Neutrino Mass, Dark Matter,
Gravitational Waves,
Monopole Condensation,
and Light Cone Quantization

Neutrino Mass, Dark Matter, Gravitational Waves, Monopole Condensation, and Light Cone Quantization

Edited by

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PREFACE

The International Conference, Orbis Scientiae 1996, focused on the topics: The Neutrino Mass, Light Cone Quantization, Monopole Condensation, Dark Matter, and Gravitational Waves which we have adopted as the title of these proceedings. Was there any exciting news at the conference? Maybe, it depends on who answers the question. There was an almost unanimous agreement on the overall success of the conference as was evidenced by the fact that in the after-dinner remarks by one of us (BNK) the suggestion of organizing the conference on a biannual basis was presented but not accepted: the participants wanted the continuation of the tradition to convene annually. We shall, of course, comply.

The expected observation of gravitational waves will constitute the most exciting vindication of Einstein's general relativity. This subject is attracting the attention of the experimentalists and theorists alike. We hope that by the first decade of the third millennium or earlier, gravitational waves will be detected, opening the way for a search for gravitons somewhere in the universe, presumably through the observations in the CMBR. The theoretical basis of the graviton search will take us to quantum gravity and eventually to the modification of general relativity to include the Planck scale behavior of gravity - at energies of the order of 10^{19} GeV.

We were very pleased to welcome the 1995 Nobel Laureate Frederick Reines to the Orbis Scientiae 1996, who moderated the conference session on neutrino masses. Professor Reines has been an enthusiastic participant of the Coral Gables Conferences, and in 1980 was awarded the J. Robert Oppenheimer Memorial Prize. We preceded the Nobel Committee!

The Trustees and Chairman of the Global Foundation wish to extend special thanks to Edward Bacinich of Alpha Omega Research Foundation for his generous support of the 1996 Orbis Scientiae.

*Behram Kursunoglu
Stephan L. Mintz
Arnold Perlmutter*

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CONFERENCE PROGRAM

INTERNATIONAL CONFERENCE ON ORBIS SCIENTIAE 1996

(NEUTRINO MASS, DARK MATTER, GRAVITATIONAL WAVES,
CONDENSATION OF ATOMS AND MONOPOLES, LIGHT CONE QUANTIZATION....)

(24TH IN A SERIES OF CORAL GABLES CONFERENCES ON
ELEMENTARY PARTICLE PHYSICS AND COSMOLOGY SINCE 1964)

JANUARY 25-28, 1996

EDEN ROC RESORT AND SPA

PROGRAM

THURSDAY, January 25, 1996 (Cotillion Ballroom)

8:00 AM - Noon **REGISTRATION** at the entrance of the Cotillion Ballroom

1:30 PM **SESSION I: PROLOGUE**

Moderator: **BEHRAM N. KURSUNOGLU**, Global Foundation, Inc.,
Coral Gables

Dissertators: **BEHRAM N. KURSUNOGLU**
"Creation of Matter via Condensation at Absolute Zero and
Planck-Scale Temperatures"
C.W. KIM, Johns Hopkins University
"Scale Dependent Cosmology for an Inhomogeneous
Universe"
KAZUHIKO NISHIJIMA, Chuo University, Tokyo
"Unbroken Non-Abelian Gauge Symmetry and Confinement"

Annotators: **ALAN KRISCH**, University of Michigan
JOSEPH LANNUTTI, Florida State University
LARRY RATNER, University of Michigan

Session Organizer: **BEHRAM N. KURSUNOGLU**

3:30 PM **Coffee Break**

**3:45 PM SESSION II: INSPIRATIONS FROM COSMOLOGY AND
ELEMENTARY PARTICLE PHYSICS**

Moderators: **KATHERINE FREESE**, University of Michigan
ROBERT HERMAN, University of Texas

Dissertators: **KATHERINE FREESE**
"Inflationary Cosmology: From Theory to Observation and
Back "
HARRISON PROSPER, Florida State University
"Bayesian Analysis of Solar Neutrino Data"
EDWIN L. TURNER, Princeton University Observatory
"Do the Cosmological Parameters have Natural Values?"

Annotators: **ANDREW HECKLER**, Fermilab

Session Organizer: **KATHERINE FREESE**

5:00 PM SESSION III: PROGRESS ON SOME NEW AND OLD IDEAS - I

Moderator: **KAZUHIKO NISHIJIMA**, Chuo University, Tokyo
GEORGE SUDARSHAN, Center for Particle Physics,
University of Texas

Dissertators: **VERNON BARGER**, University of Wisconsin
"Fixed Points in Supersymmetry: R-Parity-Violating Yukawa
Couplings"
GERALD B. CLEAVER, Ohio State University, Columbus
"Grand Unified Theories from Superstrings"
VASKEN HAGOPIAN, Florida State University
"Capability of Future CMS Detector at the LHC Searching for
Dark Matter"
FREYDOON MANSOURI, University of Cincinnati
"Supersymmetric Wilson Loops and their Stringy Extensions"
KATSUMI TANAKA, Ohio State University, Columbus
"Comments on the Symmetry Breaking Terms in the Quark
Mass Matrix"
YUN WANG, Fermilab, Batavia, Illinois
"Statistics of Extreme Gravitational Lensing Events"

Annotators: **RICHARD ARNOWITT**, Texas A & M University

Session Organizer: Dissertators

7:30 PM Orbis Scientiae adjourns for the day

FRIDAY, January 26 1995 (Mona Lisa)

8:30 AM SESSION IV: GRAVITATIONAL WAVES

Moderator: **SYDNEY MESHKOV**, Cal. Tech.

Dissertators: **BARRY BARISH**, Cal. Tech.
"Status of LIGO"

SAMUEL FINN, Northwestern University
"Binary Inspiral, Gravitational Radiation, and Cosmology"
PETER FRITSCHER, M.I.T.
"Interferometry for Gravity Wave Detection"

Annotators: **RICHARD P. WOODARD**, University of Florida
EDWARD KOLB, Fermilab

Session Organizer: **SYDNEY MESHKOV**, CALTECH

10:15 AM Coffee Break

10:30 AM ROUND TABLE DISCUSSION of Gravitational Waves

Moderator: **BARRY BARISH**, Cal. Tech.

Round Table

Dissertators: **SAMUEL FINN, PETER FRITSCHER, PETER SAULSON**

Noon Lunch Break

1:30 PM SESSION V: NEUTRINO MASSES

Moderator: **FREDERICK REINES**, University of California, Irvine

Dissertators: **MAURY GOODMAN**, Argonne National Laboratory, Argonne
"Oscillation Searches Using Atmospheric Neutrinos and Long Baseline Neutrino Experiments"
C. W. KIM, Johns Hopkins Univ., Baltimore
"The Role of the Third Generation in the Analysis of Oscillation Experiments"
WILLIAM LOUIS, Los Alamos National Laboratory
"Ongoing Neutrino Oscillation Searches at Accelerators"
RABIADREA MOHAPATRA, Univ. of Maryland, College Park
"Neutrino Mass Textures and New Physics Implied by Present Neutrino Data"
NEVILLE REAY, Kansas State Univ., Manhattan
"Fermilab MUNI Project"
JOHN WILKERSON, Univ. of Washington, Seattle
"Solar Neutrino Measurements: Current Status and Future Experiments"
LINCOLN WOLFENSTEIN, Carnegie-Mellon Univ., Pittsburgh
"Theoretical Ideas About Neutrino Masses"

Annotators: **JEREMY MARGULIES**, Los Alamos National Laboratory
HARRISON PROSPER

Session Organizer: **STEPHAN MINTZ**, Florida International University

3:30 PM Coffee Break

**3:45 PM ROUND TABLE DISCUSSION of Neutrino Masses by the Above
Dissertators**

Moderator: WILLIAM LOUIS, Los Alamos National Laboratory

5:30 PM SESSION VI: STRINGS AND FIELD THEORY

Moderator: LOUISE DOLAN, University of North Carolina

Dissertators: LOUISE DOLAN, Department of Physics, University of
North Carolina
"BPS States and Type II Superstrings"
BRIAN GREENE, Department of Physics, Cornell University
"Changing the Topology of the Universe"
RENATA KALLOSH, Department of Physics, Stanford
University
"F and H Monopoles"
JEFFREY MANDULA, DOE, Washington D.C.

Annotators: GERALD B. CLEAVER, Ohio State University, Columbus

Session Organizer: LOUISE DOLAN

7:00 PM Orbis Scientiae adjourns for the day

SATURDAY, January 27, 1996 (Mona Lisa)

8:30 AM SESSION VII: DIRAC'S LEGACY: LIGHT- CONE QUANTIZATION

Moderator: STANLEY BRODSKY, SLAC

Dissertators: STEPHEN PINSKY, Ohio State Univ., Columbus
"Introduction: Dirac's Legacy"

STAN BRODSKY, SLAC
"Applications of Light-Cone Quantization"
HANS-CHRISTIAN PAULI, Max Plank Institute,
Heidelberg
"Discrete Light-Cone Quantization"

10:00 AM Coffee Break

10:15 AM Dissertator Presentations continue

Dissertators: ALEX KALLONIATIS, University of Erlangen-Nurnberg,
Erlangen
"2-D Non-Perturbative Light-Cone Results"
DAVE ROBERTSON, Ohio State University
"The Light-Cone Gauge and Zero Modes"
BRETT VAN DE SANDE, Max-Planck Institute, Heidelberg
"Tube Model Solutions of QCD"

Annotators: ZACHARY GURALNIK, Princeton University

Session Organizer: STEPHEN PINSKY

12:00 PM Lunch Break

1:00 PM SESSION VIII: THE MATTER OF DARK MATTER

Moderator: EDWARD KOLB, FNAL, Chicago

Dissertators: RICHARD ARNOWITT, Texas A&M University
"SUSY Dark Matter with Non-Universal Soft Breaking Masses"
SHARON HAGOPIAN, Florida State University
"Search for SUSY in the DO Collider Experiment"
ANDREW HECKLER, Fermilab
"On the Formation of a Hawking-Radiation Photosphere: The Cloak Around Microscopic Black Holes"
EDWARD KOLB, Fermilab
"Light Photinos as Dark Matter"
IGOR TKACHEV, Ohio State Univ.
"Primordial Axions Appearing as Dark Matter and Other Astrophysical Objects"

Annotators: VASKEN HAGOPIAN

Session Organizer: EDWARD KOLB

3:30 PM Coffee Break

3:45 PM SESSION IX: PROGRESS ON SOME NEW AND OLD IDEAS II

Moderators: FRED ZACHARIASEN, CALTECH

Dissertators: PRAN NATH, Institute for Theoretical Physics, Santa Barbara, CA
"Superunification and Planck Scale Interactions"
MARK SAMUEL, Oklahoma State University
"Going to Higher Order - The Hard Way and the Easy Way: The Agony and the Ecstasy"
INA SARCEVIC, University of Arizona
"Domain Structure of a Disoriented Chiral Condensate from a Wavelet Perspective"
RICHARD P. WOODARD, University of Florida
"Quantum Gravity Slows Inflation"

Annotators: GERALD GURALNIK, Brown University

Session Organizer: SESSION DISSERTATORS

6:00 PM Orbis Scientiae adjourns for the day

7:30 PM Conference Banquet - MONA LISA ROOM

SUNDAY, January 28, 1996 (Key Biscayne Room)

8:30 AM SESSION X: PROGRESS ON SOME NEW AND OLD IDEAS - III

Moderator: DON B. LICHTENBERG, Indiana University

Dissertators: **DON B. LICHTENBERG**, Indiana University
 "Superflavor Symmetry and Relations Between Meson and Baryon Masses"
PAUL H. FRAMPTON, University of North Carolina at Chapel Hill
 "Constraining $\alpha(M_\alpha)$ From the Hidden Sector"
LUCA MEZINCESCU & RAFAEL NEPOMECHIE, University of Miami
 "Integrable Systems with Boundaries"
GREGORY TARLE, University of Michigan
 "Cosmic Ray Signatures for Neutralinos: New Measurements and their Implications"

Annotators: **G. BHAMATHI**, University of Texas at Austin

Session Organizer: **DISSERTATORS**

10:15 AM Coffee Break

10:30 AM SESSION XI: EXACTLY SOLVABLE QUANTUM MODELS

Moderator: **ANDRÉ LeCLAIR**, Newman Laboratory, Ithaca, New York

Dissertators: **PAUL FENDLEY**, University of Southern California, Los Angeles
 "Two-Dimensional Field Theory Meets Experiment"
SERGEI LUKYANOV, Newman Laboratory, Cornell University
 "Yang-Baxter Equation and Baxter's Q-Operators in CFT"
GIUSEPPE MUSSARDO, Scuola Internazionale Superiore di Studi Avanzati, Trieste, Italy
 "Form Factor Approach to Integrable Quantum Field Theory: The spin-spin correlation function of 2-d Ising Model in a magnetic field"
LUC VINET, Laboratoire de Physique Nucléaire et Centre de Recherches Mathématiques, Montréal, Canada
 "Exact Operator Solution of the COLOGERO SUTHERLAND Model"

Annotators: **ZACHARY GURALNIK**, Princeton University

Session Organizer: **ANDRÉ LeCLAIR**, Newman Laboratory, Ithaca, New York

12:30 AM Lunch Break

1:30 PM SESSION XII: EPILOGUE

Moderator: **GEOFFREY WEST**, Los Alamos National Laboratory

Dissertators: **ALAN CHODOS**, Yale University
 "Sonoluminescence and the Heimlich Effect"
ZACHARY GURALNIK, Princeton University
 "Critical Phenomena and the Boundary Conditions for Schwinger-Dyson Equations"
GERALD GURALNIK, Brown University

"Using Symmetry to Numerically Solve Quantum Field Theory"

GEOFFREY WEST

"Glueballs, the Essence of Non-Perturbative QCD"

DONALD WEINGARTEN, IBM, New York

"Evidence for the Observation of a Glueball"

Annotators: SESSION MODERATORS

Session Organizer: GEOFFREY WEST

3:30 PM THE 1996 ORBIS SCIENTIAE ADJOURNS

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COLD VERSUS HOT CONDENSATION TO CREATE MATTER

The process of *condensation* of the monopoles carrying magnetic charges g_n with n ranging from zero to infinity, to create an *orbiton* was first obtained twenty years ago in my paper in Physical Review D Vol. 13, Number 6, 15 March 1976, (see especially the pages 1539 and 1551). In contrast to the Bose-Einstein condensation of a dense gas of atoms near absolute zero temperature in the recent experiments (July 1995) by Eric A. Cornell and his colleague Carl Wieman to create a condensate as a “large atom”, condensation of the magnetic charges at the dawn of the universe was taking place in an inferno at Planck-scale temperatures ($\sim 10^{30}$ degrees Kelvin) to create an *orbiton* (a quark with structure). In both instances of the resulting condensates the distribution of atoms and monopoles, respectively, range from packed to sparse. The color picture above for *orbiton* represents a layered structure of magnetic charges with alternating signs and decreasing magnitudes. The painting was commissioned in 1980 to Ms. Sheila Rose of Miami. It appeared in black and white on page 1539 of the referred Physical Review paper. The confined magnetic charges, resulting from the condensation prior to the Big-Bang creation of the universe, do also confine the electric charges. For more scientific discussions, see my paper “After Einstein and Schrödinger: A New Unified Field Theory,” Journal of Physics Essays, Vol. 4, No. 4, pp 439-518, 1991 and the references there in pages 517 and 518. See also the 1994, 1995 and 1996 proceedings of the Coral Gables Conferences sponsored by the Global Foundation and published by Plenum Publishing Company, New York.

The similarities of the Bose-Einstein condensation of a dense gas of atoms at a temperature of absolute zero and that of magnetic charges at Planck-scale temperatures are most striking. Do recent experiments pertaining to Bose-Einstein cold condensation also vindicate the hot condensation pertaining to magnetic charges to create matter?

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