of Michigan
- Robert M. Ziff, Professor of Chemical Engineering, Univ. of Michigan

- Peter Smereka, Professor of Mathematics, University of Michigan
- Trachette L. Jackson, Associate Professor of Mathematics, University of Michigan
- Antony Bloch, Professor of Mathematics, University of Michigan

Other US Institutions

- Stanley Deser Ancell Professor of Physics, Brandeis University, Fellow, National Academy of Sciences
- Eric Linder Lawrence Berkeley Laboratory
- Michael R. Douglas Professor, Department of Physics and Astronomy, Rutgers University
- Frederick J. Mayer, President, Mayer Applied Research Inc, Ann Arbor, MI
- Michael Ratz, Postdoctoral Fellow, Physikalisches Institut der Universität Bonn, Germany
- Arkady Tseytlin, Professor of Physics, Ohio State University
- Howard Schnitzer, Edward and Gertrude Swartz Professor of Theoretical Physics, Brandeis University
- Rafael Nepomechie, Professor, Physics Department, University of Miami
- R. N. Mohapatra, Professor of Physics, University of Maryland
- Michael Dine, Professor of Physics, University of California Santa Cruz
- William Kinney, Assistant Professor of Physics, University of Buffalo

Foreign Institutions

- Baruch Meerson, Professor of Physics, Racah Institute, Hebrew University of Jerusalem, Israel
- Eshel Ben-Jacob, Professor of Physics, The Maguy-Glass Chair in Physics of Complex Systems, Tel Aviv University, Israel, Past President, Israel Physical Society
- Joe Silk, Savilian Professor of Astronomy, Oxford University, UK
- S.F. King, Professor, Department of Physics and Astronomy, University of Southampton, UK
- Giovanni Russo, Professor of Mathematics, University of Catania, Italy
- Igor M. Sokolov, Professor, Statistische Physik und Nichtlineare Dynamik Institut für Physik, Humboldt-Universität zu Berlin, Germany
- Jeanette E. Nelson, Dipartimento di Fisica Teorica, Università di Torino and Istituto Nazionale di Fisica Nucleare, Sezione di Torino, Italy
- George Papadopoulos, Department of Mathematics, King's College London, UK
- Sacha Davidson, Institut de Physique Nucleaire, Univ Claude Bernard, Lyon, France
- Fabio Marchesoni, Professor, Dipartimento di Fisica, Università di Camerino Camerino, Italy
- Marc Henneau, Professor of Theoretical Physics, Université Libre de Bruxelles & Director, International Solvay Institutes, Belgium
- Ignacio Cirac, Director, Max-Planck Institut für Quantenoptik, Garching, Germany
- Christophe Grojean, Staff Scientist, Theoretical Physics Division, French

Atomic Energy Commission, Saclay, France

- Eric Bergshoeff, Professor, Theoretical High Energy Physics, Groningen University, Netherlands

8.2 *External Funding Prospects*

Fundraising Analysis for Michigan Center for Theoretical Physics

February 11, 2005
Sheila Cumberworth

After a sputtering start in its fundraising efforts, the Michigan Center for Theoretical Physics is turning a corner. Several recent developments and future planning indicate potential future fundraising success.

Collaboration with the Department

The Center and Department are collaborating to identify, engage and steward potential donors and volunteers whose capacity for making gifts might be for the Center, the Department, or its outreach efforts through the Saturday Morning Physics program.

For example, when it was announced that last fall's Tai Yu Wu lecturer had won the Nobel prize, the Department sent letters to approximately 100 special friends of the Department (as identified for the "Chair's Weekend" event), inviting them to the lecture and dinner afterward. About a dozen people attended; half of whom are prospects for the MCTP, and several gift discussions for the MCTP went forward at that event.

Likewise, when the MCTP held a discussion meeting in late October, it also extended an invitation to this group to join them at Saturday Morning Physics, thus increasing the visibility of this program.

This is an excellent sign, as it widely held within the development community that multiple relationships for prospects lead to increased giving.

Progress with identifying Prospective Donors and Volunteers

The MCTP is also making progress identifying prospective donors and volunteers for its board, and in furthering philanthropic discussions among its volunteers. In the past several weeks several members have agreed to serve on the MCTP Board: Stanley and Iris Ovshinsky, Irving Salmeen, Kenneth Marko, and Sam Ting. Of this group, some are promising for future high-end giving, and others have an expectation that they will make annual contributions in the range of \$5,000 during their association with the program. Development staff are also in conversation with additional prospective high-end donors. Homer Neal has offered to help promote the Center, though no gift discussions have occurred as of this writing.

Likewise, several other prospects have come forward. Stephen D'Arcy from Detroit is one such prospect. He has offered to seek additional funding for the Center from among his friends and associates in the Detroit area. A young alumnus of the department with means is also interested in learning more about the MCTP with a view to potential support in future.

Other potentially productive conversations are going on with affluent individuals interested in theoretical physics behind the scenes.

Future fundraising

I believe that over the next three to five years, there is evidence the center can raise increasing levels of annual funds, with a starting range of \$25,000 to \$50,000 in the first and second years building to \$100,000 in year 5.

Furthermore, from the pool of currently identified prospects, I believe the MCTP might raise endowment gifts in the range of \$500,000 during this time, and could secure multi-million dollar bequest or trust commitments.

In addition, during the Einstein theme semester next fall, I believe the MCTP has an opportunity to grow its prospect base significantly with strategic public programming for members of the community.

The prospects for future progress are, in short, very good, and I believe it would be a shame to lose funding at this juncture in the program's evolution because of any uncertainty about the MCTP renewal.

February 22, 2005
Dean T. McDonald
University of Michigan

Dear Prof. McDonald,

I have the pleasure to be working with Gordy Kane and Sheila Cumberworth on the development of and fund raising for the Michigan Center for Theoretical Physics. As well as personally contributing to the Center, I am organizing a "visiting committee" made up of senior executives and leaders from the fields of business, government and non-physics academia.

The committee will assist the center through advice and fund raising efforts. It will also raise the visibility of the University's efforts to reestablish Michigan as one of the prominent world centers in theoretical physics. My efforts have just begun but I have already found a high level of interest from several Detroit areas CEO's.

Continued support from the University is, of course, essential to the MCTP and all of our efforts. Please call me if you have any questions I might be helpful with (313-394-6755).

Sincerely yours,

Stephen R. D'Arcy
Partner, PricewaterhouseCoopers LLP

8.3 Proposal Three Year Budget

This request is for renewed funding at a level of \$450,000 per year for fiscal years FY06-FY08. Note that currently the MCTP is fully funded through 31 December 2005, which covers half of FY06. The FY06 request is for a total of \$450,000 covering the entire FY06.

Expenses	FY06 request	FY07 request	FY08 request
Fixed expenses			
Administrative			
Secretary	\$35,000.00	\$36,000.00	\$37,000.00
Computing	\$17,000.00	\$17,250.00	\$17,500.00
Supplies	\$5,300.00	\$5,300.00	\$5,300.00
Miscellaneous			
Advertising	\$2,000.00	\$2,000.00	\$2,000.00
Development	\$3,000.00	\$3,000.00	\$3,000.00
Discretionary	\$12,000.00	\$12,000.00	\$12,000.00
Cost sharing commitments			
Fronts, Fluctuations, Growth	\$41,500.00		
NASA grant (Adams)	\$21,000.00	\$21,000.00	
New cost sharing (30k/yr) *		\$30,000.00	\$30,000.00
New cost sharing (20k/yr) *			\$20,000.00
MCTP postdocs**			
Current postdocs			
FY04-05 Jason Kumar	\$9,000.00		
FY04-05 Dejan Stojkovic	\$9,000.00		
FY05-06 Shi-Liang Zhu	\$27,900.00	\$4,800.00	
FY06-07 Evgeny Khain	\$46,500.00	\$57,600.00	\$9,600.00
New postdocs			
FY07-08 MCTP new postdoc 1		\$48,000.00	\$59,400.00
FY08-09 MCTP new postdoc 2			\$49,500.00
Postdoc travel	\$5,000.00	\$6,000.00	\$6,000.00
Funded proposals			
Major programs			
Workshops	\$75,000.00	\$80,000.00	\$85,000.00
Visitors	\$50,000.00	\$60,000.00	\$50,000.00
Students			
Graduate students	\$48,000.00	\$48,000.00	\$48,000.00
Undergraduate students	\$16,000.00	\$16,000.00	\$16,000.00
Total expenses	\$423,200.00	\$446,950.00	\$450,300.00
Income			
Carryover from previous fiscal year	-\$20,000.00	\$6,800.00	\$9,850.00
Request for renewed funding	\$450,000.00	\$450,000.00	\$450,000.00
Total income	\$430,000.00	\$456,800.00	\$459,850.00
Income minus expenses	\$6,800.00	\$9,850.00	\$9,550.00

* Due to recent changes in NSF cost sharing requirements, the actual amounts may be reduced from the estimates.

** Budget assumes no new postdoc in FY06; this could be changed if funds allocated to proposals are shifted to postdocs.

BUDGET JUSTIFICATION**1. Fixed expenses***a. Secretaries*

Angela Milliken @ 40% and Ricah Marquez @ 50%; the remaining appointment fractions are shared with High Energy Theory and the Physics Department.

b. Computing

This covers the salary for a part time computer support position (10 hr/week @ \$16/hr = \$8,000/year for FY06; salary inflated in subsequent years). In addition, funds to purchase new computers on a three-year replacement schedule (five computers/year) as well as hardware (disk drives, networking equipment, cables, etc.) and software. The expenses are allocated as follows

	FY06	FY07	FY08
System manager @ 10 hr/week	\$8,000	\$8,250	\$8,500
Five computers	\$7,500	\$7,500	\$7,500
Additional hardware	\$1,000	\$1,000	\$1,000
Software	\$500	\$500	\$500
Total	\$17,000	\$17,250	\$17,500

c. Supplies

- i. Copying and office supplies (\$2,500)
- ii. Postage and shipping (\$300)
- iii. Telephone (\$2,500)

d. Advertising

This is mostly for postdoc advertisements in Physics Today and AIP online. The FY06 request is to advertise the position starting FY07. The FY07 request is to advertise the two positions starting FY08. Advertising is also expected in FY08.

e. Development

Expenses related to Director's council (semi-annual meetings) as well as hosting and fund-raising activities.

f. Discretionary

The MCTP solicits major proposals on an annual cycle coinciding with the fiscal year. Part of the discretionary funds is intended to cover proposals under \$1,000 submitted outside of the regular cycle. Discretionary funds cover travel and hosting for visitors invited through the Executive Committee (such as MCTP colloquium speakers), and may also be used to cover unforeseen expenses.

g. Cost sharing commitments

The MCTP encourages its membership to pursue external funding that may leverage the resources of the MCTP through cost sharing. The center is currently committed to cost sharing on the NSF Fronts, Fluctuations and Growth grant (Sander) as well as the NASA research grant (Adams).

The MCTP anticipates entering into new cost sharing arrangements starting in FY07 (\$30k/year multi-year grant) and FY08 (\$20k/year multi-year grant). Note, however, that recent changes to NSF cost sharing requirements may result in actual cost sharing amounts lower than indicated.

2. MCTP postdocs

While the MCTP fiscal year runs from 1 July to 30 June, typical postdoc appointments run from 1 September to 31 August. The two final months of postdoc salary are encumbered on the following fiscal year.

a. Current postdocs

In FY06, the MCTP is committed to pay the final two months of salary for Jason Kumar and Dejan Stojkovic. In addition, the MCTP will have 1.5 postdocs in FY06 (Shi-Liang Zhu, shared with FOCUS, and Evgeny Khain).

b. New postdocs

We anticipate hiring one new postdoc starting September 2006, and one new postdoc starting September 2007. This hiring schedule maintains an average of two MCTP postdocs in residence every year. Note, however, that an alternate scenario would be to hire a postdoc starting September 2005. Funds for such a FY06 hire could be shifted away from funded proposals.

c. Postdoc travel

Each postdoc is allocated \$2,000 a year to support career development through travel for collaboration, conferences and workshops. In addition, incoming postdocs are given up to \$1,000 to cover moving expenses.

3. MCTP funded proposals

Major proposals are solicited on an annual basis. Proposals for FY06 are currently being sought, with a deadline of 11 March 2005. The MCTP encourages activities involving: Workshops and conferences; Visitors; Graduate student support; and Undergraduate research.

a. Workshops and conferences

One of the major activities of the center is to host workshops and major conferences. In the past few years, the MCTP has run around four or five workshops a year. We anticipate running a similar workshop program in the next three years. While the specific workshops are as yet undetermined (and contingent upon successful proposals), the workshop plan is as follows

	FY06	FY07	FY08
1 week workshop (10-20 participants)	\$10,000	\$10,000	\$10,000
1 week workshop (10-20 participants)	\$10,000	\$10,000	
2 week workshop (35-50 participants)	\$25,000		\$25,000
2 week workshop (40-50 participants)	\$30,000	\$30,000	
shared workshop (with outside funding)		\$10,000	\$10,000
major conference (100-200 participants)		\$20,000	\$40,000
Total	\$75,000	\$80,000	\$85,000

Note that the funding for the major international conference is split in two (initial \$20,000 funding in FY07; final \$40,000 funding in FY08). Much of the planning for

such a conference must be undertaken well in advance of the actual meeting dates.

b. Visitors

Outside of workshops, the MCTP supports both short-term and long-term visitors. Typically there will be anywhere from one to four long-term visitors (6 months to 1 year) in residence during the academic year. Short-term visitors typically spend about 1 to 2 weeks at the MCTP. Proposals for sponsoring visitors are solicited from the membership.

For visits of up to one month, the MCTP reimburses travel and local expenses up to a maximum of \$185 times the number of days of the visit. Longer visits are supported at up to \$4,000-\$5,000 per month, based on requested amount and possible matching support.

The MCTP also expects to fund general visitor programs proposed by the membership. Past programs include the CM/AMO visitor program and the Young string theorists visitor program.

In addition, the MCTP is delighted to sponsor annual visits of Martinus Veltman, Nobel Laureate and Professor Emeritus of Physics. The visitor budget is allocated as follows

	FY06	FY07	FY08
individual short term (8 vis. wks @ \$185/day)	\$10,000	\$10,000	\$10,000
individual long term (4 mo @ 50%)	\$10,000	\$10,000	\$10,000
second long term visitor		\$10,000	\$10,000
visitor programs	\$15,000	\$15,000	\$25,000
Martinus Veltman	\$15,000	\$15,000	
Total	\$50,000	\$60,000	\$55,000

c. Graduate student fellowships

Graduate student awards are meant to encourage research in interdisciplinary areas. The standard graduate student award is for \$12,000 and is administered by the student's advisor. Fellowships typically provide partial GSRA support, but carry only a fixed dollar amount. We are requesting funding for four graduate student fellowships a year (\$48,000/year for three years).

d. Undergraduate research scholars

The MCTP typically supports undergraduate research either through summer stipends or by matching REU funding. The standard award rate is \$2,000 per student. The budget supports eight students each year (\$16,000/year for three years).

8.4 Other U.S. Theoretical Physics Centers

UC, Berkeley: Berkeley Center for Theoretical Physics
Caltech/USC: Center for Theoretical Physics
University of Colorado: Center for Theoretical Atomic, Molecular, and Optical Physics
University of Chicago: Enrico Fermi Institute
University of Florida: Institute for Fundamental Theory
University of Minnesota: Theoretical Physics Institute
MIT: Center for Theoretical Physics
Texas A&M: Mitchell Institute for Fundamental Physics
Penn State: Center for Gravitational Physics and Geometry
UC, Santa Barbara: Institute for Theoretical Physics
SUNY Stony Brook: C.N. Yang Institute for Theoretical Physics
Stanford: Theoretical Physics Center
Ohio State: Center for Theoretical Science
Rutgers: Center for Theoretical Physics and Mathematical Sciences
University of Washington: Institute for Theoretical Particle and Nuclear Physics

8.5 The Dean's approval

Dear Ctirad,

We seem finally to have found our way through the budget thicket and I write to inform you that I will be funding the Center for Theoretical Physics, from LS&A Enrichment funds given by donors, on the following terms:

- For the current fiscal year, LS&A will provide the Institute with \$213,000 in funding. The Department is expected to contribute a further \$25,000 from its own discretionary funding.
- For the three years from July 2001 until July 2004, the Center will receive \$400,000 per annum from LS&A. In each of those years, Physics will be required to partially “match” this funding with an allocation of \$50,000 from internal departmental resources. I will review with you in each budget cycle your commitment of funds to the Institute and the actual use made of the funding.
- In the fall of 2003, the Institute is to prepare a small self-study report, outlining at least the following:
 - ⇒ the research that has been done by Center members, with a description of the extent to which the Center enabled that research
 - ⇒ the grant funding that has accrued directly to the Center, and the indirect costs that have been returned to the University as a consequence of that research funding
 - ⇒ collaborative research initiatives that have been undertaken as a consequence of the center, both with UMichigan scholars and with scholars from other universities
 - ⇒ training activities that have taken place in the Center, including training grants and graduate supervision
 - ⇒ for purposes of bench-marking, a comparison of each of the above with the level of activity in theoretical physics in the department in the

1999- 2000 academic year

- ⇒ a description of seminars, workshops, invited speakers, symposia, and outreach activities undertaken by the Center
- ⇒ an outline of external funding received to support the ongoing activities of the Center (in addition to funding for specific research projects) this information will provide the basis of an evaluation of the activities of the Center for funding beyond the fiscal 04 year.

I trust that this will enable Professor Duff and his colleagues in theoretical physics to undertake the ambitious program they have projected and will very much look forward to knowing about the work in the field which it enables.

Sincerely,

Shirley Neuman

8.6 *Further funding by the Dean*

Dear Mike,

Given the early successes of the Michigan Center for Theoretical Physics (MCTP), I am extending the current level of “seed funding” for an additional 18 months (that is, you will now have five years of funding from the date that funding commenced, rather than three and one-half). Funding will be at the same level as in the initial period.

I wish you well in your continued endeavors on behalf of MCTP.

Sincerely,

Shirley Neuman

8.7 *Full membership list*

As the list of members show, the membership is strongly interdisciplinary, across departmental and college boundaries.

C. Akerlof (Physics)
F. Adams (Physics)
R. Akhoury (Physics)
P. Berman (Physics)
A. Bloch (Mathematics)
J. Bregman (Astronomy)
P. Bucksbaum (Physics)
D. Burns (Mathematics)
T. Chupp (Physics)
C. Doering (Mathematics)
I. Dolgachev (Mathematics)
L. Duan (Physics)
M. Duff (Physics)
M. Einhorn (Physics)

G. Estabrook (Biology)
A. Evrard (Physics)
M. Falk (Materials Science and Engineering)
P. Federbush (Mathematics)
G. Ford (Physics)
J. Fornaes (Mathematics)
K. Freese (Physics)
D. Gerdes (Physics)
E. Geva (Chemistry)
K. Hecht (Physics)
P. Horja (Mathematics)
P. Hughes (Astronomy)
G. Kane (Physics)
S. Krimm (Biophysics)
J. Krisch (Physics)
F. Larsen (Physics)
R. Lewis (Physics)
J. Liu (Physics)
T. McKay (Physics)
C. Monroe (Physics)
S. Moukouri (Physics)
S. Mrenna (Fermilab)
H. Neal (Physics)
M. Newman (Physics)
F. Nori (Physics)
L. Pando Zayas (Physics)
G. Raithel (Physics)
D. Richstone (Astronomy)
B. Roe (Physics)
L. Sander (Physics)
R. Savit (Physics)
D. Scheeres (Aerospace Engineering)
C. Simon (Complex Systems)
J. Smoller (Mathematics)
R. Spatzier (Mathematics)
G. Tarle (Physics)
A. Tkachenko (Physics)
Y. Tomozawa (Physics)
A. Uribe (Mathematics)
J. Vandermeer (Biology)
M. Veltman (Physics)
J. Wells (Physics)
D. Williams (Physics)
J. Wilson (Philosophy)
H. Winful (Electrical Engineering)
A. Wu (Physics)
E. Yao (Physics)
R. Ziff (Chemical Engineering)
M. Zochowski (Physiology)

8.8 Associate membership list

L. Anguelova (Physics)
K. Augustyn (General Dynamics Advanced Information Systems)
A. Batrachenko (Physics)
J. Berstein (Astronomy)
J. Bialek (Physics)
B. Blinov (Physics)
F. Bookstein (Gerontology)
J. Bourjaily (Physics)
M. Brehob (Electrical Engineering and Computer Sciences)
A. Buchel (Physics)
B. Burrington (Physics)
J. Chapman (Physics)
Y. Chushak (Chemistry)
J. Conlan (Mathematics)
J. Dai (University of Utah)
A. Datta (Physics)
J. Davis (Physics)
M. Deutsch (Physics)
B. Dubetsky (Physics)
R. Dupke (Astronomy)
G. Flynn (Pharmacy)
T. Foth (Mathematics)
R. Freeling (Advanced Information Services)
H. Garcia (Computer and Information Science)
D. Garfinkle (Oakland University)
E. Glass (University of Windsor)
A. Greenspoon (Mathematical Reviews)
C. Hayward (Physics and Astronomy)
P. Ion (Mathematical Reviews)
L. Ji (Mathematics)
T. Kamalov (Moscow State University)
S. King (Physics)
R. Krasny (Mathematics)
J. Krick (Astronomy)
J. Kumar (Physics)
M. Lewis (Physics)
D. Li (Physics)
Y. Li (Physics)
R. Lindner (History)
J. Lu (Physics)
S. Malinovsky (FOCUS)
V. Malinovsky (Physics)
D. Manna (Physics)
F. Marchesoni (Physics)
D. Maxwell (Romance Languages and Literature)
F. Mayer (Mayer Applied Research)
R. McNees (Physics)
P. McRobbie (Physics)

D. Moehring (Physics)
L. Moffatt (Physics)
B. Nelson (Physics)
T. O'Donnell (Physics)
L. Okun (ITEP, Moscow)
D. Oros (Physics)
S. Ovshinsky (Energy Conversion Devices)
I. Ovshinsky (Energy Conversion Devices)
A. Pawl (Physics)
A. Petrov (Physics)
N. Petrov (Mathematics)
C. Rangan (Physics)
M. Ross (Physics)
M. Ryan (School of Information)
I. Salmeen (Ford Motor Company)
C. Savage (Physics)
K. Schneider (Physics)
C. Search (Physics)
Q. Shi (Chemistry)
P. Smereka (Mathematics)
N. Soparkar (Electrical Engineering and Computer Sciences)
R. Stanek (Astronomy)
D. Stojkovic (Physics)
B. Thomas (Physics)
M. Toharia (Physics)
L. Velasco-Sevilla (Physics)
T. Wang (Physics)
C. Warren (Physics)
S. Wen (Physics)
R.-J. Zhang (Physics)

8.9 *Personnel*

- *Interim Director:* Gordon Kane
- *Associate Directors:* Len Sander (Research), Jim Liu (Budget), Katie Freese (Outreach)
- *Committee to propose the MCTP:* F. Adams, M. Duff (chair), P. Berman, R. Savit, L. Sander
- *Computing committee:* J. Liu (Chair), A. Evrard, F. Nori
- *Diversity committee:* K. Freese (Chair), J. Krisch, L. Pando Zayas
- *Facilities committee:* A. Akhoury, P. Berman, D. Gidley, A. Milliken (Chair)
- *Undergraduate research committee:* J. Krisch, F. Nori, J. Wells (Chair)
- *Secretaries:* A. Milliken, R. Marquez

8.10 Publications

- MCTP-00-01 M. J. Duff, State of the Unification Address
- MCTP-00-02 M. Cvetič, M. J. Duff, James T. Liu, H. Lu, C. N. Pope, K. S. Stelle, Randall-Sundrum Brane Tensions
- MCTP-00-03 D. Anna, Nori, Critical Dynamics of Burst Instabilities in the Portevin-Le Chatelier effect
- MCTP-00-04 Reichhardt, Olson, Nori, Wigner Crystal Dynamics
- MCTP-00-05 Olson, Nori, Effects of Columnar and Point Defects on Magnetic Hysteresis Curves Produced by 3-dimensional Vortices in Layered Superconductors
- MCTP-00-06 Y.-L. Lin, Nori, Feynman Path-Integral Analytical Studies of Quantum Interference for Superconducting Networks and Josephson Junction Arrays in Magnetic Fields
- MCTP-00-07 Thomas Dent, CP violation and target-space modular invariance
- MCTP-00-08 M. Cvetič, G.W. Gibbons, H. Lu and C.N. Pope, Ricci-flat Metric, Harmonic Forms and Brane Resolutions
- MCTP-00-09 R. Akhouri, H. Wang, O. Yakovlev, Higgs Boson Production in Photon-Photon Collisions
- MCTP-00-10 Oleg Yakovlev and Stefan Groote, On t anti- t threshold and top quark mass definition
- MCTP-00-11 A. Akhouri, H. Wang, O. Yakovlev, On large logarithms in Higgs $\rightarrow \gamma\gamma$ decay
- MCTP-00-12 C. Cattuto, G. Costantini, T. Guidi, F. Marchesoni, Linear Strings in Solids
- MCTP-00-13 Oleg Yakovlev, On Higgs Production in photon photon Collisions [the contribution to the Linear Collider Workshop 2000, Fermilab, October 2000]
- MCTP-00-14 Leopoldo A. Pando Zayas and Arkady A. Tseytlin, 3-Branes on Spaces with $R \times S^2 \times S^3$ Topology
- MCTP-00-15 R.-G. Cai, J. X. Lu and Y.-S. Wu, The Galilean Nature of V-duality for Noncommutative Open String and Yang-Mills Theories
- MCTP-00-16 C. Cattuto, G. Costantini, T. Guidi, F. Marchesoni, Driven Kinks in Discrete Chains: Phonon Radiation
- MCTP-00-17 R.G. Cai, J. X. Lu, N. Ohta, S. Roy, Y. S. Wu, OM Theory and V-duality
- MCTP-00-18 M. Cvetič, G. W. Gibbons, H. Lu, and C.N. Pope, Supersymmetric Non-singular Fractional D2-branes and NS-NS 2-branes
- MCTP-00-19 C. Olson, C. Reichhardt, B. Janko, and F. Nori, Collective Interaction-Driven Ratchet for Transporting Flux Quanta
- MCTP-00-20 S. Zaroubi (MPA), G. Squires (Caltech), G. de Gasperis (Roma), A. Evrard (UMich), Y. Hoffman (HU), J. Silk (Oxford), Deprojection Galaxy Cluster X-ray, Sunyaev-Zel'dovich Temperature Decrement and Weak Lensing Mass Maps
- MCTP-00-21 John J. Bialek, August E. Evrard, Joseph J. Mohr, Effects of Preheating on X-ray Scaling Relations in Galaxy Clusters
- MCTP-00-22 N. Yoshida, J. Colberg, S. D. M. White, A. E. Evrard, T. J. MacFarland, H. M. P. Couchman, A. Jenkins, C. S. Frenk, F. R. Pearce, G. Efstathiou, J. A. Peacock, P. A. Thomas (The Virgo

- Consortium), Simulations of Deep Pencil-Beam Redshift Surveys
- MCTP-00-23 G. Mark Voit, August E. Evrard, Greg L. Bryan, Confusion of Diffuse Objects in the X-ray Sky
- MCTP-00-24 Klaus Dolag, August Evrard, Matthias Bartelmann, The temperature-mass relation in magnetized galaxy clusters
- MCTP-01-01 J. X. Lu, $(1 + p)$ -Dimensional Open $D(p - 2)$ Brane Theories
- MCTP-01-02 Lisa Everett, Gordon L. Kane, Stefano Rigolin, Lian-Tao Wang, Implications of Muon $g - 2$ for Supersymmetry and for Discovering Superpartners at Fermilab
- MCTP-01-03 Gerald Paul, Robert M. Ziff, H. Eugene Stanley, Percolation threshold, Fisher exponent, and shortest path exponent in 4 and 5 dimensions
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- MCTP-01-05 Christian D. Lorenz and Robert M. Ziff, Excess number of percolation clusters on the surface of a sphere
- MCTP-01-06 F.A. Dilkes, M.J. Duff, James T. Liu and H. Sati, Quantum $M \rightarrow 0$ discontinuity for massive gravity with a Lambda term
- MCTP-01-07 A. Buchel, C.P. Herzog, I.R. Klebanov, L.A. Pando Zayas and A.A. Tseytlin, Non-Extremal Gravity Duals For Fractional D3-Branes On The Conifold
- MCTP-01-08 J.P. Krisch and E.N. Glass, Critical Exponents For Schwarzschild-Kerr and BTZ Systems
- MCTP-01-09 M.F. Laguna, C.A. Balseiro, D. Dominguez, F. Nori, Vortex structure and dynamics in kagome and triangular pinning potentials
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- MCTP-01-14 M. Cvetič, G.W. Gibbons, H. Lu and C.N. Pope, New Complete Non-compact Spin(7) Manifolds
- MCTP-01-15 J.P. Krisch and E.N. Glass, Dimension in a Radiative Stellar Atmosphere
- MCTP-01-16 Daniel J. H. Chung, Patrick Crotty, Edward W. Kolb, Antonio Riotto, On the gravitational production of superheavy dark matter
- MCTP-01-17 Michael F. Bruist and Eric Myers, Discrete and Continuous Mathematical Models of DNA Branch Migration
- MCTP-01-18 M. J. Duff, James T. Liu and H. Sati, Quantum $M^2 \rightarrow 2\Lambda/3$ discontinuity for massive gravity with a [EQUATION] term
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- MCTP-01-21 M. Cvetič, H. Lu and C.N. Pope, Massless 3-branes in M-theory

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- MCTP-01-23 Cvetič, G.W. Gibbons, H. Lu and C.N. Pope, New Cohomogeneity One Metrics With Spin(7) Holonomy
- MCTP-01-24 heldon, E., McKay, T., *et al.*, Weak Lensing Measurements of 42 SDSS/RASS Galaxy Clusters
- MCTP-01-25 Cvetič, G.W. Gibbons, H. Lu and C.N. Pope, M3-branes on a New Class of G_2 Manifolds and Universality of Pseudo-supersymmetry
- MCTP-01-26 Jan Pieter van der Schaar, The Reduced Open Membrane Metric
- MCTP-01-27 M. J. Duff, The Michigan Center for Theoretical Physics Annual Report 2000–2001
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- MCTP-01-31 Katherine Freese and Paolo Gondolo, On the Direct Detection of Extragalactic WIMPs
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- MCTP-01-34 D.K. Park, Hungsoo Kim, Y.G. Miao, H.J. Muller-Kirsten, Randall-Sundrum Scenario at Nonzero Temperature
- MCTP-01-35 Edward Glass, A Conserved Bach Current
- MCTP-01-36 G.L. Kane, Lian-Tao Wang, James D. Wells, Supersymmetry and the position excess in cosmic rays
- MCTP-01-37 T. Abe, M. Peskin, O. Yakovlev, *et al.*, Linear Collider Physics Resource Book for Snowmass 2001
- MCTP-01-38 G.W. Gibbons, H. Lu, C.N. Pope and K.S. Stelle, Supersymmetric domain walls from metrics of special holonomy
- MCTP-01-39 M. Cvetič, G.W. Gibbons, H. Lu, and C.N. Pope, Cohomogeneity One Manifolds of Spin(7) and G_2 Holonomy
- MCTP-01-40 Yukio Tomozawa, Axisymmetric Galaxy Distribution and the Center of the Universe
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- MCTP-01-42 G.L. Kane and S.F. King, Supersymmetric Inflation, Matter, and Dark Energy
- MCTP-01-43 Baltz, Edsjo, Freese, and Gondolo, The Cosmic Ray Positron Excess and Neutralino Dark Matter
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- MCTP-01-45 M.J. Duff, L.B. Okun, and G. Veneziano, Trialogue on the number of fundamental constants
- MCTP-01-46 Roberto Vega and Jose Wudka, Static neutrino properties in the presence of a large magnetic field
- MCTP-01-47 Thomas Dent, Breaking CP and supersymmetry with orbifold moduli dynamics

- MCTP-01-48 James T. Liu and W.Y. Wen, Exact multi-membrane solutions in AdS_7
- MCTP-01-49 Thomas Dent, Baryogenesis with four-fermion operations in low-scale models
- MCTP-01-50 Thomas Dent, On the modular invariance of mass eigenstates and CP violation
- MCTP-01-52 D.K. Park, S. Tamaryan, H.J.W. Muller-Kirsten, D2-branes with magnetic flux in the presence of RR fields
- MCTP-01-54 D.K. Park, Hungsoo Kim, S. Tamaryan, Nonvanishing Cosmological Constant of Flat Universe in Brane-Worlds Scenario
- MCTP-01-55 M. Cvetič, G.W. Gibbons, H. Lu, and C.N. Pope, Orientifolds and Slumps in G_2 and Spin(7) Metrics
- MCTP-01-56 Daniel Chung and Katherine Freese, Lensed Density Perturbations in Braneworlds
- MCTP-01-58 S. Rigolin, L. Everett, G.L. Kane, Lian-Tao Wang, and Ting Wang, Alternative approach to $b \rightarrow s\gamma$ in the unconstrained MSSM
- MCTP-01-59 S. Rigolin, Update of Golden measurements at a Neutrino Factory
- MCTP-01-60 M. Duff, The world in eleven dimensions: a tribute to Oskar Klein
- MCTP-01-61 M. Cvetič, G.W. Gibbons, H. Lu, and C.N. Pope, M-theory conifolds
- MCTP-01-62 J.P. Krisch and E.N. Glass, Adding Twist to Anisotropic Fluids
- MCTP-01-63 G.W. Gibbons, H. Lu, and C.N. Pope, A G_2 Unification of the Deformed and Resolved Conifolds
- MCTP-01-64 Daniel Chung and Thomas Dent, Baryogenesis through higher dimensional operators and spacetime
- MCTP-01-65 Thomas Dent and Malcolm Fairbairn, Time-varying coupling strengths, nuclear forces and unification
- MCTP-02-01 M.J. Duff, M-theory on manifolds of G_2 holonomy: the first twenty years
- MCTP-02-02 Katherine Freese and Matt Lewis, Cardassian Expansion: A Model in which the Universe is Flat, Matter Dominated, and Accelerating
- MCTP-02-03 L. Everett, G. Kane, S. King, S. Rigolin, and L. Wang, Pati-Salam Models and Intersecting D Branes
- MCTP-02-04 Martin B. Einhorn, Instanton of Type IIB Supergravity in Ten Dimensions
- MCTP-02-05 H. Lu and J.F. Vazquez-Poritz, Resolution of overlapping branes
- MCTP-02-06 Ioannis Giannakis, James Liu, and Hai-cang Ren, Angular Momentum Mixing in Crystalline Color Superconductivity
- MCTP-02-07 G. Kane, L. Wang, and T. Wang, Supersymmetry and the Cosmic Ray Positron Excess
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- MCTP-05-05 Sergey Savel'ev, Ciro Cattuto, and Franco Nori, Force-free current-induced reentrant melting of the vortex lattice in superconductors
- MCTP-05-06 J. F. Wambaugh, F. Marchesoni, and Franco Nori, Shear and loading in channels: Oscillatory shearing and edge currents of superconducting vortices
- MCTP-05-07 B. Y. Zhu, F. Marchesoni, V. V. Moshchalkov, and Franco Nori,

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- MCTP-05-10 B. Y. Zhu, F. Marchesoni, and Franco Nori, Controlling the Motion of Magnetic Flux Quanta
- MCTP-05-11 Sergey Savel'ev, Fabio Marchesoni, Peter Hnggi, and Franco Nori, Transport via nonlinear signal mixing in ratchet devices
- MCTP-05-12 Sergey Savel'ev and Franco Nori, Magnetic and mechanical buckling: Modified Landau theory approach to study phase transitions in micromagnetic disks and compressed rods
- MCTP-05-13 Sergey Savel'ev, Fabio Marchesoni, and Franco Nori, Stochastic transport of interacting particles in periodically driven ratchets
- MCTP-05-14 Sergey Savel'ev, Xuedong Hu, Franco Nori, Quantum electromechanics: Qubits from buckling nanobars
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- MCTP-05-25 G. D'Anna, P. Mayor, A. Barrat, V. Loreto, Franco Nori, Observing Brownian motion in vibration-fluidized granular matter (also Nature's Cover Story)
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- MCTP-05-42 M. Battaglia, A. Datta, A. De Roeck, K. Kong, K. T. Matchev, Contrasting Supersymmetry and Universal Extra Dimensions at the CLIC Multi-TeV e^+e^- Collider
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