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2011 has been one of the busiest and most exciting years in particle physics and cosmology we can remember. The many years of preparation was finally brought to their ultimate use in the analysis of the unprecedented amounts of data that are now streaming in. I now invite you to take a closer look at the excitement this activity has brought about in the Discovery Center in this report.

One of our main activities comes from the fact that the Discovery Center participates in the Science Team for the Planck satellite mission. This satellite has been performing even better than planned and the data analysis has as a first step led to a wealth of new astrophysical observations, of immense interest in their own right and also needed to achieve the main goal: To provide, with unprecedented accuracy, the cosmological parameters that tell us how the Universe evolved until now, and how it will evolve into the future. Be prepared for big news from the Discovery Center later in 2012, when these new cosmological data will have been analyzed!

Moving from the largest scales in the Universe to the smallest scales ever measured, the Large Hadron Collider (LHC) has also been performing way above expectations. After a long run with protons, the LHC switched to heavy ion beams last November. The Discovery Center is deeply involved in both of these themes of the LHC adventure. Published results have included a first direct observation of ‘jet quenching’ in heavy ion collisions, many measurements at the few percent level of accuracy for processes predicted by the Standard Model of particle physics, and new strong constraints on physics beyond that. Near the end of the year a huge effort was done to quickly analyze the data pertaining to the search for the Higgs boson. The presentation of significant progress in this search was the target of an immense public interest.

The theory group at the Discovery Center has in 2011 attracted a large number of truly outstanding scientists from around the world, almost all of them attracting additional funding. The group started up one ‘big’ Sapere Aude grant from the Danish Science Research Council, two ‘smaller’ Sapere Aude Awards, one prestigious EU Marie Curie Fellowship and a Fellowship from the Carlsberg Foundation. Several post-docs also managed to come to the Center on their own funding. Just recently one of the Assistant Professors at the Discovery theory group received a prestigious ‘Lundbeck Junior Group Leader’ grant. A young post-doc in the Discovery theory group has likewise just received a Young Investigator Grant that will pay for his own salary for three years, allow him to hire his own co-worker for three years, and provide funding for new computer resources. All this additional funding has given rise to an upward spiral where strong scientists that are now attracted to Copenhagen give rise to even more focus and interest in the work done here. The 2011 Niels Bohr Summer Institute was organized by the particle physics theory group, and it attracted a large group of absolutely outstanding scientists, including Nobel prize winner G. ’t Hooft.

Perhaps one the biggest successes of the Discovery Center is its ability to cross-fertilize fields and we are now deeply involved in collaborative efforts that bridge across the disciplines.

In the following pages I will highlight some of the most exciting developments in the Center. I hope to share with you the thrill of science, theory confronting data, and discovery.
THE HUNT FOR NEW PARTICLES

If the Discovery Center had been a winery, then 2011 would without a doubt go down in history as a fantastic year with an excellent bouquet and a strong flavor. For the experimental particle physics group at Discovery, the data set collected in 2011 with the ATLAS experiment has exceeded wildest expectations.

In 2010, we recorded 0.036 fb⁻¹ (corresponding to 70,000 billion proton collisions), and the dream for 2011 was to reach 1.0 fb⁻¹. However, the LHC was to display a hidden potential, and by the 6th of November of 2011 it had delivered an amazing 5.27 fb⁻¹, which is more than 140 times the size of last year’s data. For the remainder of 2011 LHC collided lead ions, which were recorded in both ATLAS and ALICE experiments.

As should be clear from this report, 2011 has been an extremely active year at the Discovery Center. New results have been produced at a tremendous rate, demanding a heavy workload in the quality control and processing of the data. The results from the analysis of last year’s data were published (73 publications in 2011 up to now, mostly in Physics Letters and Physical Review Letters) and also presented at numerous conferences. One of these was the annual meeting in the Danish Physical Society where an entire session was devoted to the Discovery center and another one was our very successful Summer Institute, visited, among others, by Nobel prize winner Gerard’t Hooft and the father of the ATLAS experiment, Peter Jenni. At the annual Moriond conference in March, it was shown that the 2010 LHC data could already match the data collected over many years at the American Tevatron Collider in terms of exclusion limits on various hypothetical particles. One of the more striking results presented at the Moriond meeting was based on an analysis performed at the Discovery Center. It is described in some detail below.

Other analyses with very significant contributions from the Discovery Center was the search for the Higgs boson, both the one of the Standard Model and the ones implied by supersymmetry. Essential here was the study of background processes predicted by the Standard Model. By now these efforts have lead to important progress in the search, the result of which was presented with much attention from the press and the general public. In the figure below we show a candidate Higgs decay into two Z bosons, each subsequently going to two muons of opposite electric charge (red lines).

On the outreach front, one remarkable achievement was the design and construction of a model of the ATLAS detector made with 10,000 LEGO bricks. The construction started as a public event during the Copenhagen “Culture Night” and it is being mentioned in the science news around the world.

In addition, in 2011 we produced a film aimed at the public: http://www.nbi.ku.dk/sciencexplorer/atlas_fysik/cern_powerforskning/video/ as well as countless public talks, many of them on video.

The experimental particle physics group at the Discovery Center had three Ph.D. defenses and six master thesis defenses during 2011. This is beyond doubt the largest number ever for the group. In the late summer and fall of 2011 we hosted two Ph.D. schools and several workshops including one on Heavy Ion physics gathering some of the most prominent people in the field.
Stable Massive Particle Searches at Discovery

The Discovery-ATLAS group plays a central role in the search for stable massive particles (SMPs) and has extended the mass limits for their possible existence significantly.

All known heavy particles decay very rapidly, and all we see in our detectors are the debris from these decays. However, many of the theories that extend the Standard Model predict (meta-)stable particles that are able to penetrate the ATLAS detector, leaving unusual signatures in the sensors.

The main difficulty in the search for SMP’s is the fact that the detector is designed with the detection of normal particles in mind and not for particles which, like the SMP’s, may travel much slower than light and may change their electric charge along their way. Therefore the signals from the sub-detectors had to be combined in a novel way in order to retain sensitivity in all cases. Another difficulty arises from the background which comes from the tails of detector signals and is therefore not necessarily correctly reproduced by simulation. Therefore the background contribution has to be determined from the data.

All of the above mentioned difficulties were overcome by the Discovery team in close collaboration with the group in Stockholm, and new lower limits for the possible masses of new stable hadrons were published which greatly extended previous limits as seen in the accompanying figure. With the full set of data from 2011, the limits are expected to be pushed out beyond 1 TeV and the range of covered lifetimes to be similarly extended.
The LHC ended the year of 2010 with a month of colliding lead ions. The collisions of lead-ions produced spectacular displays of what the early universe looked like. The data has been rapidly analyzed with results shown at the Quark Matter Conference in May 2011.

**Particle production in lead nucleus collisions**

The Discovery heavy-ion group has analyzed the data from these collisions and evaluated some of the global properties of the “mini-early universes” arising. The Copenhagen contribution to the ALICE experiment of the Forward Multiplicity Detector allowed for the measurement of charged particles over a broad angular range. Our analysis showed that the lead collisions produced up to 25000 particles. This information allows one to estimate that the energy density in which the particles were created is approximately 30 times the energy density of a proton and 16 times the energy density required to form the state of matter that existed 1 µs after the big bang. This state of matter is termed the quark-gluon plasma.

Further studies of the spatial distribution of particles have been carried out in the azimuthal direction. Due to the way lead ions collide, the density of particles varies in different directions. In a strongly interacting medium, like the quark-gluon plasma of the early universe this would result in a pressure gradient leading to a preferential direction for particles to emerge from the collision. We managed to find a significant anisotropy that can be described using a hydrodynamic model of an equilibrium state of matter. Such models have been used to extract properties such as the viscosity of the early universe.

**Interdisciplinary Projects**

The Discovery center profits from its collaboration between heavy-ion, high-energy, theoretical, and cosmological physics to develop new techniques to analyze data. The analysis of the cosmic microwave background.

Elliptic flow in heavy ion collisions manifests itself as a characteristic pattern in the typical representation used for analyzing the cosmic microwave background (left). It can be extracted as a single mode in the decomposition into spherical harmonics (right), here the Y22 component. By imposing particular selection criteria on the spherical harmonics, one can exclude or enhance particular symmetries of the distribution.
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background uses projections onto spherical harmonic modes to characterize the data and this technique has now been used for the first time as an alternate method to study the anisotropy of the distribution of particles emerging from a heavy-ion collision. The goal is to use this complex framework to identify better characteristics of the quark-gluon plasma. Another key question in the collision of heavy-ions is whether a medium is created that “quenches” high momentum quarks and gluons in the sense that they radiate their energy away as they traverse it. This has been confirmed. Very high momentum quarks and gluons identified with the ATLAS detector were observed to distribute their energy over a much broader angular extent in heavy-ion collisions as compared with proton-proton collisions. The same phenomenon can be observed looking at the relative number of high momentum particles created in lead-lead collisions and proton-proton collisions. Using the ALICE detector, we have seen that the number of high momentum particles is suppressed in heavy-ion collisions. The two detectors are thus complementing each other in the study of the quark-gluon plasma.

The amount of data taken in 2011 is more than 10 times what was taken in 2010. The new data will bring the opportunity for much more detailed studies of the quark-gluon plasma giving novel contributions to the understanding of the early universe.
THE LIGHT FROM THE EARLY UNIVERSE

The physics of the Cosmic Microwave background (CMB) is the “gold mine” for the modern cosmology in which theoretical predictions can be confronted with observations. This area of cosmology provides a unique opportunity to obtain information about very early stages of the cosmological expansion, about properties of the space and time and about the birth of the Universe. During the last two years there has been an enormous growth in observational cosmology and in particular in the physics of the CMB. The Discovery Center has started up at just the right time to profit from the Planck satellite data as they keep flowing in. In this connection it has been crucial that the group at the Niels Bohr Institute already constituted the theory part of the Danish Planck Team. Equally, the combination of the Planck space mission data and the particle physics data from the LHC may solve many of the most urgent questions about dark matter in the Universe.

Recently, the Discovery Center team seems to have identified an unusual anomaly of the CMB power spectrum, named parity asymmetry. It reveals itself in a dominance of asymmetric (odd) modes of the power spectrum over symmetric one. This parity asymmetry could possibly have a primordial origin, connected to fundamental properties of the space and time, or it can be just the result of contamination of the CMB power by “new foregrounds”, residuals of the point source subtraction. It could even by an artifact of systematics. In all cases, this new anomaly needs additional investigation. The Discovery team is presently pursuing this based on the recently released data, and will continue to investigate it in the future based on the publicly available Planck data. The work done in Copenhagen has prompted the Planck Science team has set up a new working group of the Planck project under the title: “Fundamental physics with Planck”. It will be devoted to an investigation of potential parity, CPT and Lorentz violation in the CMB data. The Discovery team will contribute to that project through an analysis of the statistical properties of the Planck data, such as Random walks in phase space, Directional statistics and CMB symmetries.

In broader sense, the activities of the Planck group at the Discovery center has been devoted to the following topics in 2011:

Classification of symmetries of the CMB. Parity asymmetry

The CMB signal on the sky can be decomposed into a symmetric and anti-symmetric part under a parity inversion. Given the standard cosmological model, we do not expect a preference for a particular parity in CMB sky. Contrary to the expectation of the standard model, we have found indications of a statistically significant odd-parity preference at the largest scales.

We have investigated its possible origins and ruled out various non-cosmological causes. The cleaning of the CMB data with respects to the galactic foregrounds poses a particularly significant challenge. By taking advantage of the fact that the galactic foregrounds have a remarkable symmetry with respect to their antipodal points and with respect to the galactic plane, and that the CMB show none of these symmetries, one can identify several peculiar multipoles. These multipoles follows symmetries related to the galactic plane (see Fig.1), and in particular, we have identified the WMAP octupole as very symmetric, which might shed new light on the famous alignment between quadrupole and octupole.
Parity test and the temperature auto-correlations
In the COBE and WMAP data, there is intriguing lack of the large-angle correlation. Noting the equivalence between CMB angular power spectrum and angular correlation, we have investigated the association between the WMAP large-angle correlation anomalies and the odd-parity preference in the WMAP power spectrum. We have found that the odd-parity preference at low multipoles is the phenomenological origin of the large-angle correlation anomalies. Recently, cold and large dust grains in the outer part of solar system were suggested for the underlying origin of various CMB anomalies. We investigated the Edgeworth Kuiper Belt Objects, in particular, and found it indeed may produce some anomalies.

Random walk in phase space
The Cosmic Microwave Background can be decomposed into ordinary spherical harmonics multiplied by complex coefficients of decomposition. The simplest scenario of inflation predicts that the phases of these decomposition coefficients should be distributed randomly, without any preference for even or odd multipoles. This prediction has been analyzed by performing a random walk test for the phases of the decomposition coefficients (see Fig.3). Our results have shown, that there are discrepancies between the phases of the even and the odd multipoles, in contradiction to the prediction from theory. This ties in well with our work on parity asymmetry. The CMB data surely contain some level of contamination from the foreground. Understanding such systematic effects and the associated identification of the affected multipoles is paramount to accurately measure cosmological parameters. A directional statistics test to measure the smoothness of the CMB power spectrum by comparing the amplitude at one multipole with its nearest or next-nearest neighbors were developed by the Discovery team. Large deviations compared to its neighbors can indicate whether the multipole in question is anomalous or not. Upon comparison with predictions from theory, and after several thousand simulations, many ranges of anomalous multipoles were identified by our group using the directional statistics.
**First release of Planck data**

The Planck observations of the radio sky in combination with X-ray data by the XMM Newton open a new window for detection of new clusters of galaxies with corresponding redshifts around $z=0.5-1$. In Fig. 5, we show the result of reconstruction of the PLCK G226.6-27.3 cluster of galaxies at 5-sigma threshold by the Planck and XMM Newton data. This observation illustrates the new way for systematic study of population evolution in the exponential tail of the mass function. Numerous analogous projects related to large-distance astrophysics are currently being pursued by the Planck group at the Discovery Center.

**CMB tools for analyzing of LHC Heavy Ion collision**

In cooperation with the ALICE group in the Discovery Center it has been investigated whether the statistical tools of the CMB sky may give an entirely new and alternative way of analyzing heavy ion collisions at the LHC. In Fig. 4 we show the result of reconstruction of elliptic flow versus input data from a single event of an event generator for the ALICE experiment. This approach has proven to be quite successful, and the project is now continuing in several new directions.

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Figure 6: The PLANCK sky maps of the Perseus molecular cloud.

Figure 7: Spectrum of dust emission in the Perseus molecular cloud. The spinning dust at $17\theta$ corresponds to the magenta line.
THEORETICAL DEVELOPMENTS
AT DISCOVERY

The Discovery theory group has been rapidly growing in size over the past 12 months. 2011 has seen the arrival of a new assistant professor, Alberto Guffanti, working in the fields of Parton Distribution Functions and precision QCD. Three post-docs have started this Autumn, Guido Macorini, Valery Yundin and Yang Zhang, joining PhD Students Hjalte Frellesvig who began in January and Rijun Huang. We continue to support a large number of Master students whose projects cover a wide range of topics from mathematical properties of scattering amplitudes to new models for neutrino masses.

We are also pleased to congratulate Emil Bjerrum-Bohr on his Junior Group Leader grant from the Lundbeck Foundation. In the coming years this will open up three new post-doc positions and a new PhD studentship working on amplitude computations for the LHC.

The group meets regularly for the amplitude journal club and has begun a series of colloquia attracting world class speakers. We also are keen to take part in public outreach projects, with members giving regular lectures for the Folke Universtitet. Anders Tranberg and Poul Henrik Damgaard contributed an introduction to Einstein’s theories of relativity for DR’s “Danskerne’s Akademie” television series.

Precision QCD Predictions
While the LHC experiments have been busy gathering data, the Discovery theory group has been working intensely to make accurate predictions for the enormous Standard Model background dominated by Quantum Chromo-Dynamics (QCD). Even at LHC energies, the large size of the QCD coupling constant means that the standard perturbative approach to cross-section predictions at collider physics struggles to achieve the desired precision.

The computations in perturbative quantum field theory have always pushed the boundaries of our technology. The sheer size of the expressions has been the bottleneck in making quantitative predictions for hadronic collisions. Modern techniques, inspired by string theories and more mathematical super-symmetric constructions, have begun to offer a general solution to this problem. Experts at the NBI have been working hard on investigating both future improvements to the methods, and writing computer codes that can provide these results directly to the experimentalists.

As well as the obvious application, testing the Standard Model to new limits, these highly complicated final states form a large background to signals of new physics. Further phenomenological studies and analysis will hope improve the on-going searches and maximize the discovery potential.

NBI Summer Institute
A highlight of 2011’s events was undoubtedly the NBI Summer Institute, co-organized with the Niels Bohr International Academy and the High Energy Theory group of the NBI. For the last two weeks of August over 50 scientists from around the world gathered to discuss “Strings, Gauge Theory and the LHC”. Distinguished guests, including Nima Arkani-Hamed, Nobel Prize winner Gerard ‘t Hooft and Lu-
casian Professor Michael Green, gave a wide variety of talks on modern aspects of theoretical physics. With the LHC standing out at the forefront of current advances we were delighted to have Peter Jenni, former ATLAS spokesperson, overview the latest results. In addition, there was a rather important matter to resolve, since ten years ago at a similar meeting a wager on whether super-symmetry would be discovered by 2010 had been made. Many of the original participants had returned and concerns as to whether technical problems with the experiments had unfairly influenced the outcome were raised. Therefore, in order to be completely fair, the date of the wager was extended until 2016. The list of participants on the wager makes rather interesting reading and we are looking forward to many of them returning to settle the matter once and for all in five years time!
DISCOVERY PEOPLE

Scientific Staff
Alberto Guffanti
Anders Tranberg
Björn Stefan Nilsson
Borge Svane Nielsen
Christian Holm Christensen
Donal Francis O’Connell
Esben Bryndt Klinkby
Frederik Orelana
Guido Marcortin
Hans Bøggild
Ian Bearden
Jaiserung Kim
Jens Jørgen Gaardboje
Johan Lundqvist
John Renner Hansen
Jørn Dines Hansen
Kim Splitterf
Kristjan Gulbrandsen
Marger Simonyan
Mogens Dam
Nele Maria Phlomema Boelaert
Niels Emil J. Bjerrum-Boh
Pavel Naselisky
Per Rex Christensen

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Alexander Hansen
Almut Pingel
Ask Emil Løvschall-Jensen
Carsten Søgaard
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Hjalte Frellevig
Kristian Anders Gregersen
Lotte Ansgaard Thomsen
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Peter Rosendahl
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Rijun Huang
Simon J. Franz Heisterkamp

Master students
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Anne Mette Frejel
Yang Zhang
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Sune Jakobsen
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Scientific Associates
Amanda Cooper-Sarkar
Anupan Mazumdar
Bo Feng, Zhejiang University
Else Lynkten, Lund University
Guido Altarelli
Ian Hincliffe
Jürgen Schukraft
Katri Huitu, University of Helsinki
Leif Lönnblad, Lund University
Lung-Yih Chang, Academia Sinica, Taiwan
Maxim Perelstein, Cornell University
Oleg Verkhodanov
Peter Coles
Pierre Vanhove
Raju Venugopalan
Richard Ball
Stefano Forte
Urs Wiedemann
Zvi Bern

Discovery Advisory Board
Andrei Linde, Stanford University
Chris Quigg, Fermilab
Jurgen Schukraft, CERN
Nick Ellis, CERN
DISCOVERY VISITORS

Jamie Nagle, University of Colorado at Boulder, USA, Jan 2011
Darren Forde, CERN, Switzerland, Mar 2011
Sereau, Observatoire de Paris, France, Mar 2011
Mona Frommert, Geneva Cosmology Group, Switzerland, Mar 2011
John Donoghue, Apr 2011
Eleanor Dobson, Apr 2011
Benedikt Biedermann, Fritz Haber Institute, Berlin, Germany, Apr-May 2011
Cristina Carloganu, CNRS, France, Apr-May 2011
Lance Dixon, Stanford University, USA, May 2011
Suvrat Raju, University of Allahabad, India, May 2011
Peter Coles, Cardiff University, UK, June 2011
Richard Ball, University of Edinburgh, UK, July 2011
Tony Zee, University of California, Santa Barbara, USA, Aug 2011
Diana Vaman, University of Virginia, USA, Aug 2011
Ruth Britto, Saclay, France, Aug 2011
P. VanHove, Paris, France, Aug-Sep 2011
Henrik Johansson, Paris, France, Aug-Sep 2011
Chris Quigg, Fermilab, USA, Sep 2011
Thomas M. Kousouridou, CERN, Switzerland, Sep 2011
M. Perelstein, Cornell University, USA, Sep-Oct 2011
Benjamin Grinstein, University of California in San Diego, USA, Oct 2011
Marco Cirelli, CERN, Switzerland, Oct 2011
Dmitry Gorbunov, Moscow, Russia, Oct 2011

Harald Ita, UCLA, USA, Oct 2011
Hidenori Fukaya, Osaka University, Oct 2011
Urs Heller, the American Physical Society, USA, Oct-Nov 2011
Leif Linnblad, Lund University, Sweden, Nov 2011
Jan Fiete Grosse-Oetringhaus, CERN, Switzerland, Nov 2011
Urs Wiedemann, CERN, Switzerland, Nov 2011
Wolfgang Kuehn, University of Giessen, NL, Nov 2011
Raju Venugopalan, Brookhaven National Laboratory, USA, Nov 2011
Raimond Snellings, Utrecht University, NL, Nov 2011
Edward Shuryak, Stony Brook, USA, Nov 2011
Robert Pisarski, Brookhaven National Laboratory, USA, Nov 2011
James Nagle, University of Colorado at Boulder, USA, Nov 2011
Stefan Floechinger, CERN, Switzerland, Nov 2011
Richard Ball, University of Edinburgh, UK, Nov-Dec 2011
Igor Novikov, Lebedev Physical Institute, Moscow, Russia, Nov 2011
John Mark Russel, Oxford University, UK, Nov 2011
Song He, University of Berlin, Germany, Nov-Dec 2011
Josh Cogan from SLAC, USA, Dec 2011
Christian Ohm, Stockholm University, Sweden, Dec 2011
Kari Enqvist, University of Helsinki, Finland, Dec 2011
Louis Helary, Université de Savoie, France, Dec 2011
Lung-Yih Chiang, Academia Sinica, Taiwan, Dec 2011
DISCOVERY WORKSHOPS

Nordic Winter School on Cosmology and Particle Physics, Jan 2-7, 2011
Workshop on Cosmology and astroparticle physics from the LHC to PLANCK, Jun 7-9, 2011
PhD School on Particle Physics Phenomenology, Oct 3-7, 2011
Workshop on Heavy Ion: Experiments confront Theory, Nov 7-9, 2011
PhD School on Advanced Methods in Statistical Data Analysis, Nov 14-18, 2011

DISCOVERY PUBLICATIONS

B. Abelev et al., ALICE Collaboration, Light vector meson production in pp collisions at sqrt(s) = 7 TeV, [arXiv:1112.2222 [hep-ex]].
B. Abelev et al., the ALICE Collaboration, polarization in pp collisions at sqrt(s)=7 TeV," [arXiv:1111.1630 [hep-ex]].
C. Hartmann, "The Frobenius group T13 and the canonical see-saw mechanism applied to neutrino mixing" [arXiv:1109.5143 [hep-ph]].
P. Naselsky, W. Zhao, J. Kim, S. Chen, "Is the CMD asymmetry due to the kinematic dipole", [arXiv:1108.4376 [astro-ph]].


Planck Early Results XXVI: Detection with Planck and confirmation by XM-M-Newton of PLCK G266.6-27.3, an exceptionally X-ray luminous and massive galaxy cluster at z~1.


[arXiv:1105.5546 [hep-ph]].


[arXiv:1105.3865 [nucl-ex]].

[arXiv:1105.2565 [hep-th]].

[arXiv:1105.0380 [hep-ex]].


[arXiv:1104.1858]


K. Aamodt et al., ALICE Collaboration, Femtoscopy of pp collisions at sqrt(s)=0.9 and 7 TeV at the LHC with two-pion Bose-Einstein correlations,” [arXiv:1101.3665 [hep-ex]].


DISCOVERY FINANCING

The Discovery budget for 2011 is 6,750,742 DKK including overhead from the Danish National Research Foundation. This amount was also in 2011 supplemented by a large number of other grants and by Copenhagen University contributions. In the figure below overhead is not included.

EXTERNAL GRANTS BY DISCOVERY GROUPS IN 2011

The Discovery Center has also in 2011 received an impressive and essential supplementary funding from Danish public and private agencies. The additional funding has been granted by The Lundbeck Foundation (two new Junior Group Leader Grants of 10 Mkr each; one recipient moved to another university after having secured a permanent position there), The Danish National Research Council (one 4-year Steno grant, one post-doc grant), the Villum Foundation (one Young Investigator Grant of 4 Mkr). A ‘large’ Sapere Aude grant and two ‘small’ Sapere Aude grants started up in 2011 as well. One post-doc at the Discovery Center was also awarded a Marie Curie grant from the EU. Support from the Oticon Foundation has allowed one PhD-student from Russia to spend a year with the Discovery Center. Indirect support to center activities comes from the Niels Bohr International Academy, especially in connection with workshops and PhD schools.

DISCOVERY CENTER IS INCLUDED IN NEW COLLABORATION WITH CERN

The Discovery Center has been included as participating center in a new agreement between CERN and the Planck Consortium. This opens up for a new cross-disciplinary collaboration between particle physics and cosmology precisely in the spirit of the Discovery Center itself. Topics listed as of common interest are: testing fundamental symmetries like Parity, CPT, and Lorentz Invariance in forthcoming Planck data, constraining neutrino masses and the number of neutrino species, testing theories of Inflation, and many more. As part of the agreement Planck scientists, including those of the Discovery Center, will now have access to CERN facilities.