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1 Summary

The main goal of this project was the construction of a coherent framework able to include and go beyond the present Standard Models in Cosmology and Particle Physics. It is well-known that the present cosmological data give evidence for the presence of Dark Matter (DM) and Dark Energy (DE), for which there is no candidate within the Standard Model of Particle Physics and that extensions of the Standard Model itself very often suffer from cosmological problems, like the gravitino problem or the moduli problem. Therefore constructing a coherent, self-consistent and unifying model is highly non-trivial.

During the 5 years of work we were able to make substantial steps toward a concrete modelling of the physics beyond both the Standard Models. In particular we concentrated our studies on the gravitino as lightest Supersymmetric Particle (LSP) and Dark Matter candidate. We suggested as first the possibility of observing signatures of gravitino Dark Matter at colliders in the guise of a long-lived Next-to-Lightest Supersymmetric Particle (NLSP) [1,2]. Moreover we proposed a cosmologically consistent scenario, addressing at the same time not only the question of Dark Matter, but also baryogenesis and including Supergravity [23]: in such model the Dark Matter is a decaying gravitino, which has a lifetime much longer than the age of the Universe. Its decay is produced by the introduction of small R-parity and lepton number breaking couplings, that are harmless for leptogenesis, but allow the NLSP to decay before Nucleosynthesis and relax therefore the bounds on the reheat temperature, which can so be sufficiently high for thermal leptogenesis.

The decay of the gravitino, which must be in the 10-100 GeV mass scale to explain the DM energy density, may be observable in present cosmic rays satellite experiments if the couplings are near to their upper bound. Such possibility attracted quite some attention after the release of the PAMELA data and the observation of an excess in the positron flux in the 10-100 GeV range, but recent FERMI data on the total electron-position and gamma-ray fluxes pose strong constraints on this scenario.

Another important results of the project were also obtained in the study of orbifold compactifications and the constructions of unified models from the heterotic string theory. In the latter, top-down, strategy not one but many MSSM-like models have been found, which all contain massive vector-like exotics and a plethora of singlet fields. From the bottom-up perspective, we concentrated our efforts on a simple field-theoretic model based on $SO(10)$ in 6D and there we were able to discuss explicitly and quantitatively fermionic masses, proton decay, CP violation and leptogenesis and also supersymmetry breaking via gaugino mediation. While no counterpart of this model has yet been found in the heterotic string constructions, some of its

characteristics, i.e. the presence of split multiplets and mixing with exotic vectorial states, etc.., seem to be a general feature of orbifold models and determine its phenomenological properties.

Finally we also engaged in inflationary model building in SUGRA, concentrating especially to the connection with supersymmetry breaking and moduli stabilisation, and investigated observational and theoretical bounds on a specific class of inflationary models.

While the results of the project were many and quite encouraging, opening also novel directions as e.g. the decaying Dark Matter case, still more work need to be done in the direction of embedding also inflation in the same setting, realising full moduli stabilisation and formulating finally a complete New Standard Model.

2 Report on the Project's Activities and Results

2.1 Proposed project

The original proposal of the project was to tackle the open questions that still haunt both the Standard Models of Particle Physics and of Cosmology. We know in fact since long time that these two Standard Models are incomplete and that their key questions are tightly interrelated. On one side cosmological observations offer first hand evidence for the need of extending the Standard Model (e.g. the presence of a baryonic asymmetry or of Dark Matter), on the other side the simple Big Bang model is unable to explain what is the main component of the energy density of our Universe, Dark Energy, or which quantum field was responsible for the inflationary phase. These and many open issues that we were and are facing in both fields are connected and that gave us hope to find a common solution.

At the beginning of the project, there were different mechanisms for solving the single problems, but not much had been done in a global perspective and trying to connect together the different questions. Our proposal was to concentrate the efforts at the boundary of the two fields and to combine the different ingredients to single out a new model. We put strong weight on the coherence and consistency of all aspects of the scenario studied, both from the particle physics as from the cosmology side. We identified the central issues of the proposal in three main categories, one related more strictly to particle physics, the other two to cosmology. These themes and their milestones were

- Grand Unified Theories (GUT) and Supersymmetry: construction and phenomenological study of GUT models in extra-dimensional setting, both from the heterotic string and in field theoretic orbifold models.
- Dark Matter: study the cosmology and phenomenology of very weakly interacting DM candidates like the gravitino and the axino.
- Inflation: try to explicitly embed the inflationary potential in GUT models, explore specific phenomenological signatures and investigate the connection with Supersymmetry breaking and possible mechanisms of pre/reheating.

These three main themes all reflect key questions of the present Standard Models and we hoped that their theoretical study could enlighten and open the road toward a New Standard Model.

2.2 Work progress

The project proceeded slightly differently than planned from the beginning, due to three important reasons:

1. the original project leader, Laura Covi, moved to CERN at the beginning of 2004 and left the leadership of the project to her successor as DESY junior staff, Koichi Hamaguchi. She nevertheless remained involved in the project and in particular in the supervision of the Ph.D. student Jan Hamann. In this way the project actually benefited of the expertise and work of two project leaders instead of one. Laura Covi took over again full responsibility as project leader in May 2006, after she had returned with a permanent staff position in the DESY Theory group and when Koichi Hamaguchi left DESY for a permanent professorship at the University of Tokyo in Japan.

2. the hiring policy in theoretical particle physics is such that post-doc positions are offered the winter before the post is taken and therefore the first post-doc of the project could be hired only in October 2004, even if it was offered in January 2004. This led in total to the cost-neutral postponement of the project by 9 months (6 months from January 2004 to July 2004 from the start and 3 months from July 2009 to the end of September 2009 at the end, to coincide with the end of the post-doc employment at DESY in September 2009). The Padova group had also some bureaucratic troubles in opening the Post-doc position and therefore filled the post for the first time only in October 2005.

3. in general the project suffered of a very strong turn-over of manpower since three of the project post-docs were offered permanent or long-term jobs and left their post before the end of their contract: Gianfranco Bertone for IAP in Paris, Marieke Postma for a Junior Staff position at NIKHEF and Pasquale di Bari for a lecturer position at Southampton University. Moreover since the project was initially financed only for 3 years, before renewal we could offer only short term contracts to Florian Bauer and Felipe Joaquim (Florian Bauer was integrated in the VIPAC program for his second year), instead of full 2 year positions. The frequent change of group members hindered a bit the collaboration within the group, but most of the milestones were nevertheless reached.

The members of the group were:

- Koichi Hamaguchi, group leader from 1/2004 to 4/2006;
- Laura Covi, group leader in the original proposal and from 5/2006 to 9/2009;
- Jan Hamann, Ph.D. student at DESY from 3/2004 to 4/2007;
- Jörn Kersten, post-doc at DESY from 10/2004-9/2006;
- Gianfranco Bertone, post-doc in Padova from 10/2005 to 4/2007, when he left for a permanent CNRS job at IAP in Paris;
- Florian Bauer, post-doc at DESY, project member from 10/2006 to 9/2007;
- Felipe Joaquim, post-doc in Padova from 6 to 9/2007;
- Michael Grefe, Diploma student at DESY from 9/2007 to 9/2008 and then Ph.D. student from 11/2008 to presumably 10/2011;
- Marieke Postma, post-doc at DESY from 10/2007 to 6/2008, when she moved to NIKHEF for a 5 year position;
- Pasquale di Bari, post-doc in Padova from 10/2007 to 7/2009, when he moved to Southampton University as a lecturer;

- Jasper Hasenkamp, Diploma student from 4/2008 to 3/2009;
- Cecelie Hector, Ph. D. student from 9/2008 to presumably 8/2011;
- Fumihiro Takayama, post-doc at DESY from 9/2008 to 9/2009.

After the initial delay, we started the work on the project trying from the beginning to attack more than one single issue at once and from different perspective (i.e. top-down and bottom-up) as can be seen from the yearly reports. This strategy revealed itself very fruitful and brought about not only parallel advancement, but mutual stimulation and original ideas between the different issues.

Regarding the financial plan, we had some residual funding due to the late filling of the post-doc position in Padova and the early vacancies and we used them to finance the two Ph.D. students involved in the project, Michael Grefe and Cecelie Hector for their first year, while the rest of their Ph.D salaries until graduation will be paid by DESY.

2.3 Results

As discussed in the proposal, we tried in the project to proceed in parallel on all three directions and let the different subjects interweave. We have obtained important results in all three themes, but possibly the more substantial and visible in the international arena were on the Dark Matter side. Therefore we will describe first this research activity.

2.3.1 Dark Matter

We performed a thorough study of the case of gravitino Dark Matter and of the gravitino problem in different incarnations and this led to 18 publications and one preprint [1,2,5,7,9,10,14-17,19,23,24,30,39,42,45,46,S1]. In particular we were the first to propose long-lived NLSPs as collider signatures for gravitino DM [1,2,5,7] and to suggest how to distinguish it from singlino [2] or axino DM [9]. These papers started a new direction for DM searches at colliders and attracted a lot of attention with more than 300 citations in total.

We considered as well possible signals of long-lived staus in neutrino detectors [15], the gravitino problem induce by moduli or inflaton decay [14,16] and possible dilutions of the gravitino number density [17]. Moreover we studied gravitino DM in the context of gaugino mediation [10,19,24], which can be realised in some extra-dimensional orbifold models like our $SO(10)$ GUT model in 6D. We also considered in a more model independent way a general charged NLSP [39] or a general neutralino NLSP [46]. In fact in the case of a gravitino LSP and DM, the most important cosmological constraints coming from Nucleosynthesis and the collider signatures depend very strongly on the nature of the NLSP and the superparticle spectrum. In our studies we included both neutral NLSPs within the MSSM, the sneutrino and neutralino, which are more difficult to disentangle from the neutralino LSP case and therefore need specific and targeted analysis strategies at colliders. We also analysed the scenario of a charged NLSP, which gives clear and spectacular signals at colliders, but can endanger the Nucleosynthesis predictions and in some cases is consistent with our cosmological history only if the particle is very heavy and out of reach of the LHC. We found in our studies that even for RH stop NLSP a viable cosmological window remains open in the LHC mass range.

More recently we proposed one of the few cosmologically consistent scenarios [23], capable of explaining Dark Matter as thermally produced gravitinos and including baryogenesis via thermal leptogenesis: the case of a decaying gravitino, with a lifetime much longer than the age of the Universe. In this model, the NLSP decays before Nucleosynthesis via small R-parity and lepton number breaking couplings, that are harmless for leptogenesis. The same couplings allow

the gravitino DM to decay into gauge boson and neutrino, but, due to the double suppression coming from the Planck scale and the small couplings, such particle is naturally very long-lived. We have explored the DM indirect detection of these type of decaying DM models both in gamma-rays [30, 45] and in neutrinos [42, S1]. Note that these papers have been quite seminal works and have drawn attention to the case of decaying Dark Matter long before the PAMELA data excited the activity of most of the particle physics and astrophysics community in this direction. This particular study started as a cross-linking between the Padova and DESY group expertise's. In fact another line of research pursued in Padova included the analysis of the possible signatures of WIMP Dark Matter in Indirect Detection [13,20,25-28] and of the strategies for disentangling DM candidates from Direct Detection [29]. More exotic scenarios with very weakly interacting Dark Matter, like a RH neutrino [43] and an axino [44], were also studied.

In general the project leaders and some of the post-docs of the project established themselves in the international community as Dark Matter experts, as can be seen from the list of invited plenary talks: in particular K. Hamaguchi was invited to talk at SUSY 04, L. Covi at Planck 07, COSMO 07, TEV PA 07, the DPG Tagung and the Patras Workshop 2009.

2.3.2 Supersymmetric GUTs

The question of the existence of a realistic supersymmetric GUT model beyond the Standard Model of particle physics was revived in the years before the beginning of this project by the advent of field theoretic models based on orbifold constructions in more than 4 dimensions. From this basis, we extended the study of orbifold GUTs both with a top-down and bottom-up approach in a complementary way. On the theoretical formal side, we constructed supersymmetric standard models directly from heterotic string theory in [11], another seminal paper with 100 citations. Instead from the more phenomenological side, in order to be able to study a simpler, but not trivial case, we concentrated on a field-theoretic 6D orbifold model with bulk SO(10) GUT symmetry. In this specific model, which shares some of the basic features with the constructions obtained in [11], we computed the symmetry breaking from gaugino mediation and the superpartner spectra [10,12] and studied the possibility of gravitino DM [19,24]. Moreover we were able to give explicit predictions for the proton decay branching ratios [4], which are quite characteristic for this type of supersymmetric extra-dimensional models, where dimension 6 proton decay operators dominate, but have a peculiar flavour structure. In the same setting we also gave a model for Standard Model fermion masses and computed the related CP violation [31] in the quark sector, in the neutrino sector and for leptogenesis. The question of flavoured thermal leptogenesis in general and in SO(10) models of this type has been studied also by the group in Padova [40,41].

2.3.3 Inflation

We realised very soon that inflation and reheating are tightly connected to moduli stabilisation. In this direction at the beginning we considered temperature effects in the early Universe in relation to dilaton destabilisation [3,6]. On the phenomenological side, we discussed signatures of a weak phase transitions during inflation, which may produce a step in the inflation mass parameters and therefore features in the primordial perturbation spectrum [18,22]. We also checked the robustness of general cosmological constraints on inflationary models against the inclusion of a varying number of cosmological parameters [21]. These studies became quite well-known also in the international CMB experimental community and are well-cited.

Later on, we were active on inflationary model building in Supergravity [32, 34-37], always keeping in mind the trouble with the large eta parameter and the issue of moduli stabilisa-

tion [35,36,38]. We found some models that achieve a slow-roll inflationary phase without destabilising the moduli, but they are unfortunately not so easily embedded in string-inspired supergravity models [38]. Since we did not achieve a full extra-dimensional supergravity model, including moduli stabilisation, supersymmetry breaking and a supersymmetric GUT, we could not study the question of reheating to the SM sector and the reheat temperature of the thermal phase of the Universe.

2.4 Future prospects

As we argued above, we were able to construct a consistent cosmological scenario addressing the question of Dark Matter and leptogenesis and such scenario could easily be embedded in an orbifold GUT model. On the other hand, the question of inflation and moduli stabilisation is not yet completely solved and no top-down model has been found that addresses all the problems or able to embed at the same time inflation and supersymmetry breaking and moduli stabilisation. More theoretical work will be needed in that direction and we are planning to continue working on this.

Regarding our proposed signals at colliders and for DM indirect detection, the next few years will tell us if our models are realised in nature or not: the LHC collider should be able to tell us if a charged NLSP is long-lived and if R-parity is indeed broken. Also gamma-ray observations from the FERMI satellite and measurements at neutrino observatories like ICECUBE could exclude or support the decaying gravitino scenario. We are therefore looking forward to having our models tested in the very near future. In the most optimistic case, were our models realised in nature, such measurements could give us information on the gravitino mass and therefore on the mechanism of supersymmetry breaking and transmission and this knowledge would be very important for future model building and theoretical work.

Also for what regards inflation, we are expecting soon new data from the Planck satellite, which should improve our phenomenological constraints and test more strongly inflationary models. In this case though it is not clear if the new information will be sufficient to single out a particular model or tell us the scale at which inflation took place.

2.5 Relevance and application

Our studies will become important in the next years for the correct interpretation of the LHC and other collider data beyond the neutralino DM and WIMP case. We hope indeed to apply some of our strategies of disentangling the different DM scenarios at colliders as soon as possible.

Moreover the key issue of consistency of the cosmological history has shown itself to be quite a fruitful criterium pointing towards new possibilities, like the one of a decaying very weakly interacting Dark Matter. Such type of candidates are now being tested in DM indirect detection and neutrino experiments and contact with the experimental collaborations has been made to look also for these signatures.

From the more theoretical side, we have now a better understanding of orbifold GUT constructions and of the connection between inflation, supersymmetry breaking and moduli stabilisation and we will use this experience and knowledge in future work.

3 Education and training

During the course of the project, the project leader has been involved in teaching courses in Summer and Winter Schools, at the University of Hamburg and graduate courses at the University of Milan. In particular L. Covi has given lecture in the following Schools:

- Astroparticle Physics
  lecture series at the Summer Institute "New Trends in Particle Physics and Cosmology", Sheffield, U.K., 19-23 June 2006
- Particle Physics and Cosmology
  three lectures at the 38. Herbstschule für Hochenergiephysik, Maria Laach, Germany, 5-15 September 2006
- WMAP and Cosmological Perturbations
  SFB Lecture Series in November 2006, Hamburg University, Hamburg, Germany
- Dark Energy and Dark Matter
  lecture series at PASC Winter School, Sesimbra, Portugal 19-21 December 2007
- Masterclass in Particle Cosmology
  held for Ph. D students, on 18 January 2009 at Physics at FOM, Veldhoven, Netherlands

Apart for the teaching activity, the group leaders have acted as supervisors of the project students. In fact most of the work done in this project has been carried out together with Diploma students and Ph.D. students. In particular one doctoral degree was obtained by Jan Hamann in April 2007, with a dissertation on *Inflation and cosmological parameter estimation*, and two Diploma thesis were written by Michael Grefe on *Neutrino signals from gravitino dark matter with broken R-parity*, in September 2008 and by Jasper Hasenkamp on *General neutralino NLSP with gravitino dark matter vs. big bang nucleosynthesis*, in March 2009. Both the Diploma thesis resulted in a published paper. Moreover, the thesis of Michael Grefe was awarded the "Otto Stern Prize" for the best Diploma thesis in the Physics Department at the University of Hamburg during the Summer Semester 2008. The project leader is still supervising two Ph.D. students who were attached to this project, Michael Grefe and Cecelie Hector and they are expected to gain the doctoral degree in 2011.

All the students attached to the Project have participated to international schools and conferences and presented their work in workshops and seminars.

In particular within the young physicists training activity, the project fully financed an international workshop in Padova "Early Universe Thermometers", with plenary review talks by international experts in the field like E. Kolb, J. Lesgourges, S. Matarrese, H. Murayama, M. Quiros and E. Roulet, and parallel session talks by the young participants. Moreover the project partially financed a Visitor Program on Dark Matter at DESY, with lively discussion sessions on all aspects of Dark Matter.

4 Publication list

The project has lead to a total of 46 published articles, 7 conference proceeding, 1 submitted paper, 1 preprint, 1 Dissertation and 2 Diploma theses. Another couple of publications are expected to be completed in the next months, in particular one review article on "Gravitino Dark Matter" which has been solicited by Reviews of Modern Physics.

Publications in Refereed Journals in chronological order

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46. L. Covi, J. Hasenkamp, S. Pokorski and J. Roberts,
Gravitino Dark Matter and general neutralino NLSP,
JHEP **0911** (2009) 003 [arXiv:0908.3399 [hep-ph]].

Conference proceedings

P1. K. Hamaguchi,
Gravitino in the past and in the future,
Proceedings of SUSY 2004, 17-23 June 2004, Tsukuba, Japan, eds K. Hagiwara, J. Kanzaki and N. Okada, Tsukuba, KEK, 2004.

P2. L. Covi,
Proton decay in a 6D SO(10) model,
Proceedings of the 40th Rencontres De Moriond On Electroweak Interactions And Unified Theories, 5-12 Mar 2005, La Thuile, Aosta Valley, Italy, arXiv:hep-ph/0506255.

P3. Jörn Kersten,
Squarks and sleptons between branes and bulk: Gaugino mediation and gravitino dark matter in an SO(10) orbifold GUT,
Proceedings of the 41st Rencontres De Moriond On Electroweak Interactions And Unified Theories, 11-18 Mar 2006, La Thuile, Aosta Valley, Italy, arXiv:hep-ph/0605171.

P4. Gianfranco Bertone,
Dark matter: The connection with gamma-ray astrophysics,
Astrophys. Space Sci. **309** (2007) 505 [arXiv:astro-ph/0608706].

P5. Laura Covi,
Axinos as cold dark matter,
AIP Conf. Proc. **878** (2006) 145 [arXiv:hep-ph/0610114].

P6. Florian Bauer,
Gravity and quantum fields in discrete space-times,
J. Phys. A **40** (2007) 6957 [arXiv:hep-th/0610289].

P7. I. De Mitri and P. Di Bari,
Astroparticle and neutrino physics,
Nuovo Cim. **123B**, 869 (2008).

Invited plenary talks

T1. K. Hamaguchi,
Gravitino in the past and in the future,
invited plenary talk at SUSY 2004, 17-23 June 2004, Tsukuba, Japan.

T2. L. Covi,
Constraining Inflationary Models,
invited talk at the 1st Workshop on Particle Physics and Cosmology, 29 April-3 May 2006, Warsaw, Poland.

T3. L. Covi,
Axinos as cold dark matter,
invited talk at the 2nd International Conference on the Dark Side of the Universe (DSU 2006), 20-24 June 2006, Madrid, Spain.

T4. Gianfranco Bertone,
Dark matter: The connection with gamma-ray astrophysics,
invited talk at the conference "The multi-messenger approach to high energy gamma-ray sources", July 4-7, 2006, Barcelona, Spain.

T5. Laura Covi,
Supersymmetric Dark Matter and Colliders, invited plenary talk at Cortona 2007 - 29th Congress of Theoretical Physics, 28 May - 1 June 2007 Cortona, Italy.

T6. Laura Covi,
Gravitino Dark Matter in Gaugino Mediation (and Beyond ...) ,
invited plenary talk at 10th European Meeting From the Planck Scale to the Electroweak Scale (Planck '07), 9-13 June 2007, Warsaw, Poland.

T7. Laura Covi,
Dark Matter Candidates,
invited plenary talk at Cosmo-07, International Workshop on Particle Physics and the Early Universe, 21-25 August 2007, Brighton, UK.

T8. Laura Covi,
Gravitino Dark Matter,
invited plenary talk at TeV Particle Astrophysics III Workshop (TeV PA 2007), 27-31 August 2007, Venice, Italy.

T9. Laura Covi,
Supersymmetric Dark Matter, invited plenary talk at Transregio 33 Annual Meeting, 30 September - 3 October 2007, Bad Honnef, Germany.

T10. Laura Covi,
Gravitino as Dark Matter Candidate,
invited talk at 4th Workshop on Particle Physics and Cosmology: The Interface, 13-16 February 2008, Warsaw, Poland .

T11. P. Di Bari,
Astroparticle and neutrino physics theory summary,
invited summary at the Incontri di Fisica delle Alte Energie 2008 (IFAE2008), 26-28 March 2008, Bologna, Italy.

T12. Laura Covi,
Supersymmetric Dark Matter and the LHC
invited focus session talk at Physics at FOM, 19-21 January 2009, Veldhoven, Netherlands.

T13. Laura Covi,
Cosmology of light gravitini
invited talk at the 5th Workshop on Particle Physics and Cosmology: The Interface, 4-7 February 2009, Warsaw, Poland.

T14. Laura Covi,
Dark Matter in the Laboratory,
invited plenary talk at the Symposium "Das Dunkle Universum" during the DPG Frühjahrstagung Teilchenphysik 2009 (DPG 2009), 9-13 March 2009, Munich, Germany.

T15. Laura Covi,
News from the sky,
invited pedagogical lecture, Beyond the Standard Model Workshop 2009, 16-19 March 2009, Bad Honnef, Germany.

T16. Laura Covi,
The case for Dark Matter,
invited review talk at 5th Patras Workshop on Axions, WIMPs and WISPs, 13-17 July 2009, Durham, United Kingdom.

T17. Laura Covi,
Gravitino Dark Matter & the ILC,
Linear Collider Workshop 2009 (LC09), 21-24 September 2009, Perugia, Italy.

Diploma and doctoral thesis in chronological order

PhD1. Jan Hamann, *Inflation and cosmological parameter estimation*, PhD Thesis, DESY-THESIS-2007-016, May 2007.

D1. Michael Grefe, *Neutrino signals from gravitino dark matter with broken R-parity*, Diploma Thesis, DESY-THESIS-2008-043, September 2008.

D2. Jasper Hasenkamp, *General neutralino NLSP with gravitino dark matter vs. big bang nucleosynthesis*, Diploma Thesis, DESY-THESIS-2009-016, March 2009.

Submitted publications

S1. L. Covi, M. Grefe, A. Ibarra and D. Tran,
Neutrino Signals from Dark Matter Decay,
arXiv:0912.3521 [hep-ph], submitted to JCAP.

Preprints

P1. G. Bertone, T. Bringmann, R. Rando, G. Busetto and A. Morselli,
GLAST sensitivity to point sources of dark matter annihilation, arXiv:astro-ph/0612387.

Workshops financed by the project funds

W1. Workshop "Early Universe Thermometers" at the Physics Department, University of Padova on 6-8 February 2008,
http://www.pd.infn.it/ dibari/workshop.html

W2. "ENTApP Dark Matter Visitor's Program" at DESY Hamburg, 25-29 February 2008,
http://www.desy.de/ covil/entapp-vp08.html

5 Outreach activities

The project leader has participated to the outreach activity of DESY and given a talk on the question of proton decay with the title "Sind wir stabil ? (Are we stable ?)" in June 2009 at the "Science Cafe‘" organised weekly by DESY-PR.

Moreover the project leader has also participated and given invited talks at the German Women Physicist Conferences in 2006 ("Das dunkle Universum") and 2008 ("Bringing Light into the Dark: The Search for Dark Matter Candidates") with the goal of increasing the number of women students interested in cosmology and particle physics.