

The ALPS-II proposal.

An enlightening way of looking for new physics

Babette Döbrich (for the ALPS
collaboration)

LEXI Cluster Meeting

DESY Hamburg, october 11th, 2012

- > Shedding light onto new physics
- > What can we expect to find?
- > From ALPS-I to ALPS-II
- > Concluding thoughts

Connecting Particles with the Cosmos...

...through questions!

- > Fundamental (pseudo-) scalar particle? (✓) More?
- > Finetuning/Hierarchy?
- > What is the UV-completion of the Standard Model?
- > Puzzles in astroparticle physics
- > What is the nature Dark Matter/Dark Energy?

The Any Light
Particle Search ALPS

sheds light on all these matters
from a certain
angle



Beyond SM physics \leftrightarrow undiscovered particles?

massive particles?

- > high energies \rightarrow LHC
- > direct WIMP Dark Matter detectors



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low mass but weakly coupled?

- > Weakly Interacting Slim Particles
- > high intensities, low background (as for ν , events are rare)



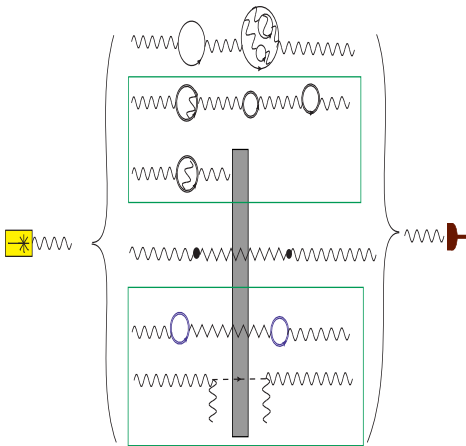
How to look for weakly coupled particles?

- > High intensities \Rightarrow photons/laser + cavity
- > low background \Rightarrow find setup that
excludes Standard Model processes

Light-shining-through-a-wall!



The Light-shining-through-a-wall principle



- > photon propagation in QFT can be nontrivial
- > shine laser on opaque wall
- > wall blocks all SM processes except neutrino (via W) and “graviton” (both negligible!)
- > Beyond SM: WISPs traverse wall due to weak coupling, reconvert to photons
- > some need **B**-field (spin!)
- > What can be found?

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The Axion and ALPs - nucleus of WISP physics



- > Axion = pseudo-scalar pseudo-GBS
↔ 'wash away' the strong CP
problem [Peccei/Quinn '77, Weinberg '78, Wilczek '78]

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J. J. Sakurai Prize for Theoretical Particle Physics

To recognize and encourage outstanding achievement in particle theory. The prize consists of \$10,000, an allowance for travel to the meeting of the Society at which the prize is to be awarded, and a certificate citing the contributions made by the recipient. It will be presented annually.

Establishment & Support

This prize was endowed in 1984 as a memorial to and in recognition of the accomplishments of J. J. Sakurai by the family and friends of J. J. Sakurai.

Rules & Eligibility

Nominations are open to scientists of all nationalities regardless of the geographical site at which the work was done. The prize may be awarded to more than one person on a shared basis. The prize will normally be awarded for theoretical contributions made at an early stage of the recipients research career. Nominations are active for three years.

Nomination & Selection Process

This year's deadline has passed. Please check back soon for next year's nomination information and deadline.

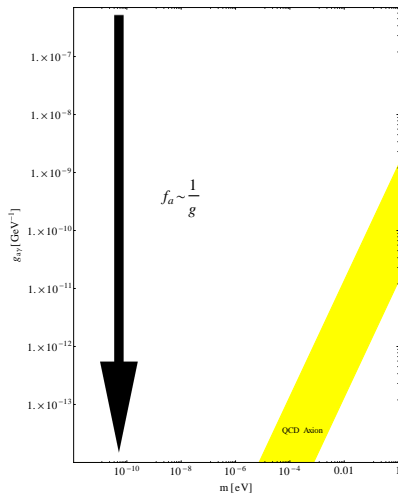
2013 Selection Committee: James Wells, Chair; H. Murayama; K. Lane; J. Bagger; M. Carena

2012 J.J. Sakurai Prize for Theoretical Particle Physics Recipient(s):
[Bryan Webber](#)
University of Cambridge
[Guido Altarelli](#)
Universita di Roma Tre
[Torbjorn Sjostrand](#)
Lund University

Past Recipients:
2011: [Chris Quigg](#)
[Estia Eichten](#)
[Ian Hinchliffe](#)
[Kenneth Lane](#)
2010: [Carl R. Hagen](#)
[Francis Englert](#)
[Gerald S. Gounaris](#)
[Peter W. Higgs](#)
[Robert Brout](#)
[T.W.B. Kibble](#)
2009: [Davidson E. Soper](#)
[John C. Collins](#)
[R. Keith Ellis](#)

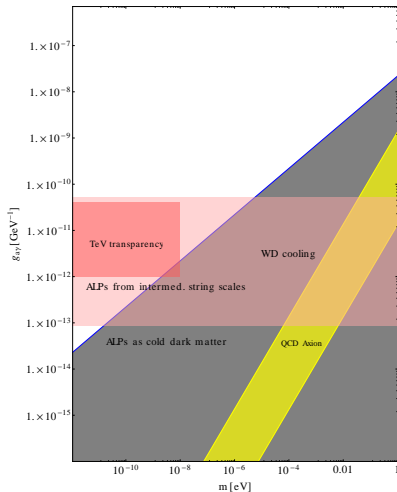


The Axion and ALPs - nucleus of WISP physics



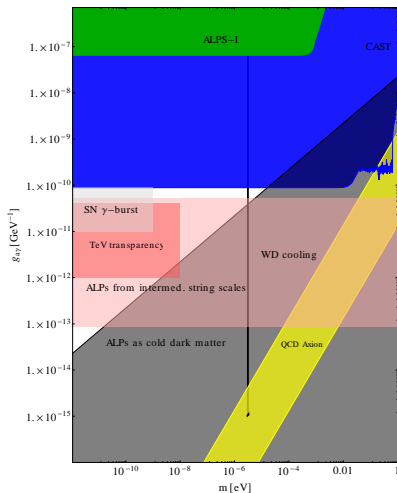
- > Axion = pseudo-scalar pseudo-GBS
 \leftrightarrow 'wash away' the strong CP problem [Peccei/Quinn '77, Weinberg '78, Wilczek '78]
- > fixed relation between m and g ,
symmetry breaking scale $f_a \sim 1/g$

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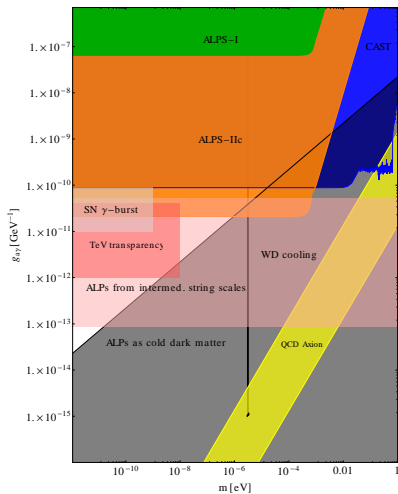
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- > reasons for axion-*like* particles
 - > intermediate string scale scenario
 - > **astrophysics puzzles (TeV + WD)**
 - > Dark Matter candidate

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- > search strategy: axion-photon conversion in *magnetic field*
 - > solar (e.g. CAST)
 - > Dark Matter (e.g. ADMX)
 - > homemade modelindependent (ALPS-I)

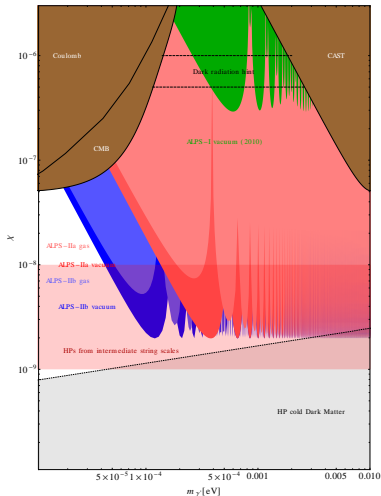
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 - > homemade modelindependent (ALPS-I)
- > ALPS-II: tackle all hints (partially)!

Further WISPs to be discovered with ALPS-II

- > hidden photons kinetically mixed U(1) e.g. from string & field-theory extensions
 - > Dark Matter candidate & possibly Dark Radiation
 - > experimentally no need for B-fields, oscillation process
 - > if B-field applied, also sensitive to minicharged particles (fractionally charged hidden matter)



Further WISPs to be discovered with ALPS-II

Shining Light on Modifications of Gravity

Philippe Brax,¹ Clare Burrage² and Anne-Christine Davis¹

¹Institut de Physique Théorique, CEA, IPhT, CNRS, URA2306, F-91191 Gif-sur-Yvette cedex, France

²School of Physics and Astronomy, University of Nottingham, Nottingham NG7 2RD, UK

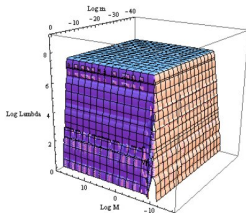


Figure 3. The constraint of the ALPS experiment on the m, M, Λ parameter space. All regions below the surface are excluded. The parameters are measured in units of GeV.

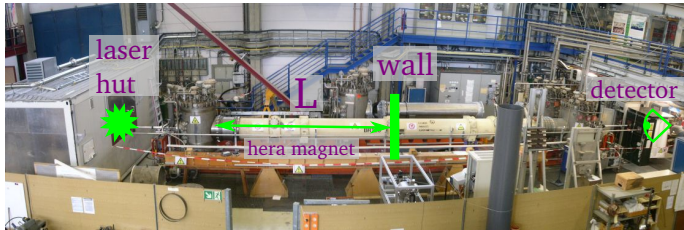
In Figure 3 the constraint of the ALPS experiment is shown in the three dimensional parameter space (m, M, Λ) . We see that in almost all of the interesting range the constraint on Λ is that of the conformally coupled axion-like particle case $\Lambda \gtrsim 10^7$ GeV.

- > hidden photons kinetically mixed U(1) e.g. from string & field-theory extensions
 - > Dark Matter candidate & possibly Dark Radiation
 - > experimentally no need for B-fields, oscillation process
 - > if B-field applied, also sensitive to minicharged particles (fractionally charged hidden matter)
- > scalar fields of massive gravity theories
 - > resolve Dark Energy through “very, very light gravitons”
 - > still a very young field

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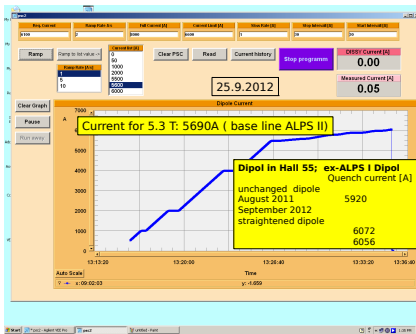


ALPS-I – and why NOT rest on our laurels



- > spare out-of-the-box HERA magnet, laser cavity on production side, CCD detector
- > concluded in 2010, still world-leading laboratory limits
- > Why ALPS-II: goes beyond limits from solar measurements and tackles favored parameter space for WISPs, pushes “Best-you-can-recycle-principle” to its limits

The ALPS-II proposal

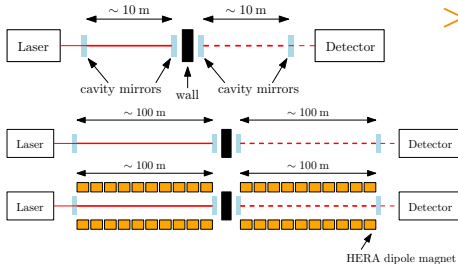


- > Main features of ALPS-II:
 - > 10+10 straightened *spare* HERA dipoles (due to aperture!)
 - > photon-cavities on both sides
 - > custom-made detector (transition edge sensor)



The ALPS-II proposal

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- > staged approach:
 - > ALPS-IIa (until 2014) 10m+10m *without* magnets
 - > ALPS-IIb (2015) 100m+100m *without* magnets (HERA West)
 - > ALPS-IIc (2017) 100m+100m *with* magnets (HERA North)



The ALPS-II proposal

Technical Design Report
Any Light Particle Search II
by the
ALPS Collaboration



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 - > ALPS-IIc (2017) 100m+100m *with* magnets (HERA North)
- > TDR handed in to PRC on august 31th, preparing for next PRC meeting in november (Zeuthen)

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Take-home messages

Hopefully you have not suffered from a

W I S P



Take-home messages

Hopefully you have not suffered from a Weakly Interacting Short-term-memory Presentation

- > Experiments such as the ALPS-II proposal *complement* high-energy searches for physics beyond the SM (need both!)
- > Circumstances seem right for ALPS-II
 - > infrastructure (HERA tunnel), manpower (several new supporters since ALPS-I), and expertise (e.g. staff familiar with HERA magnets)
 - > timing (growing theoretical interest and U.S. competition) and timeline (fixed! done in 2017)
- > Hoping for positive evaluation and – eventually – discoveries!

Thank you! And thanks to my fellow ALPSians at
DESY, U. Hamburg and U. Hannover



Open questions?

Forbidden questions:

- > Is there a hole in the wall to let the laser shine through?
- > Why name an experiment in Hamburg like some mountains in Bavaria?!
- > When do we get dinner?

<http://www.desy.de~doeblich/jch.html>

More questions? Join our seminar!