IRGAC 2006

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PREFACE

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This special issue contains the proceedings of the 2nd International Conference on Quantum Theories and Renormalization Group in Gravity and Cosmology (IRGAC 2006), which was held in Cosmocaixa, Barcelona, on 11–15 July 2006 (`http://ns.ecm.ub.es/IRGAC2006/index.htm`).

A few words to clarify the framework and main purposes of this conference are in order. In the course of the last decade we have witnessed a progressively increasing interaction between high energy physics/particle physics and cosmology/astrophysics. Cosmology, in particular, is rapidly becoming an experimental branch of precision physics. It is no longer a realm of theoretical (sometimes philosophical) speculation; theoretical models can be tested, and new and more accurate data in the near future will restrict our conceptions of the Universe to within a few per cent accuracy. Particle physics, on the other hand, is not only the science of highest experimental accuracy, but also the natural theoretical arena where one can try to get a fundamental understanding of the basic laws of Nature, from the lowest to the highest scales available. There is no doubt that the present observational data (obtained from different and independent experimental sources, ranging from measurements of distant high redshift supernovae to the universal microscopic anisotropies of the cosmic microwave background) confirm the process of accelerated expansion of the Universe. This fundamental fact, which is nowadays amply recognized and endorsed by the international scientific community, has revitalized and boosted more than ever the relationship between the fields of high energy physics and cosmology. It is generally accepted that the physical cause of the accelerated expansion of the Universe is the existence of a (positive) cosmological constant, or in general of a 'dark energy' fluid which pervades uniformly all corners of the known part of the Universe, and mimics a positive cosmological term in Einstein's equations. We also know, from experimental observations, that it constitutes roughly 70% of the critical density. But we really don't know what it is yet; we need some microphysical input on the ultimate nature of this substratum. What is the explanation for that bulk 70% of the cosmological energy budget? Is it really the ground state energy associated with the quantum field theory vacuum? Is it, instead, the current value of the energy density of some slowly evolving homogeneous and isotropic scalar field (the so-called *quintessence*)? Perhaps a hint of a modified gravitational theory? Or just the most likely vacuum state of the string theoretical 'landscape', consisting of some 10^{1000} metastable (non-supersymmetric) vacua? Whatever it may be, it is currently the cause of one of the most troublesome headaches of modern cosmology, if not of the whole of theoretical physics: the so-called 'cosmological constant problem'—the deepest mystery of fundamental physics ever!

IRGAC is a series of international conferences intended to enhance the interdisciplinary collaboration among scientists working in precisely the above research fields. The ultimate aim is to combine their efforts to address, in the most efficient way, basic problems in cosmology which at the same time appear as fundamental problems of physics, such as the aforementioned cosmological constant problem, the nature of the dark energy, and the dark matter problem in the Universe. A central topic in this series of conferences is to establish what are the current state of the art and outlook for the quantum theories of gravitation and cosmology, in particular the role played by the latest theoretical developments in theoretical high energy

physics, both in quantum field theory and string theory (including the general methods of the renormalization group, common to both) in our search for a satisfactory explanation of those fundamental problems. Equally important is to confront the theoretical status with the current experimental situation, i.e. to keep an eye on the future experiments that are planned to gather observational data on the cosmological parameters with unprecedented accuracy. Undoubtedly, some balanced phenomenology ingredient in a field like this is not only highly desirable, but actually indispensable to enable researchers to assess by themselves during the conference the real impact of the theoretical ideas versus experiments and observations, and vice versa.

IRGAC 2006 in Barcelona was a follow-up to the first conference held in Ouro Preto, Brazil, in 2003 (under the slightly different acronym of IRGA 2003) [1]. The present, and more complete, name for this series (note the ending 'C') intends to stress the cosmology component of the meeting, and it is intended to stay in future editions. In this respect it is worth emphasizing that 2006 represented the 25th anniversary of the formulation of the inflationary paradigm, which nowadays appears as a theoretical conception perfectly compatible with, if not the most likely explanation for, the spatial flatness of our Universe as measured by the CMB data. This 25th anniversary was obviously a unique opportunity to accentuate and enhance the cosmology background of IRGAC 2006: see the full scientific program at `http://ns.ecm.ub.es/IRGAC2006/Program.htm`.

As the chairman organizer of the conference, I was particularly interested to count, on this very special occasion, on the participation of the three outstanding cosmologists who first proposed the idea of inflation: Alan Guth, Andrei Linde and Alexei Starobinsky. I am very grateful to the three of them for being so positive in accepting my invitation to participate. I am especially grateful to Alan Guth for his early interest in our conference, expressed some two years before it took place. Needless to say, I am pleased to extend these thanks to the rest of the speakers and participants, without whom this conference would not have attained the high degree of scientific performance and successful level of participation that it finally achieved (namely 140 registered participants from 25 different countries). As chairman, I was proud of these achievements, especially if we take into account that IRGAC 2006 was just the second edition of the series. Certainly this constitutes a great motivation and provides a strong boost to encourage future editions. I would like to take this opportunity to thank the many participants who, either through email or personally during the conference, expressed their satisfaction with the logistics, smoothness and scientific success of the conference. At the same time, my sincere apologies for any shortcomings that the participants might have experienced.

There were many talks at IRGAC 2006: to be precise 97; of these 34 were plenary and 63 parallel. Clearly, the level of participation was high. Three conference rooms were ordered in Cosmocaixa for simultaneous parallel talks. We are especially proud to have arranged for a substantial number of these parallel talks to be given by students and young researchers from different countries. At the same time we could offer to many of them (although, regretfully, not to all of them) some financial support. We also set out a substantially reduced fee for all students who participated in the conference.

I wish to thank all the members of the International Advisory Committee of IRGAC 2006 for honouring us with their help and support: I Antoniadis (CERN), M Asorey (Zaragoza), L Bergstrom (Stockholm), S Deser (Brandeis), E Fernández (IFAE), D Z Freedman (MIT), A Guth (MIT), J Isern (CSIC), R Jackiw (MIT), V F Mukhanov (Munich), R D Peccei (UCLA), A Schwimmer (Weizmann Institute), I L Shapiro (UFJF), J Silk (Oxford), A Starobinsky (Landau Institute), R Tarrach (UB), P K Townsend (Cambridge), A Vilenkin (Tufts), S Weinberg (Austin) and C Wetterich (Heidelberg). Particular thanks go to Manuel Asorey

and Ilya Shapiro (the previous organizers) for their advice. I am especially obliged to Ilya Shapiro for his encouragement to organize the conference in Barcelona and for his continuous support. To organize an event like this is not a completely trivial task. I counted on the collaboration of the other members of the Local Organizing Committee, to whom I am also very grateful: J Garriga, E Gaztañaga, J Gomis, J A Grifols, J I Latorre and E Verdaguer.

The efficient performance of the huge secretariat work would not have been possible without the superb collaboration of our secretary, Ariadna Frutos, to whom I am indebted for her intense and competent dedication. Many thanks also go to the Cosmocaixa staff, and especially to Paquita Ciller for her unfailing positive attitude and for her taking care of so many things. It is fair to say that the Cosmocaixa support to the IRGAC 2006 event was magnificent. I also wish to thank Rolf Tarrach for his crucial advice at the initial stages of the organization of the conference, in particular for introducing me to the Cosmocaixa staff.

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My hearty thanks are also addressed to some of our PhD students and postdocs of the Department d'Estructura i Constituents de la Matèria, and of the Departament de Fisica Fonamental, of the Universitat de Barcelona, for their invaluable help and collaboration in solving innumerable niceties and logistical problems that appeared during the frantic days of the conference. Thank you very much to all of them: Daniel Arteaga, Diego Blas, Joan Camps, Noela Fariña, Javier Grande, Laia Jornet, David López Val, Guillem Pérez and Hrvoje Štefančić.

I cannot finish without mentioning Dolors (my wife) and Clara (my daughter) who suffered during the many months I had to devote to the detailed organization of this event, a task that I had to combine of course with the research work and the ordinary duties of any university professor. In fact, although the conference took place during just those five (sunny) days of July 2006 mentioned above, the first preliminary searches for speakers had begun in mid-2004, and now I still find myself writing this preface in May 2007—roughly three years' intermittent work for just a one-week event! No complaints whatsoever, of course. I just feel immensely gratified knowing in my heart that most of the participants, if not all of them, truly enjoyed IRGAC 2006 in Barcelona. The challenge was worth it!

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Guest Editor

References

[1] Asorey M and Shapiro I L 2004 *Proc. Renormalization Group and Anomalies in Gravity and Cosmology (Ouro Preto, March 2003) Nuclear Physics* B *(Proc. Suppl.)* **127**