

**Advisory Committee Session
Crete, 17-20 November 2009**

*Crete Center for Theoretical
Physics*

Plan

- The European Capacities Project
- The Physics Department
- The center and its Personnel
- The Physics

The European Capacities Project

- The REGPOT program of the European Capacities framework aims at giving a once-a-time support to high quality research teams of the "periphery" of Europe, in order to help them compete and become comparable top good teams of the most advanced areas in Europe.
- The proposal CreteHEPCosmo for "Crete Center for Theoretical Physics" was evaluated in the 2008 round of proposals, and finished first among all proposals (about 300 in all sciences) with a perfect score (15/15).
- It involves 1,120 kEuros over period of 3 years. It officially started in 1/4/2009.
- It involves 5 Work-packages with a different focus each.

- Hiring of a 3-year senior research fellow. Position offered to Marika Taylor that eventually declined. Offered to **Vasilis Niarchos (Ecole Polytechnique)** that accepted and will start in June 2010.
- Hiring of several postdoctoral research fellows (9 man/years). Positions advertised in 2008. Hired :**Rene Meyer (PhD Munich), Matthew Lippert (PhD Santa Barbara) and Hong Bao Zhang, (PhD Beijing University)**
- Developing a small scale computational facility (15 processors have been bought and are currently installed).
- Developing the local infrastructure for hosting extra researchers.

Work-package 2: Personnel exchanges and twinning

- The purpose of this work package is to establish research connections and to support exchanges between the Center and several high quality European institutions. In particular this includes
 - Outgoing visits by the Center members to these institutions
 - Incoming visits of researchers of such institutions (or others if there is an incentive)
 - The development of more formalized relations with such institutions if appropriate, at the level of closer collaboration in research exchanges, organization of events and eventually education, via MoUs.

1. **Laboratoire de Physique Théorique de l'Ecole Normale Supérieure, Paris**
C. Bachas, C. Kounnas, V. Kazakov, K. Zarembo, B. Pioline
2. **Theory Group, Università de Roma II, Tor Vergata**
M. Bianchi, F. Fucito, T. Vladikas, E. Pradisi
3. **Arnold Sommerfeld Institute, Max Planck Institute, Munich**
D. Lust, S. Mukhanov, R. Blumenhagen, J. Erdmenger, S. Stieberger, M. Haack
4. **Physics Division, CERN, Geneva**
I. Antoniadis, L. Alvarez Gaume, G. Dvali, C. Grosjean, A. Uranga, J. Wells, U. Wiedemann
5. **Institute for Theoretical Physics, University of Amsterdam.**
E. Verlinde, J. de Boer, K. Skenderis, J. P. Van der Schaar, K. Schalm, M. Taylor
6. **Department of Applied mathematics and Theoretical Physics, University of Cambridge.**
F. Quevedo, A. Davis, N. Dorey, M. Green, G. Gibbons, P. Shellard, P. Townsend, D. Tong
7. **Theory group, Imperial College, London.**
K. Stelle, A. Hannany, C. Hull, J. Gauntlett, A. Tseytlin, D. Waldram
8. **Center of Excellence, Hebrew-Weizmann-Tel Aviv.**
E. Rabinovici, A. Giveon, J. Sonnenschein, Y. Oz, N. Itzhaki, O. Aharony, M. Berkooz, A. Schwimmer, B. Kol
9. **Laboratoire d'Astroparticule et Cosmologie (APC), Paris.**
S. Katsanevas, P. Binetruy, C. Deffayet, T. Hertog, D. Langlois, J. Mourad, F. Nitti, D. Steer.

Work-package 3: Organization of meetings

- This is an important part of the project that aims at the organization of conferences and workshops locally. The purpose is to bring in expertise, and make the Center known to outside researchers.
- Two workshops and a conference are planned
- [A Workshop on the Frontiers of Cosmology](#) (Heraklion, 28 March-5 April 2010)

30 researchers, participation by invitation, 1-2 overview talks per day, with extended discussion time.

- [A Conference on Gauge theories and the structure of spacetime](#) (Kolymbari, 10-17 September 2010)

10 Keynote speakers, several shorter talks, researchers, expect 100-200 participants.

- [A workshop in 2011](#) (Heraklion, date to be decided)

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- The role is to advise us on science and science policy and to evaluate the evolution of the project.

Members are highly distinguished physicists.

- **Curtis G. Callan Jr** is since 1995 James S. McDonnell Distinguished University Professor of Physics at Princeton University, and Director of the Princeton Center for Theoretical Physics (2005-2008). He is currently chairman of the Physics Department. He is the recipient of the Sakurai prize for physics (2000) and the 2004 Dirac Medal.
- **John Iliopoulos** is directeur de Recherche au CNRS, (classe exceptionnelle) at the Laboratoire de Physique Théorique, Ecole Normale Supérieure and a member of the French Académie des Sciences. He is the recipient of the Sakurai prize in Physics (1987) and the Dirac Medal (2007).
- **Gabriele Veneziano**, is a senior staff member at the CERN theory group and holds the chair of particle physics and cosmology at the College de France since 2002. He is the recipient of the I. Ya. Pomeranchuk prize (1999), the Enrico Fermi Prize (2005) and the Danny Heinemann prize (2004).

Finally there is an additional work-package devoted to the management of the project.

The Physics Department

- The Physics Department of the University of Crete was founded in 1978.
- It has 33 faculty members, 5 emeriti, 25 postdoctoral research fellows, 12 technical and administrative personnel, and on the average 40 Master's students and 24 PhD students.
- It has close ties and collaboration with the nearby Foundation for Research and Technology Hellas (FO.R.T.H) (A European Laser Facility).
- The Physics Department is the top of its kind in Greece. It was the first in Greece (1984) to have organized graduate studies (all other universities followed suit in the late nineties following pressure from the EU), a curriculum on a par with modern standards, and to cultivate high-quality experimental research (subject from difficult to impossible in countries like Greece).
- the research areas that are represented involve
 - ♠ High Energy Physics and Cosmology (theoretical)
 - ♠ Astrophysics (theoretical and observational)
 - ♠ Condensed matter physics (Theoretical and experimental)
 - ♠ Applied physics and material science (Mostly experimental)
 - ♠ Atomic physics and Lasers (theoretical and experimental)
 - ♠ Others (atmospheric physics, plasma physics, accelerator physics etc)

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The Crete Center for Theoretical Physics

- It is a structure emerging from a recent European Grant which we are trying to consolidate
- The underlying unit is the section of the Department associated to high energy physics (initial and official name : "particle and nuclear physics")
- Faculty in order of arrival date:

George Grammatikakis (PhD Imperial, 1973) Emeritus, Experimental high Energy physics

Petros Ditsas (PhD Manchester 1976), theory, phenomenology of particle interactions.

Nikos Papanicolaou (PhD NYU, 1975) currently working on spin models, high T_c superconductivity, topological defects in condensed matter etc.

Theodore Tomaras (PhD Harvard, 1980), currently working on gravity and cosmology

Gregory Athanasiou (PhD Stanford, 1987), working on neural networks.

Elias Kiritsis (PhD Caltech, 1988) currently working on string phenomenology, AdS/CFT and cosmology.

Nikolas Tsamis (PhD Harvard, 1983) currently working on quantum effects in gravity and inflation.

Anastasios Petkou (PhD Cambridge, 1994), currently working on the AdS/CFT correspondence.

- Affiliated members (frequent visitors/collaborators, other disciplines)

Richard Woodard (U of Florida)

Nicolas Toumbas (U of Cyprus)

Andrei Mironov (ITEP, Moscow)

Alexei Morozov (ITEP, Moscow)

Petros Rakintzis (Atomic Physics, Physics Department, Crete)

Christos Panagopoulos (Condensed matter, Physics Department, Crete)

Costas Skenderis (Amsterdam)

Marika Taylor (Amsterdam)

- Researchers and Postdoctoral fellows

Andreas Gustaffson (PhD Chalmers, 2005) Marie Curie Fellow, will start January 2010.

Bom Soo Kim (PhD Berkeley, 2009)

Georgios Kofinas (PhD Athens,)

Matthew Lippert (PhD UC Santa Barbara, 2006)

Rene Meyer (PhD Munich, 2009)

Vassilis Niarchos (PhD U. of Chicago, 2004) will start June 2010.

Daisuke Yamada (PhD University of Washington, Seattle, 2006) Marie Curie Fellow.

Hong Bao Zhang (PhD Beijing University, 2009)

Overview of the Physics

- **Research Direction 1:** AdS/CFT correspondence and “applications”
 - ♠ Studies for confirming and extending the correspondence
 - ♠ Applications to QCD and heavy-ion collisions
 - ♠ Applications to cosmology.
 - ♠ Applications to other interesting strongly coupled systems (N=1 sQCD, technicolor, supersymmetry breaking via gauge mediation)
 - ♠ Potential applications to condensed matter (quantum critical points, high- T_c superconductivity, disordered systems)

- The study of higher spin theories in the holographic context, and their implications for weakly coupled gauge theories. (T. Petkou and collaborators)
- The study of 3D CFTs using holographic techniques.
Study of the reduction of degrees of freedom at large 't Hooft coupling
Gravitational electric-magnetic duality and implications. (T. Petkou and collaborators)
- The study of double-trace perturbations in holography and their RG flows.
Related applications to the study of massive gravity theories and its potential instabilities.
Other applications to quenched disordered systems (via the replica method). (E. Kiritsis and V. Niarchos)
- Development of phenomenological holographic models for YM at zero and finite Temperature using Einstein-dilaton gravity.
Applications to the calculation of transport coefficients at finite temperature to explain heavy-ion experimental data. (E. Kiritsis and collaborators)
- Inclusion of flavor (above) in the “quenched” approximation (probe flavor branes).
Calculation of meson spectra and observables.
Corrections to transport coefficients at finite temperature.
Physics at finite baryon density (both $T = 0$ and $T > 0$), potential applications to neutron stars and the early universe. (E. Kiritsis, and collaborators, M. Lippert)

- Holographic study of unquenched flavor (Veneziano limit). Applications to QCD at finite N_f/N_c , and technicolor. Study of exotic phases at finite density (color superconductivity, CFL phases). (E. Kiritsis and collaborators, R. Meyer)
- To do:the (holographic) analysis of strongly-coupled theories that may be relevant for TeV scale physics or supersymmetry breaking.
- Search for 2+1 holographic theories with linear resistivity.
Search for 2+1 holographic theories with d-wave superconductivity.(E. Kiritsis, C. Panagopoulos, B. S. Kim and others)

- **Research Direction 2: BSM physics and String Theory**

- Large scale study of string vacua (using RCFT techniques) and search for SM-like spectra. (E. Kiritsis and collaborators)
- Study of charge patterns in orientifolds that allow for a generation of the hierarchy of masses via the interplay of perturbative couplings, non-perturbative effects (D-instantons) and vevs. (E. Kiritsis and collaborators)
- The low energy phenomenology of anomalous U(1) gauge bosons, as a window to high scale physics. (E. Kiritsis and collaborators)

● Research Direction 3: Gravity and Cosmology

- Study of the cosmology and the impact of phase transitions for strongly coupled cosmological fluids. (E. Kiritsis and collaborators)
 - Study of cosmological perturbations in strongly coupled fluids. (E. Kiritsis and collaborators)
 - Partly diffeomorphic theories of gravity (aka Hořava-Lifshitz gravity theories)
New idea to produce power counting renormalizable theories of gravity
- Plus:** Potential renormalizability (if dimensionless couplings are asymptotically free)
No inflation needed in the early period (no horizon problem, very mild flatness problem, generic scale invariant perturbations.)
- Minus:** Seems to have generic strong coupling regions
RG flow must be appropriate to get GR in the IR.
- Study of the early cosmology of HL gravities (E. Kiritsis and G. Kofinas)
 - Study of BH solutions in several HL theories. Study of the horizon and singularity properties of such solutions, as well as the consistency of the associated “gravitational thermodynamics”. (E. Kiritsis, G. Kofinas, H. B. Zhang)

Further Physics

- Theodore Tomaras
- Nikolas Tsamis
- Petros Rakintzis
- Georgios Kofinas
- Matthew Lippert
- Daisuke Yamada
- Rene Meyer
- Hong Bao Zhang

The Future?

- Stability of the structure in the long-term
- Funding sources (Greek State, Private foundations)
- Faculty evolution (One position will soon open, another in 2-3 years)
- Subject of research evolution.

THANK YOU

Cosmology Workshop

Crete Workshop on the Frontiers of Cosmology

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Crete Center of Theoretical Physics
Heraklion
28 March-5 April

(28 March is arrival day, 5 April is departure day)



International Organizing Committee	Local Organizing Committee
<ul style="list-style-type: none">■ P. Binetruy (APC, Paris)■ B. Craps (VUB, Brussels)■ G. Dvali (CERN)■ G. Gibbons (Cambridge)■ C. Kounnas (Paris)■ S. Mukhanov (LMU, Munich)	<ul style="list-style-type: none">● E. Kiritsis (U. of Crete)● G. Kofinas (U. of Crete)● T. Petkou (U. of Crete)● T. Tomaras (U. of Crete)● N. Tsamis (U. of Crete) (chair)

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Crete Conference On Gauge Theories And The Structure Of Spacetime



Crete Center for Theoretical Physics
Heraklion

10-17 September 2010

(10 is arrival day, 17 is departure day)



International Organizing Committee	Local Organizing Committee
<ul style="list-style-type: none"> • L. Alvarez-Gaume (CERN) • I. Antoniadis (CERN) • C. Bachas (Paris) • M. Bianchi (Roma) • D. Lust (Munich) • F. Quevedo (Cambridge) • E. Rabinovici (Jerusalem) • K. Skenderis (Amsterdam) • K. Stelle (Imperial) 	<ul style="list-style-type: none"> • E. Kiritsis (U. of Crete) • G. Kofinas (U. of Crete) • T. Petkou (U. of Crete) • T. Tomaras (U. of Crete) (chair) • N. Tzamis (U. of Crete)

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Detailed plan of the presentation

- Title page 1 minutes
- Plan 2 minutes
- The European Capacities Project 3 minutes
- Work-package 1:Strengthening the Research Potentia 5 minutes
- Work-package 2:Personnel exchanges and twining 7 minutes
- Work-package 3:Organization of meetings 10 minutes
- Work-package 4:EXternal Advisory/Evaluation Committee 13 minutes
- The Physics Department 16 minutes
- The Crete Center for Theoretical Physics 17 minutes
- Overview of the Physics 19 minutes
- Further Physics 20 minutes