

**Center for Theoretical Underground Physics and Related Areas –  
CETUP\*2013 Summer Program**  
*June 24<sup>th</sup> – July 26<sup>th</sup>, 2013*  
*Lead/Deadwood, South Dakota*  
**&**  
**VII<sup>th</sup> International Conference on Interconnections  
between Particle Physics and Cosmology - PPC 2013**  
*July 8<sup>th</sup> – July 13<sup>th</sup>, 2013*  
*Deadwood, South Dakota*

**Final Technical Report**

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Program Manager: Alan Stone  
Award Period: June 15, 2013 to March 31, 2014

## **CETUP\*2013 & PPC2013 OVERVIEW**

In response to an increasing interest in experiments conducted at deep underground facilities around the world, in 2010 the theory community has proposed a new initiative - a Center for Theoretical Underground Physics and Related Areas (CETUP\*). The main goal of CETUP\* is to bring together people with different talents and skills to address the most exciting questions in particle and nuclear physics, astrophysics, geosciences, and geomicrobiology. Scientists invited to participate in the program do not only provide theoretical support to the underground science, they also examine underlying universal questions of the 21<sup>st</sup> century including: What is dark matter?, What are the masses of neutrinos?, How have neutrinos shaped the evolution of the universe?, How were the elements from iron to uranium made?, What is the origin and thermal history of the Earth?

The mission of the CETUP\* is to promote an organized research in physics, astrophysics, geoscience, geomicrobiology and other fields related to the underground science via individual and collaborative research in dynamic atmosphere of intense scientific interactions. Our main goal is to bring together scientists scattered around the world, promote the deep underground science and provide a stimulating environment for creative thinking and open communication between researchers of varying ages and nationalities.

CETUP\*2014 included 5 week long program (June 24 – July 26, 2013) covering various theoretical and experimental aspects of Dark Matter, Neutrino Physics and Astrophysics. Two week long session focused on Dark Matter (June 24-July 6) was followed by two week long program on Neutrino Physics and Astrophysics (July 15-26). The VII<sup>th</sup> International Conference on Interconnections between Particle Physics and Cosmology (PPC) was sandwiched between these sessions (July 8-13) covering the subjects of dark matter, neutrino physics, gravitational waves, collider physics and other from both theoretical and experimental aspects. PPC was initiated at Texas A&M University in 2007 and travelled to many places which include Geneva, Turin, Seoul (S. Korea) etc. during the last 5 years before coming back to USA.

The objectives of CETUP\* and PPC were to analyze the connection between dark matter and particle physics models, discuss the connections among dark matter, grand unification models and recent neutrino results and predictions for possible experiments, develop a theoretical understanding of the three-neutrino oscillation parameters, provide a stimulating venue for exchange of scientific ideas among experts in neutrino physics and unification, connect with venues for public education outreach to communicate the importance of dark matter, neutrino research, and support of investment in science education, support mission of the Snowmass meeting and allow for extensive discussions of the ideas crucial for the future of high energy physics.

The selected subjects represented the forefront of research topics in particle and nuclear physics, for example: recent precise measurements of all the neutrino mixing angles (that necessitate a theoretical roadmap for future experiments) or understanding of the nature of dark matter (that allows us to comprehend the composition of the cosmos better). All the covered topics are considered as a base for new physics beyond the Standard Model of particle physics.

Separate panel discussion hosted during PPC was design to support and stimulate the discussions at Snowmass meeting in Minnesota which took place shortly after. Seven eminent scientists representing

three frontiers (Howard Baer – Energy Frontier; David Burke – Cosmic Frontier; Nicolao Fornengo – Cosmic Frontier; Joanne Hewett – Intensity Frontier; Alex Himmel – Intensity Frontier; Teruki Kamon – Energy Frontier; Louis Strigari – Cosmic Frontier) were asked to respond the following questions prepared by the organizing committee:

1. What would be the most important discovery in your frontier in the next decade that would transform the field?
2. We have three frontiers: Cosmic, Intensity, and Energy. How do you see the interconnections among these frontiers for the progress of high energy physics? Is there a way for the three frontiers to come together to produce a unified vision of future research?
3. What are your thoughts on astrophysical uncertainties and their impacts in future discoveries?
4. What is the current status of the particle physics models for cosmology in the light of various particle physics and astrophysics uncertainties?
5. What are the major hurdles in the upcoming days of the LHC that will create potential problems for discovering new physics?
6. Are supersymmetry models still alive? If they are still alive what are your thoughts on discovering them at the LHC?
7. Why is observation of CP violation in neutrino oscillation so important? What are the other major goals in neutrino physics?
8. What is the impact of the results from lepton flavor violation experiments, e.g.,  $\mu \rightarrow e\gamma$ , g-2 of the muon, during these days of direct production of particles at the LHC?

The responses to the above questions led to an extended discussion with multiple questions from the audience, for example:

1. Is there any direct detection signal that would make you believe that dark matter has been seen? What would DAMA have to do to make you believe their signal?
2. Is there a possibility of another DAMA experiment? Who would be convinced to do this? Is there any way another DAMA would be funded?
3. Is it okay if the LHC does not observe SUSY?
4. Is SUSY fine-tuned as a solution to the dark matter problem?
5. What are the prospects for detecting the cosmic neutrino background?

## **CONFERENCE ORGANIZATION:**

### **Time and location:**

CETUP\* 2013 took place on June 24 – July 26, 2013 in Lead/Deadwood, SD. Two week long session focused on Dark Matter was followed by two week long program on Neutrino Physics and Astrophysics. There were 4-5 talks a day, with the afternoons left mostly free for discussions and collaborations. Although the program focused on theory, few experimental talks were also given. Dark matter, neutrino phenomenology and model-building as well as tests of grand unification were covered in the program. The CETUP\* attendees were provided by Deadwood-Lead Middle School with a spacious office space, access to the meeting rooms, break room, fax and copy machine, as well as high speed wireless internet connection.

The PPC conference was sandwiched between these sessions covering the subjects of dark matter, neutrino physics, collider physics from both theoretical and experimental aspects.

### **Speakers:**

CETUP\*'s scientific program involved hour-long talks on the current status of dark matter and neutrino theory and experiments. The talks were followed by questions and discussion sessions. The format of this program accommodated separate discussion sessions where the outstanding issues of the disciplines were explored. The selected speakers were very active senior and junior members of the community in order to make the discussions informative and productive. During the PPC conference experts from theory and experiment community gathered together to cover topics related to Collider Physics, Dark Matter, Extra solar planet searches, Genesis, Gravitation Wave, Inflation, Large Scale Structure and Galaxy Formation, Neutrinos, String Cosmology and many others. The list of the speakers for 2013 CETUP\* is available at <http://www.dsu.edu/research/cetup/2013.aspx> and for the PPC 2013 at <http://www.dsu.edu/research/ppc2013/participants.aspx> .

### **CETUP\* Organizing Committee:**

Rouzbeh Allahverdi – University of New Mexico, Albuquerque, NM  
Baha Balantekin – University of Wisconsin, Madison, WI  
Bhaskar Dutta – Texas A&M University, College Station, TX  
Teruki Kamon – Texas A&M University, College Station, TX  
Babu Kaladi – Oklahoma University, Stillwater, OK  
Jason Kumar – University of Hawaii, Honolulu, HI  
Pearl Sandick – University of Utah, Salt Lake City, UT  
Barbara Szczerbinska – Dakota State University, Madison, SD

### **PPC2013 Local Organizing Committee:**

Barbara Szczerbinska (DSU)  
Kaladi Babu (OSU)  
Rouzbeh Allahverdi (UNM)  
Bhaskar Dutta (TAMU)  
Teruki Kamon (TAMU & KNU)

### **PPC2013 International Program Advisory Committee:**

Adam Riess (Johns Hopkins)  
David Cline (UCLA)  
David Spergel (Princeton)  
Dmitri I. Kazakov (JINR, Dubna)  
Fabiola Gianotti (CERN)  
Frank Paige (BNL)  
George F. Smoot (UC Berkeley)  
Gordon Kane (Michigan)  
Graham Ross (Oxford)

Ian Hinchliffe (LBL)  
JoAnne Hewett (SLAC)  
Joe Incandela (UCSB)  
Johnathan Ellis (CERN)  
Melvyn Shochet (Chicago)  
Michael Peskin (SLAC)  
Mihoko Nojiri (KEK)  
Paris Sphicas (CERN & Athens U.)  
Paul Shapiro (UT Austin)  
Pran Nath (NEU)  
Pyuangwon Ko (KIAS)  
Robert Kirshner (Harvard)  
S.C.C. Ting (MIT)  
Sally Dawson (BNL)  
Salman Habib (LANL)  
Saul Perlmutter (LBNL)  
Steven Weinberg (UT Austin)  
Tomio Kobayashi (Tokyo)  
Wim de Boer (Karlsruhe)

## **SUPPORT FOR CETUP\*2013 and PPC2013**

Supporting organizations:

- Black Hills Vision
- Chamber of Commerce of Deadwood
- City of Deadwood
- Dakota Sciences
- Dakota State University
- Department of Energy
- John T. Vucurevich Foundation
- Lead-Deadwood School District
- Lodge of Deadwood
- National Science Foundation
- South Dakota Board of Regents
- South Dakota Governor's Office of Economic Development
- South Dakota Science and Technology Authority

The support provided by DOE was used to cover lodging for graduate students and postdocs: Bibhusha Shakya, Chris Kelso, Tina Lund, David Sanford, Kuver Sinha, Brooks Thomas, Sean Tulin, Yue Zhang.

## **CETUP\*2013 - EDUCATION AND OUTREACH**

Attendees of CETUP\* also participated in educational outreach programs conducted during the five week time period:

- On June 28<sup>th</sup> Dark Matter participants met with Davis Bahcall scholars, SURF interns and QuarkNet participants and discuss the latest on Dark Matter and Dark Energy as well as what it takes to be a scientist and different carrier paths for people interested in studying science
- Badlands Star Gazing program – July 5<sup>th</sup> - 12 scientists attending Dark Matter session participated in the program organized by ranchers at Badlands National Park – during two hour long session the scientists discussed the concept of dark matter, dark energy, neutrinos, origins of the Universe, Big Bang with ~60 general public participants
- July 11<sup>th</sup> – South Dakota Public Broadcasting conducted 30min interviews with Kaladi Babu, Bhaskar Dutta, Jason Kumar, Barbara Szczerbinska on cutting edge underground science researched during CETUP\* summer programs – the interviews were available to the general public on the SDPB website
- Neutrino Day – July 12 and 13<sup>th</sup> – scientists attending PPC participated in different activities and interacted with general public attending the event at Sanford Lab
- On July 18<sup>th</sup> Boris Kayser, theoretical scientists from Fermilab participating in Neutrino Physics and Astrophysics session meet with the Davis-Bahcall scholars, the QuarkNet program students and summer interns at Sanford Underground Research Facility and gave a talk on “A Neutrino Conversation”. This two hour long overview of neutrino knowledge ended with very rich Q&A session.
- On July 20<sup>th</sup> the participants of Neutrino Physics and Astrophysics session met with 32 Native American students participating in the summer program organized by the Indian University of North America at Crazy Horse Monument. The two hour long Q&A session during which scientists discussed the cutting edge subjects discussed during CETUP\*, what it takes to be a scientist, different STEM carrier paths, and was followed by informal lunch with more discussions between the students and physicists.

## **CETUP\*2013 & PPC2013 SUMMARY**

CETUP\*2013 – brought together 58 scientists from around the world, PPC 2013 brought 72 scientists – list of attendees is provided in Appendix A – representing 14 countries and 75 universities, laboratories, institutions.

57 scientific talks were given during CETUP\* covering the latest subjects in Neutrino Physics, Astrophysics and Dark Matter. 67 talks related to Collider Physics, Dark Matter, Extra solar planet searches, Genesis, Gravitation Wave, Inflation, Large Scale Structure and Galaxy Formation, Neutrinos, String Cosmology were given during PPC (mainly plenary sessions and half a day parallel session). Talks for CETUP\* and PPC are posted on <http://www.dsu.edu/research/cetup/2013.aspx> and <http://www.dsu.edu/research/ppc2013/agenda.aspx> respectively. The agenda for CETUP\*2013 and PPC2013 can be also find on the corresponding websites.

During CETUP\* 2013 21 preprints were published (during the period of June 26, 2013 – May 31, 2014). The list of authors and titles is included in Appendix A. More detailed information including an abstract is included on the CETUP\* website - <http://www.dsu.edu/research/cetup/preprints2013.aspx>.

The proceedings from CETUP\*2013 and PPC2013 are submitted for publication to American Institute of Physics. 59 contributed papers will be published in *AIP Conf. Proc.*, Vol. 1604, pp 1 – 459.

## APPENDIX A: CETUP\* 2013 – list of preprints submitted (June 26, 2013 – May 30, 2014)

1. Isospin-Violating Dark Matter Benchmarks for Snowmass 2013, Jason Kumar, Jonathan L. Feng, Danny Marfatia and David Sanford - CETUP2013-001
2. Phenomenology of Dirac Neutralino Dark Matter, Matthew R. Buckley, Dan Hooper and Jason Kumar - CETUP2013-002
3. Non-thermal Dark Matter in String Compactifications, Rouzbeh Allahverdi, Michele Cicoli, Bhaskar Dutta, Kuver Sinha - CETUP2013-003
4. Lowering the Threshold in the DAMA Dark Matter Search, Chris Kelso, Pearl Sandick and Christopher Savage - CETUP2013-004
5. Cosmic Variance of the Spectral Index from Mode Coupling, Joseph Bramante, Jason Kumar, Elliot Nelson and Sarah Shandera - CETUP2013-005
6. LHC Phenomenology of SO(10) models with Yukawa Unification, A. Anandakrishnan, B. Bryant, S. Raby and A. Wingerter - CETUP2013-006
7. Unified framework for matter and dark matter, Ernest Ma - CETUP2013-007
8. On sbottom resonances in Dark Matter scattering, Paolo Gondolo, Stefano Scopel - CETUP2013-008
9. Sparticle Spectroscopy from SO(10) GUT with a Unified Higgs Sector, M. Adeel Ajaib, Ilia Gogoladze and Qaisar Shafi - CETUP2013-009
10. On baryogenesis from dark matter annihilation, Nicolas Bernal, Stefano Colucci, Francois-Xavier Josse-Michaux, J. Racker, Lorenzo Ubaldi - CETUP2013-010
11. Dipole Moment Bounds on Dark Matter Annihilation, Keita Fukushima and Jason Kumar - CETUP2013-011
12. Constraining the  $Z^{\prime}$  Mass in 331 Models using Direct Dark Matter Detection, Stefano Profumo and Farinaldo S. Queiroz - CETUP2013-012
13. SU(5) x SU(5) Twinification And D2 Parity, Zurab Tavartkiladze - CETUP2013-013
14. A 331 WIMPY Dark Radiation Model, Chris Kelso, C. A. de S. Pires, Stefano Profumo, Farinaldo S. Queiroz and P. S. Rodrigues da Silva - CETUP2013-014
15. WIMPY Leptogenesis With Absorptive Final State Interactions, Jason Kumar and Patrick Stengel - CETUP2013-015
16. Higgs phenomenology in Type-I 2HDM with  $U(1)_H$  Higgs gauge symmetry, P. Ko, Yuji Omura and Chaehyun Yu - CETUP2013-016
17. Supernova Constraints on MeV Dark Sectors from  $e^+e^-$  Annihilations, Herbert Dreiner, Jean-Francois Fortin, Christoph Hanhart, and Lorenzo Ubaldi - CETUP2013-017
18. Direct Detection Portals for Self-interacting Dark Matter, Manoj Kaplinghat, Sean Tulin, and Hai-Bo Yu – CETUP2013-018
19. Towards the minimal renormalizable supersymmetric  $E_6$  model, Borut Bajc and Vasja Susic - CETUP2013-019
20. Matter-Neutrino Resonance Above Merging Compact Objects, A. Malkus, A. Friedland, G. C. McLaughlin – CETUP2013-020
21. The Incredible Bulk, Keita Fukushima, Chris Kelso, Jason Kumar, Pearl Sandick and Takahiro Yamamoto – CETUP2013-021
22. The Dark  $Z^{\prime}$  Portal: Direct, Indirect and Collider Searches, Alexandre Alves, Stefano Profumo, Farinaldo S. Queiroz – CETUP2013-022
23. The Muon Anomalous Magnetic Moment in the Reduced Minimal 3-3-1 Model, Chris Kelso, P.R.D. Pinheiro, Farinaldo S. Queiroz, William Shepherd – CETUP2013-023

24. New Physics Contributions to the Muon Anomalous Magnetic Moment: A Numerical Code,  
 Farinaldo S. Queiroz and William Shepherd – CETUP2013-024

25. The Poker Face of the Majoron Dark Matter Model: LUX to keV Line, Farinaldo S. Queiroz and  
 Kuver Sinha – CETUP2013 - 025

## APENDIX B: CETUP\* and PPC participants:

### CETUP\* - Dark Matter Session

Rouzbeh	Allahverdi	Assistant Professor	University of New Mexico
Yang	Bai	Assistant Professor	University of Wisconsin-Madison
Sheldon	Campbell	Postdoc	The Ohio State University
Keith	Dienes	Professor	NSF / University of Arizona / University of Maryland
Bhaskar	Dutta	Professor	Texas A&M University
Nicolao	Fornengo	Associate Professor	University of Torino and INFN
Steve	Gabriel	Other	Spearfish High School
Paolo	Gondolo	Associate Professor	University of Utah
Kyle	Grist	Graduate Student	Portland State University
Ahmed	Ismail	Graduate Student	SLAC National Accelerator Laboratory
Kara	Keeter	Assistant Professor	Black Hills State University
Chris	Kelso	Postdoc	University of Utah
Savvas	Koushiappas	Assistant Professor	Brown University
Jason	Kumar	Assistant Professor	University of Hawaii
Nicole	Larsen	Graduate Student	Yale University
Brianna	Mount	Postdoc	Black Hills State University
Wan-II	Park	Postdoc	Korea Institute for Advanced Study (KIAS)
Farinaldo	Queiroz	Postdoc	University of California, Santa Cruz
Pearl	Sandick	Assistant Professor	University of Utah
David	Sanford	Postdoc	California Institute of Technology
Greg	Serfling	Graduate Student	BHSU / SDSM&T
Bibhushan	Shakya	Graduate Student	Cornell University
Kuver	Sinha	Postdoc	Texas A&M University
Louis	Strigari	Postdoc	Stanford University/Indiana University
Barbara	Szczerbinska	Associate Professor	Dakota State University
Brooks	Thomas	Postdoc	University of Hawaii
Sean	Tulin	Postdoc	University of Michigan
Lorenzo	Ubaldi	Postdoc	University of Bonn

## CETUP\*- Neutrino Physics and Astrophysics Session

Kaladi	Babu	Professor	Oklahoma State University
Borut	Bajc	Professor	Jozef Stefan Institute
Baha	Balantekin	Professor	University of Wisconsin
Joseph	Carlson	Lab Researcher	Los Alamos National Laboratory
Myung-Ki	Cheoun	Associate Professor	Soongsil University
Cemsinan	Deliduman	Associate Professor	Mimar Sinan University
Yamac	Deliduman	Associate Professor	Mimar Sinan University
Huaiyu	Duan	Assistant Professor	University of New Mexico
Alexander	Friedland	Lab Researcher	Los Alamos National Laboratory
Carla	Frohlich	Assistant Professor	North Carolina State University
Steve	Gabriel	Other	Spearfish High School
Ilia	Gogoladze	Postdoc	University of Delaware
Paolo	Gondolo	Associate Professor	University of Utah
Taka	Kajino	Associate Professor	National Astronomical Observatory of Japan, University of Tokyo
Subhash	Kak	Professor	Oklahoma State University
Boris	Kayser	Lab Researcher	Fermilab
Kara	Keeter	Assistant Professor	Black Hills State University
Jim	Kneller	Assistant Professor	North Carolina State University
Pyungwon	Ko	Professor	Korea Institute for Advanced Study (KIAS)
Cecilia	Lunardini	Associate Professor	Arizona State University
Tina	Lund	Postdoc	North Carolina State University
Ernest	Ma	Professor	University of California, Riverside
Michal	Malinsky	Postdoc	IPNP, Charles University in Prague
Gail	McLaughlin	Professor	North Carolina State University
Brianna	Mount	Postdoc	Black Hills State University
Stuart	Raby	Professor	The Ohio State University
Greg	Serfling	Graduate Student	BHSU / SDSM&T
Rebecca	Surman	Professor	Union College
Barbara	Szczerbinska	Associate Professor	Dakota State University
Zurab	Tavartkiladze	Associate Professor	Ilia State University
Kerry	Whisnant	Professor	Iowa State University
Yue	Zhang	Postdoc	California Institute of Technology

## PPC2013

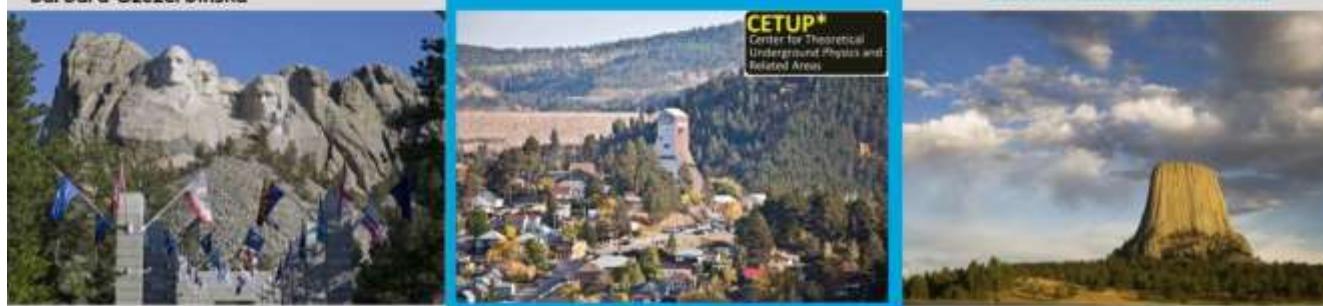
Rouzbeh	Allahverdi	Assistant Professor	University of New Mexico
Frank	Avignone	Professor	University of South Carolina
Kaladi	Babu	Professor	Oklahoma State University
Howard	Baer	Professor	University of Oklahoma
Xinhua	Bai	Assistant Professor	South Dakota School of Mines and Technology
Borut	Bajc	Professor	Jozef Stefan Institute
Bruce	Berger	Assistant Professor	Colorado State University
Marco	Bersanelli	Professor	University of Milano
Fedor	Bezrukov	Assistant Professor	University of Connecticut
Kurt	Brendlinger	Graduate Student	University of Pennsylvania
Andrew	Brown	Postdoc	Purdue University
Hugues	Brun	Postdoc	Oviedo University
David	Burke	Professor	Stanford/SLAC National Accelerator Laboratory
Sheldon	Campbell	Postdoc	The Ohio State University
Daniel	Cherdack	Postdoc	Colorado State University
John	Cummings	Assistant Professor	Siena College
Hooman	Davoudiasl	Lab Researcher	Brookhaven National Laboratory
Roland	de Putter	Postdoc	JPL/Caltech
Edward	Diehl	Lab Researcher	University of Michigan
Keith	Dienes	Professor	NSF / University of Arizona / University of Maryland
Bhaskar	Dutta	Professor	Texas A&M University
Will	Flanagan	Graduate Student	Texas A&M University
Raphael	Flauger	Postdoc	Institute for Advanced Study/NYU
Nicolao	Fornengo	Associate Professor	University of Torino and INFN
Raymond	Frey	Professor	University of Oregon
Karl	Gebhardt	Professor	University of Texas
Ilia	Gogoladze	Postdoc	University of Delaware
Paolo	Gondolo	Associate Professor	University of Utah
Jaret	Heise	Lab Researcher	Sanford Underground Research Facility
JoAnne	Hewett	Professor	SLAC National Accelerator Laboratory
Alexander	Himmel	Postdoc	Duke University
Peisi	Huang	Graduate Student	University of Wisconsin-Madison
Asher	Kaboth	Postdoc	Imperial College London
Teruki	Kamon	Professor	Texas A&M University / Kyungpook National University
Chris	Kelso	Postdoc	University of Utah
Pyungwon	Ko	Professor	Korea Institute for Advanced Study (KIAS)
Kyoungchul	Kong	Assistant Professor	University of Kansas
Savvas	Koushiappas	Assistant Professor	Brown University
Jason	Kumar	Assistant Professor	University of Hawaii
Shuichi	Kunori	Professor	Texas Tech University

Régis	Lefèvre	Professor	Université Blaise Pascal, Laboratoire de Physique Corpusculaire de Clermont
Jing	Liu	Postdoc	Kavli IPMU, University of Tokyo
Dinesh	Loomba	Associate Professor	University of New Mexico
Ernest	Ma	Professor	University of California, Riverside
Ryan	MacLellan	Postdoc	SLAC National Accelerator Laboratory
Salvatore	Mangano	Postdoc	IFIC-CSIC
Ryan	Martin	Assistant Professor	Lawrence Berkeley National Laboratory and University of South Dakota
Rabindra	Mohapatra	Professor	University of Maryland
Brianna	Mount	Postdoc	Black Hills State University
Curt	Nehrkorn	Graduate Student	University of California, Santa Barbara
John	Orrell	Lab Researcher	Pacific Northwest National Laboratory
Wan-II	Park	Postdoc	Korea Institute for Advanced Study (KIAS)
Jungsic	Park	Postdoc	Seoul National University
Marco	Peloso	Professor	University of Minnesota
Farinaldo	Queiroz	Postdoc	University of California, Santa Cruz
Bharat	Ratra	Professor	Kansas State University
Juergen	Reichenbacher	Lab Researcher	The University of Alabama
Tarek	Saab	Associate Professor	University of Florida
Oscar	Sabido	Professor	Universidad de Guanajuato
Pearl	Sandick	Assistant Professor	University of Utah
Kate	Scholberg	Professor	Duke University
Osamu	Seto	Professor	Hokkai-Gakuen University
Logan	Sibley	Graduate Student	University of Alberta
Jennifer	Siegel-Gaskins	Postdoc	California Institute of Technology
Kuver	Sinha	Postdoc	Texas A&M University
Ian	Stern	Graduate Student	University of Florida
Louis	Strigari	Postdoc	Stanford University/Indiana University
Barbara	Szczerbinska	Associate Professor	Dakota State University
Zurab	Tavartkiladze	Associate Professor	Ilia State University
Brooks	Thomas	Postdoc	University of Hawaii
Yue	Zhang	Postdoc	California Institute of Technology

## CETUP\* 2013 POSTER

# Center For Theoretical Underground Physics and Related Areas

## CETUP\*



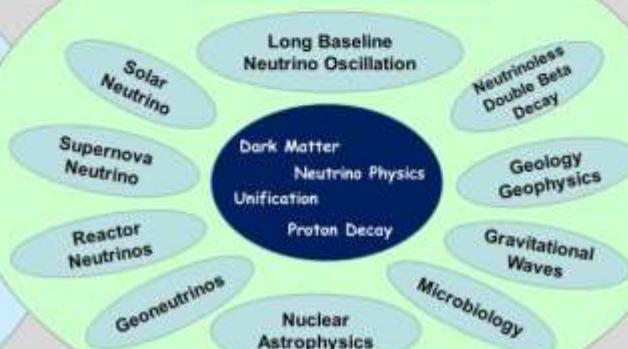
**CETUP\* Scientific Advisory Board:**  
Kaladi Babu  
Baha Balantekin  
Bhaskar Dutta  
Jaret Heise  
Rabi Mohapatra  
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Website: <http://www.dsu.edu/research/cetup>

### Mission Statement

The Center for Theoretical Underground Physics and Related Areas is intended to be the central collaboration point for long term, intermediate, and programmatic functions for physics and related fields that deal directly with the experimental work being conducted at the worlds 20 plus underground laboratories. Our goal is to bring together people with different talents and skills to address the most exciting questions in particle physics, nuclear physics, astrophysics and geosciences.

### CETUP\* Science Focus



### Past programs

#### CETUP\* 2011 Program

- 35 International physicists for 3 week program
- Initiated various research collaborations
- 5 Scientific Papers resulted from ability to collaborate at CETUP\* 2011

#### CETUP\* 2012 Program

- 60+ physicists for 3 week program
- International and national participants
- 20 Scientific Papers resulted from ability to collaborate at CETUP\* 2012
- Initiated various research collaborations
- AIP (American Institute of Physics) Proceedings (with ~40 scientific papers)

### CETUP\* 2013

- CETUP\* Dark Matter session – June 24 – July 5
- 7th International Workshop on Interconnections between Particle Physics and Cosmology – July 8-13
- CETUP\* Neutrino Physics session – July 15-26

### Over 100 participants expected

#### Friends & Supporters:

- Department of Energy
- National Science Foundation
- Black Hills Vision
- City of Deadwood
- Dakota State University
- Forward Sioux Falls
- John T. Vucurevich Foundation
- SD Gov.'s Office of Economic Development
- SD Board of Regents
- SD Science & Technology Authority