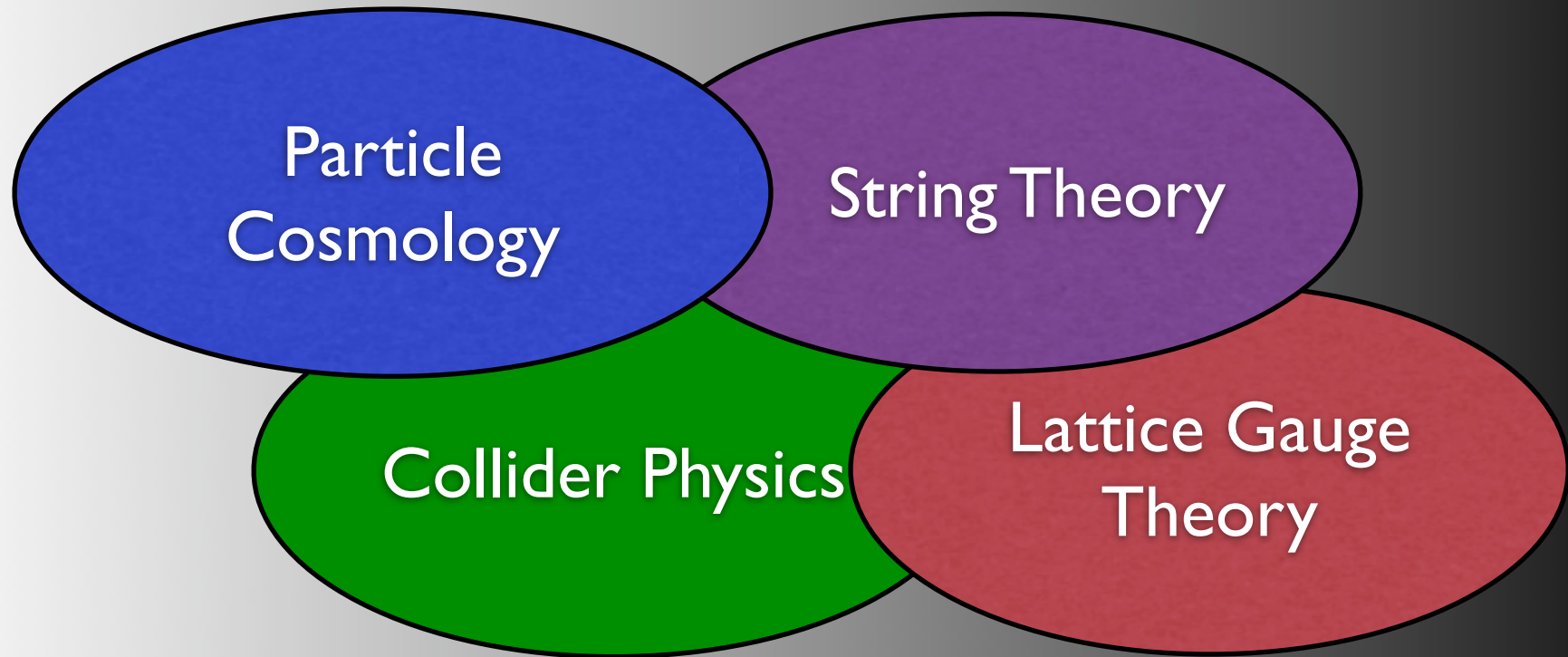


# DESY THEORY GROUP



Perturbative

Non-perturbative

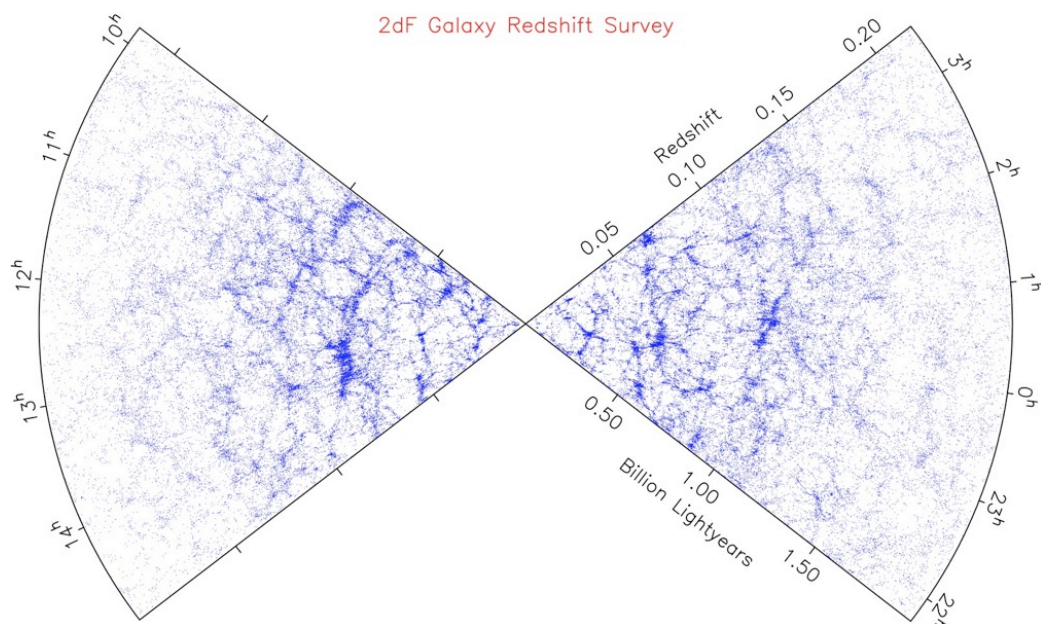
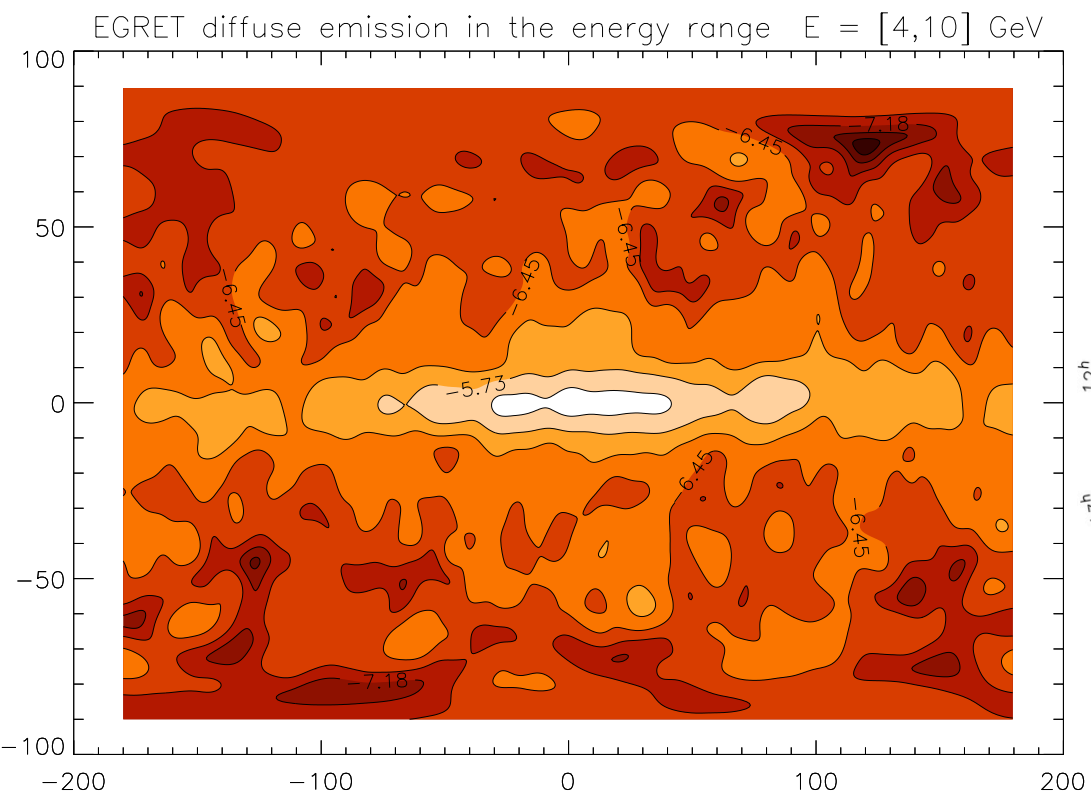
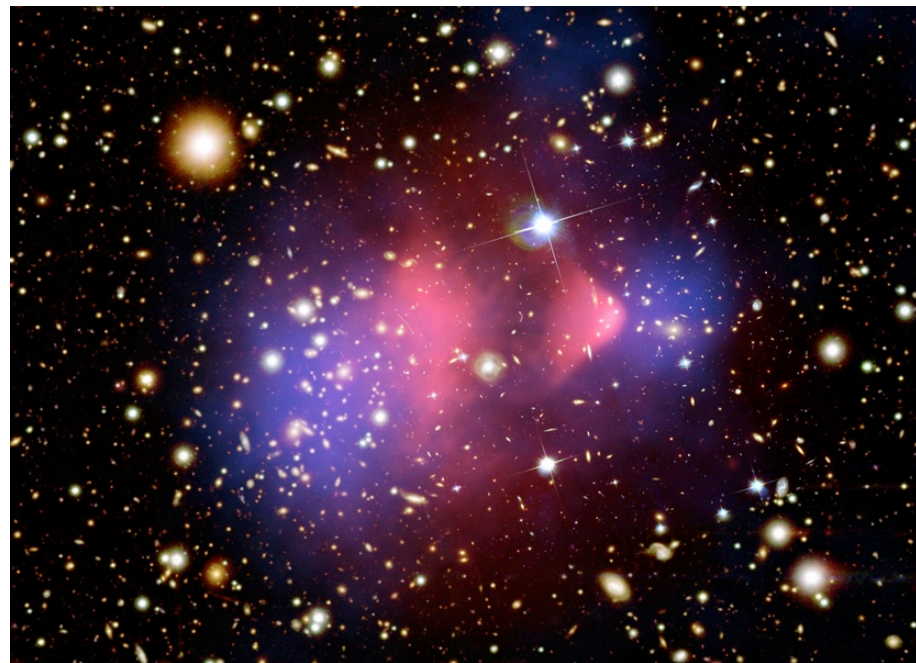
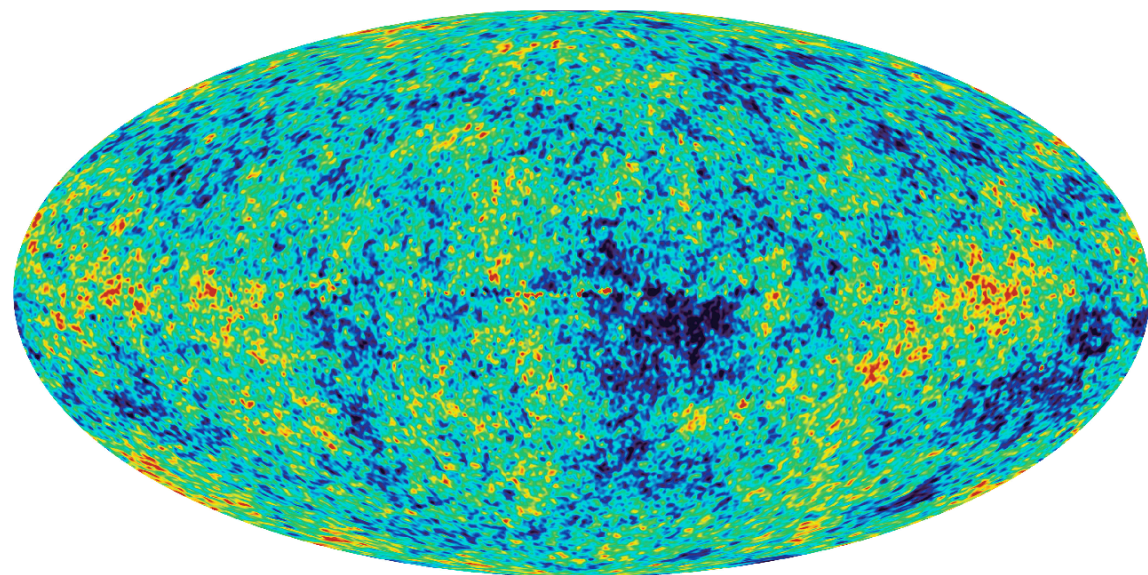
# PARTICLE COSMOLOGY GROUP

Wilfried Buchmuller, Laura Covi,  
Oleg Lebedev, Andreas Ringwald  
3(DESY)+5(YIG,SFB) PostDocs, 10 students



HELMHOLTZ  
| ASSOCIATION

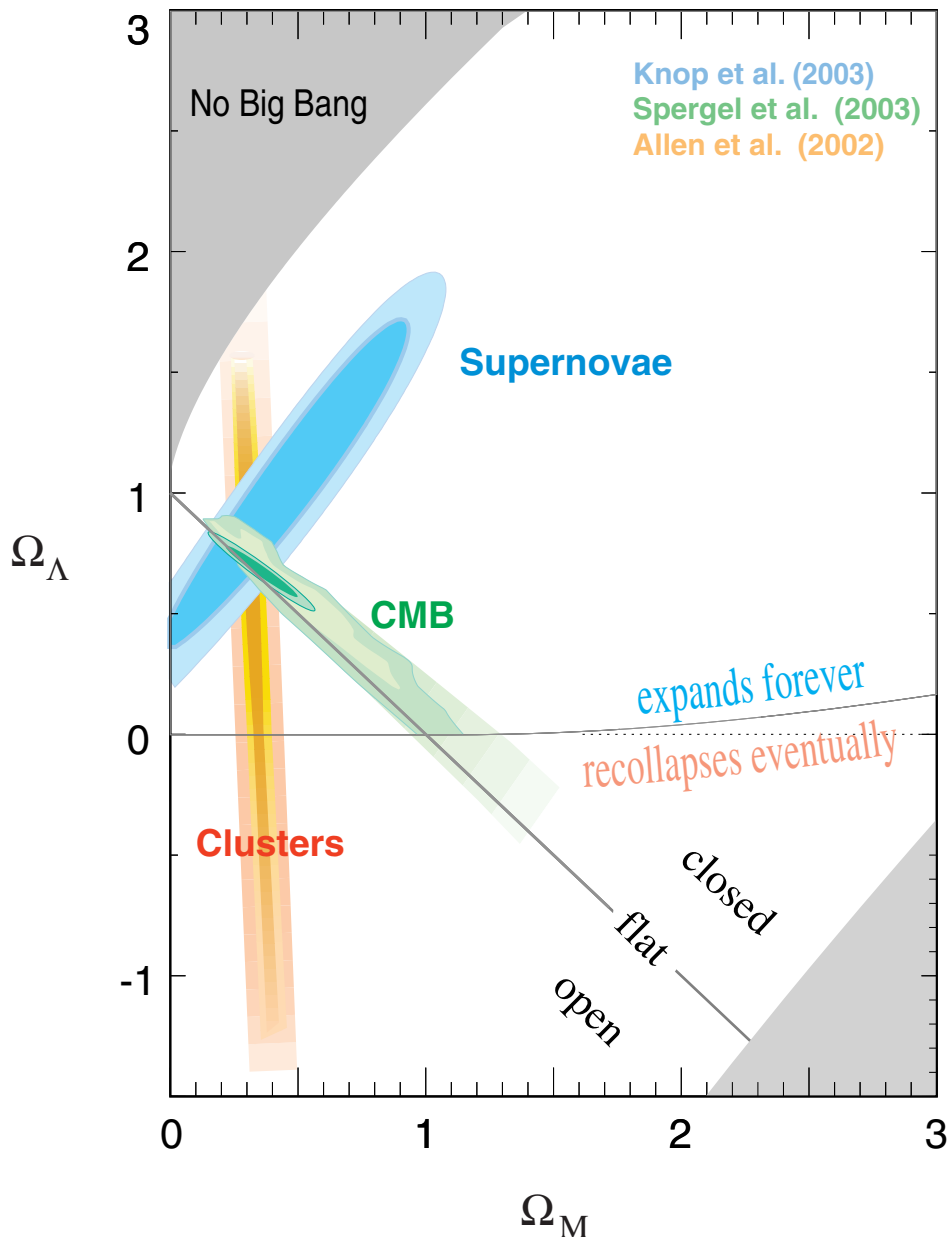
# Data driven field





# ... in search of a theory !

Supernova Cosmology Project



The “concordance”  
cosmological model  
emerged in the last years  
leaves many question  
unanswered:

What is Dark Energy ?  
What is Dark Matter ?  
How do Baryons survive ?  
Who is the inflaton ?  
How high was T ?

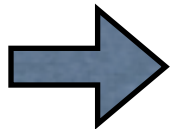
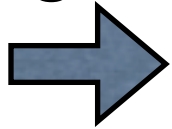
.....

# Many mechanisms, no model

- DE: cosmological constant, quintessence, ???
- DM: neutrinos, WIMP, superWIMP ???
- BA: EW baryogenesis, leptogenesis ???
- Inflation: single scalar field, hybrid, ???
- T: reheating, preheating, ???

All hints of physics beyond the Standard Model...,  
but no clear signature for a specific one yet !

# Our strategy:

- Look for connections between “signals” and for a consistent and coherent picture, e.g. **SUPERGRAVITY**
- Exploit information from all sides: cosmology, astroparticle, colliders, low energy data, etc...  **Collider Physics, SFB B,C**
- Exploit the theoretical developments and engage in model building  **String Theory, SFB A**

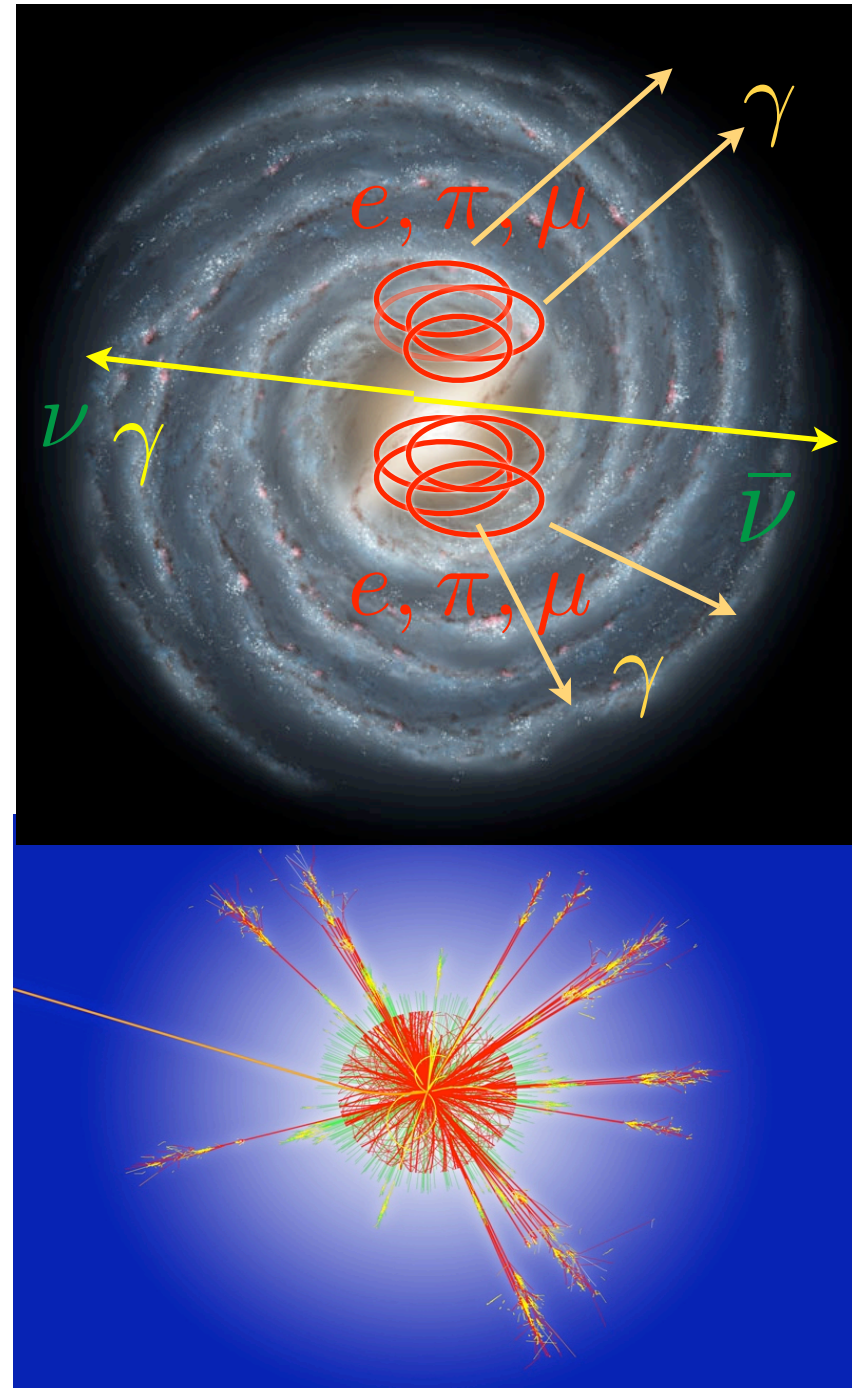
**Unique opportunity of the Hamburg environment !**

# A “consistent” history of time

$T(\text{GeV})$		
$\sim 0$	Inflation e.g. driven by a modulus ending in dS	C6
	Reheating/preheating to MSSM sector	SFB
$10^{10}$	Gravitino LSP production $m_{3/2} \geq 10 \text{ GeV}$	C3
$10^9$	Leptogenesis via RH neutrino decay	
$\geq 10^2$	Sphalerons reprocess L into B, B-L conserved	
$\sim 10$	NLSP freeze-out	
1	NLSP decay via R-parity breaking	(DESY YIG-IPMU)
$10^{-2}$		
$10^{-3}$	Nucleosynthesis and Standard Cosmology	

# Gravitino DM connection

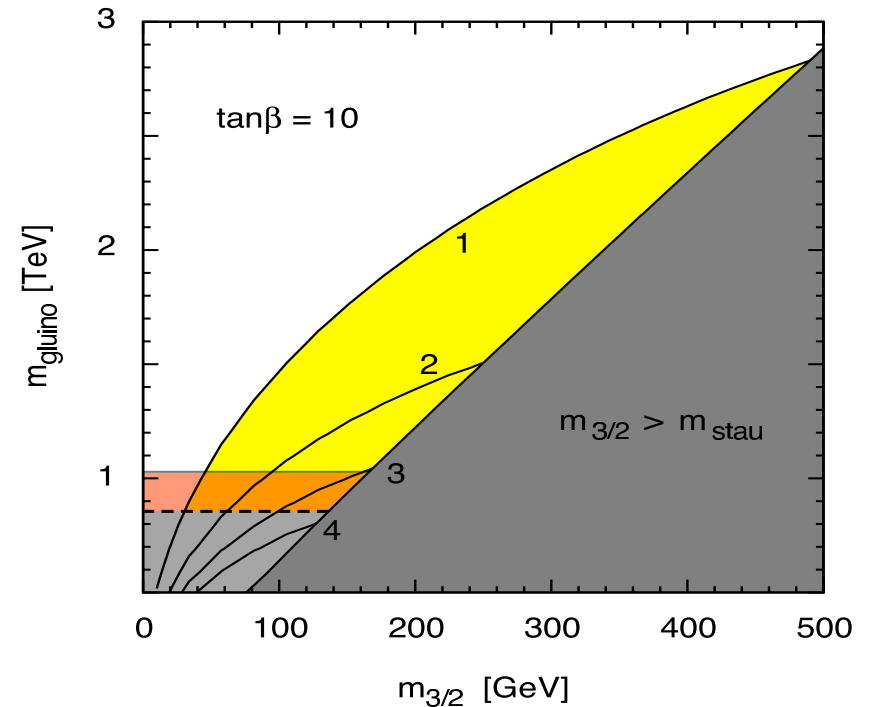
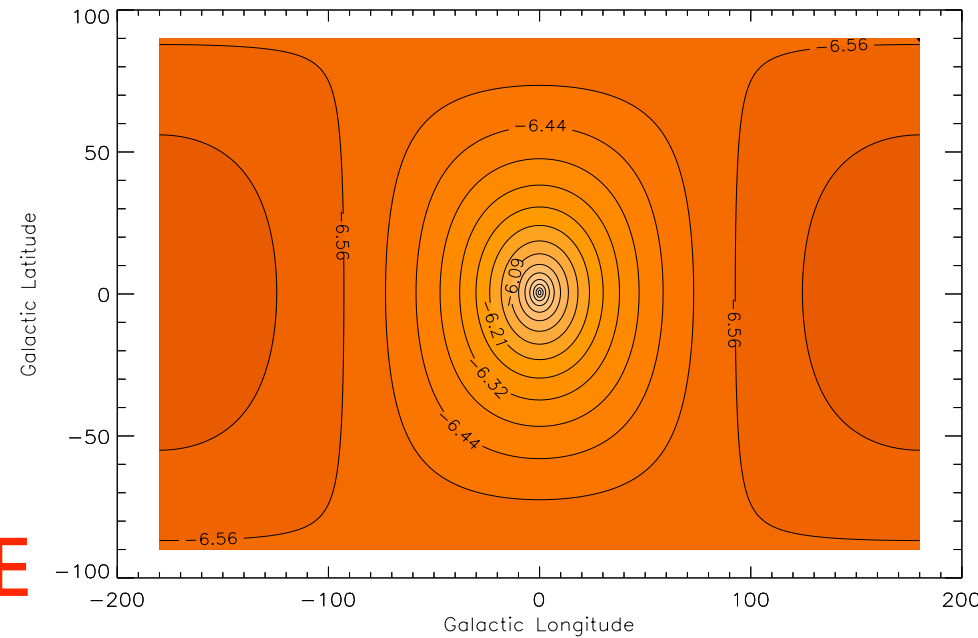
- Signal from DM decay in indirect detection channels: gamma-rays, positrons, antiprotons, neutrinos  
➔ **FERMI, PAMELA, ICECUBE**
- **Supersymmetry @ LHC** with NLSP as (meta)stable state: stau, neutralino, sneutrino, stop... with or without missing energy !





# Gravitino DM connection

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➔ **FERMI, PAMELA, ICECUBE**
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# Model building goes on...

- **Inflation in no-scale SUGRA:** at least two fields needed
  - > Pattern of SUSY breaking
  - > Non-gaussianities ???
- **Local GUTs in string theory**
  - > Role of R-symmetries
  - > Mass matrices and Flavour
  - > Proton decay
- **Hidden sector physics:** Weakly interacting sub-eV and axion-like particles from Strings
  - > ALPs experiment
  - > similar signature as decaying DM ?

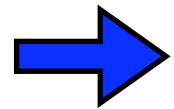
SFB: C6

AI

CI

# Future plans:

- keep up the activity at the same level after running out of VIPAC and Helmholtz YIG



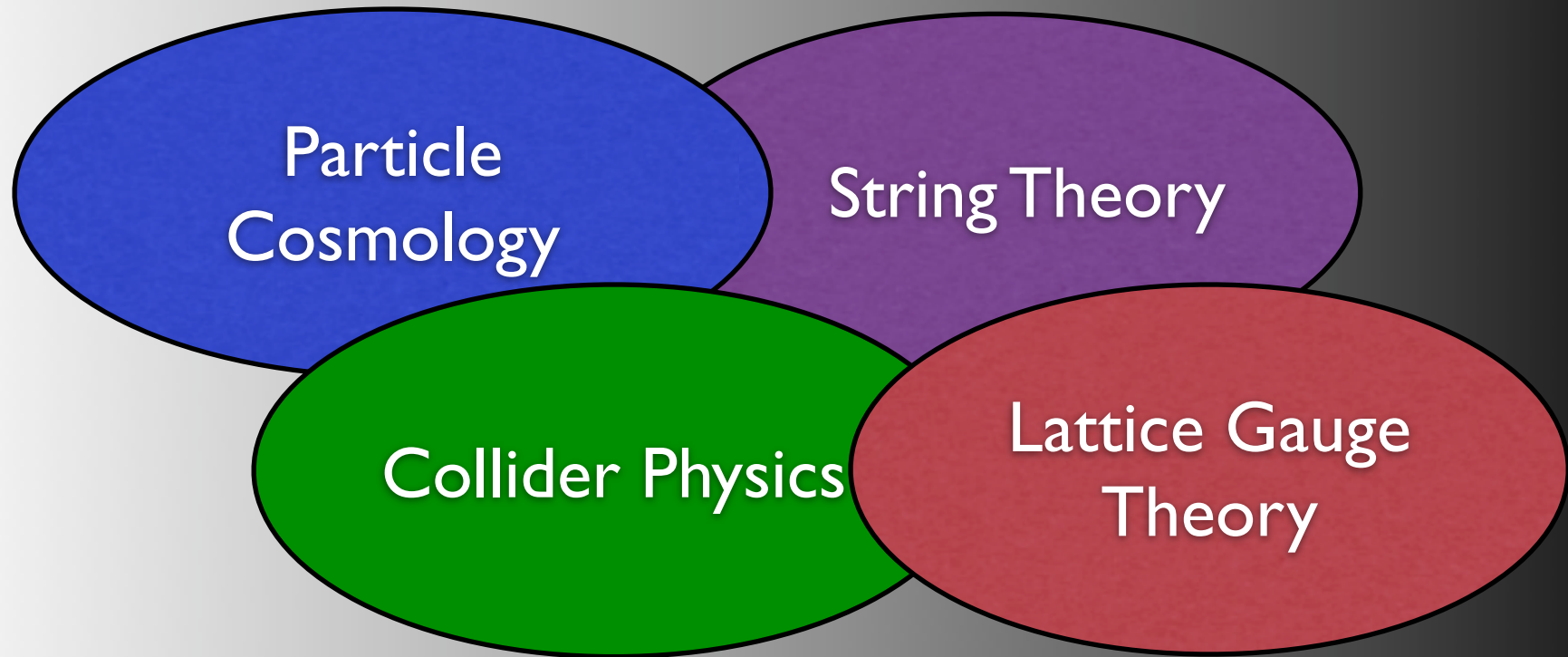
Gravitino DM connection  
(Premium Funding)

- extend the collaboration with **IPMU** INSTITUTE FOR THE PHYSICS AND MATHEMATICS OF THE UNIVERSE with a common Fellow/visitor program
- continue to play a leading role in Germany bridging between particle and astrophysics communities, organizing workshops, schools..
- contribute to the new **Hamburg Centre for Theoretical Physics** and **SFB 676**, etc...

“If we knew what it was  
we were doing it would  
not be called research,  
would it ?”

Albert Einstein

# DESY THEORY GROUP



Perturbative

Non-perturbative



**Back-Up slides**

# Conferences & Co

- PASCOS 2009 Conference in July
- Workshop Seminar in the WS and Workshop on “GUTs in Strings” in February 2009
- DESY Theory Workshop 2008 on Dark Matter  
4th Patras Workshop on Axions, WIMPs & WISPs
- VIPAC Meetings in Hamburg, Bad Honnef and Heidelberg
- SFB Lectures, MasterClass@FOM, Maria-Laach School, etc...

# Axions and other WISPs BSM

- Well motivated extensions of the SM predict WISPs: axions, hidden sector U(1) gauge bosons, etc...
- Strong ties between theory and phenomenology: from string model building to astroparticle and cosmology
- White Paper on physics case for a Low Energy Frontier of Fundamental Physics [in prep. 09]
- Shape worldwide WISPs expermntl. opportunities,

➔ **ALPS & Co**

