GDR Cophy, Episode 4, Clermont Ferrand — 01- 03 June 2026

Working Group TUG
Theory Universe Gravitation

Vivian Poulin *& Julien Lavalle*
Laboratoire Univers et Particules de Montpellier

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1. The TUG Initiative
2. 2025 TUG workshop
3. String-Cosmo Meeting

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The TUG initiative

- The TUG initiative brings together theoretical physicists from French institutes working cosmology, gravitation, and high-energy / astroparticle physics => **annual national workshop, started 2021**
- (~70-100 participants/yr since 2021, ~250 on mailing list)
- Highlight current research topics to a broad audience of th. physicists (incl. students)
- Exchange ideas/viewpoints between fields, increase contact within French co/gr-qc/th/ph community
- Promote participation/work of young scientists

TUG'25 workshop @ IPhT-Saclay

Main topics:

- String theory and quantum gravity in the context of black hole physics or cosmology
- Gravitation in the strong field regime w/wo connection to observations (Gws), incl. modified gravity
- Amplitudes**:** high-energy scattering tools applied to GR, GW and possible beyond-GR corrections.
- primordial cosmology: Inflation, bouncing cosmology, phase transitions/cosmic strings
- The dark universe (dark energy, dark matter, structures) – models, signatures, probes

Symmetries of asymptotically flat spacetimes

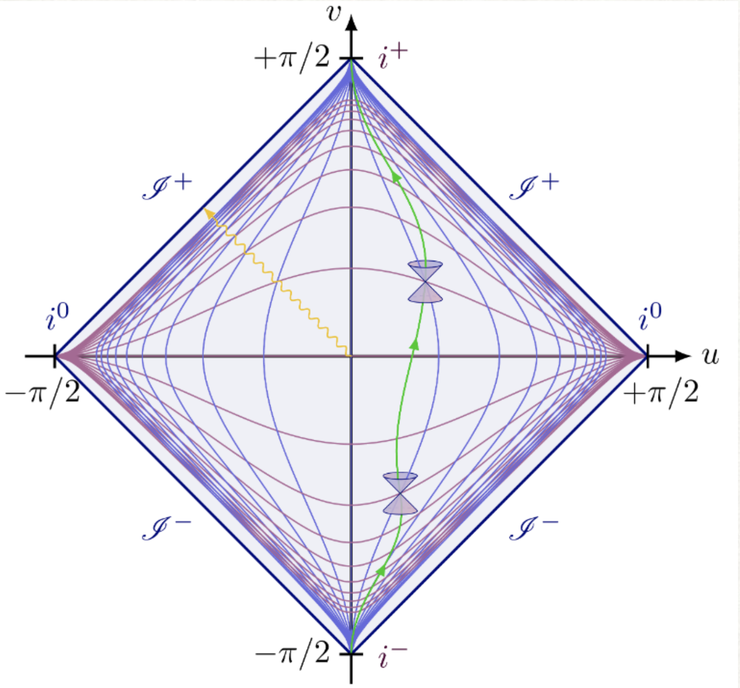
Céline Zwikel

Why?

- Definition of observables for gravity (ex: energy)
- Bottom-up approach to new holographic dualities
- Quantum Gravity: quantum states form a representation of the asymptotic symmetry algebra → Non-perturbative handle on Quantum Gravity
- Connection with low energy physics (infrared red triangle)

Conclusion

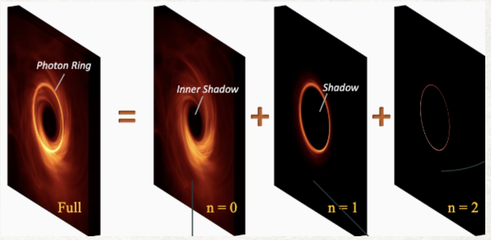
- BMS symmetry has important consequences for infrared physics and in building a flat hologram
- New symmetries to be investigated and tested!
- This is not tied to general relativity in 4d asymptotically flat spacetimes
  This applies to
  - other theories (ex: twistor theory and celestial symmetries)
  - other dimensions
  - other boundaries (ex: for instance: black hole horizon)
  - with matter and other gauge fields



Symmetries in GR → another example:

A new integrable parametrization for deformations to the Kerr photon ring

Hugo Roussille
with J. Ben Achour, É. Gourgoulhon

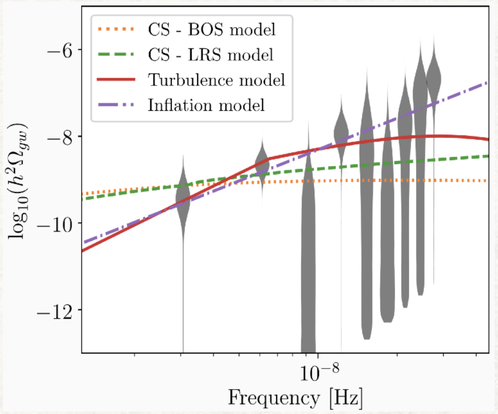


Cosmic strings: a decade in the gravitational wave era

Pierre Auclair

TUG 2025

EPTA Credits: Antoniadis et al. 2023



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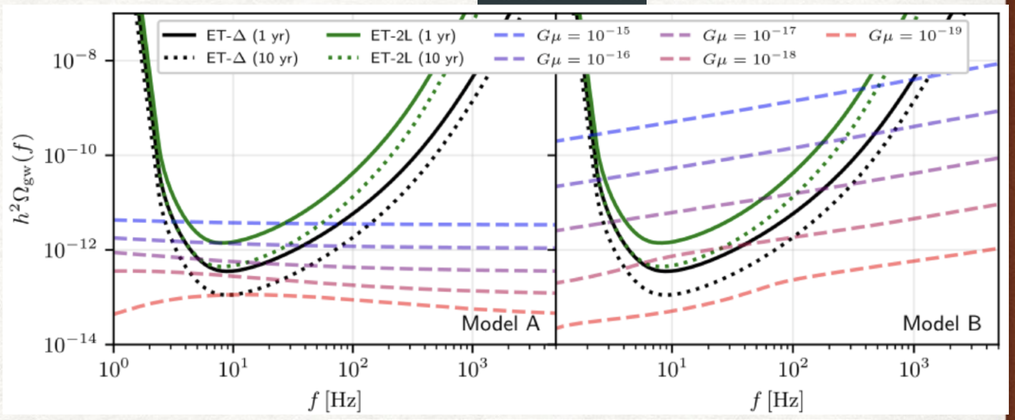
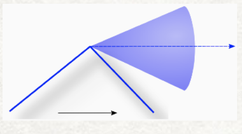


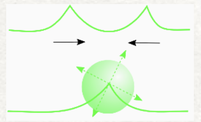
The Science of the Einstein Telescope

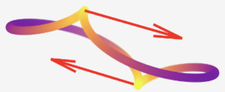
$$\mathbf{X}(t,\sigma) = \frac{1}{2}[\mathbf{a}(t-\sigma) + \mathbf{b}(t+\sigma)]$$

Cosmic strings emit gravitational waves:

- Oscillation
- Kink: when $\mathbf{X}'$ is not continuous
- Kink-kink collision
- Cusp: when $\dot{\mathbf{X}}^2 = 1$



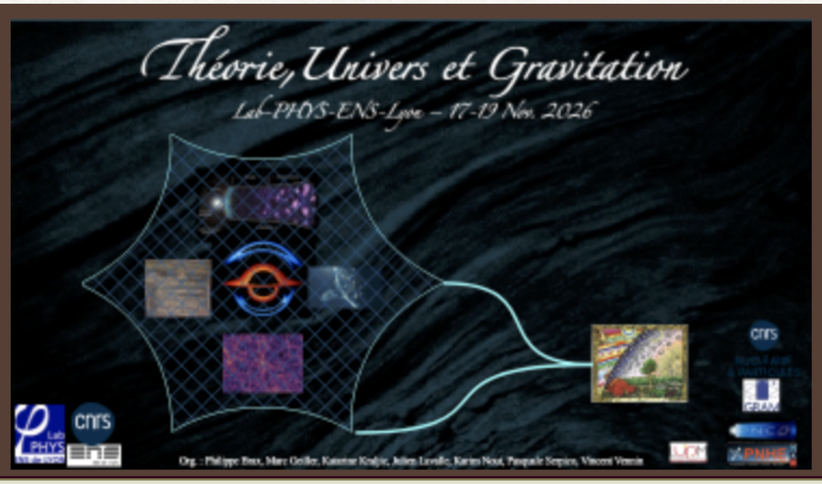




Conclusion

- Observations are already here and will be more and more precise
- There are tensions in our current approach to cosmic string predictions
- There are hints that fragmentation may play a role

Next TUG @ LP-ENS-Lyon,'26-11-17



Théorie, Univers et Gravitation - TUG

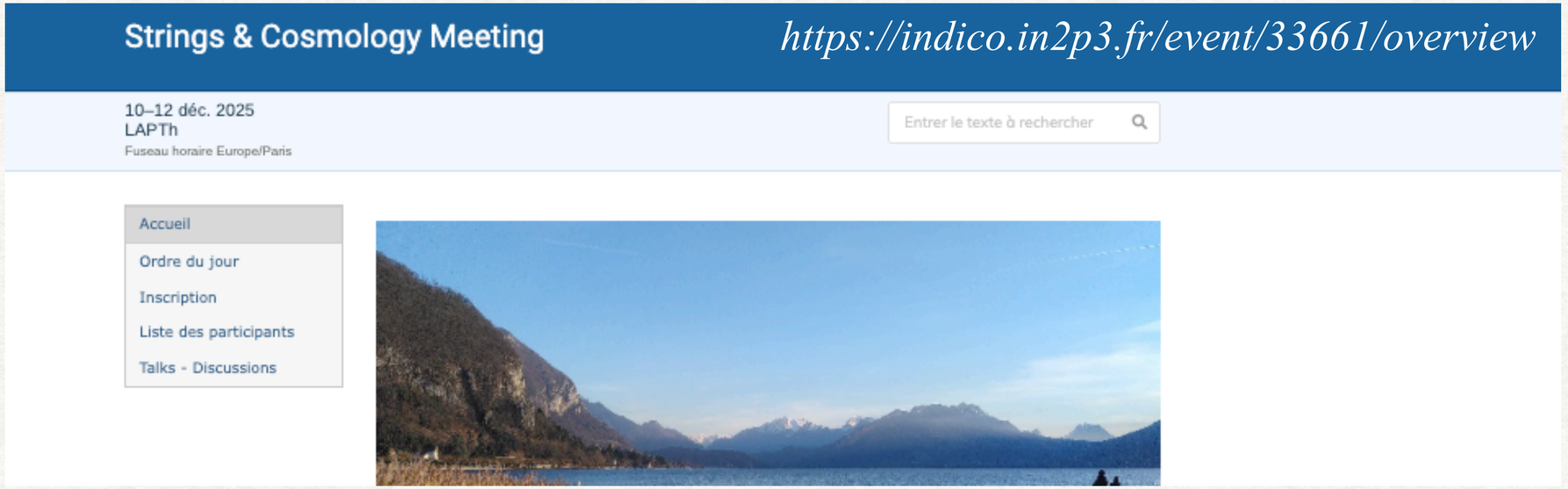
Nov 17 – 19, 2026
ENS de Lyon

https://indico.in2p3.fr/event/38354/

Enter your search term

Registrations are open and abstract submission is welcome!

Strings & Cosmology meeting



- Three days meeting bringing together **String Theorists** and **Cosmologists (ratio 60%:40%)**
- **LAPTh Annecy** 10-12 dec 2025 ; 2nd edition after the **String-Cosmo Day in 2023**
- ~75 people with **~50 international + ~25 French** participants
- 20 invited talks (including **reviews** & talks by **young researchers**) + 6 discussion conveners
- **Organisers:** David Andriot, Vivian Poulin, Sébastien Renaux-Petel, Gary Shiu
- **Funding:** CPTGA, CSAA CG, Enigmass+, EuCAPT, GdR CoPhy, IRN:QFS, LAPTh, LUPM, Owners of Annales H. Poincaré, Région AURA

Scientific motivations

"String theory for cosmologists ... Cosmology for String Theorists"

From the string theory side

- Since BICEP2 (2014) , the Swampland de Sitter Conjecture (2018)

  —> important activity / renewed interest in **string theory** to **derive cosmological models**

- Getting informed about New DESI results / Cosmic tensions / Inflation
- Difficult to get observationally valid models

From the cosmo side

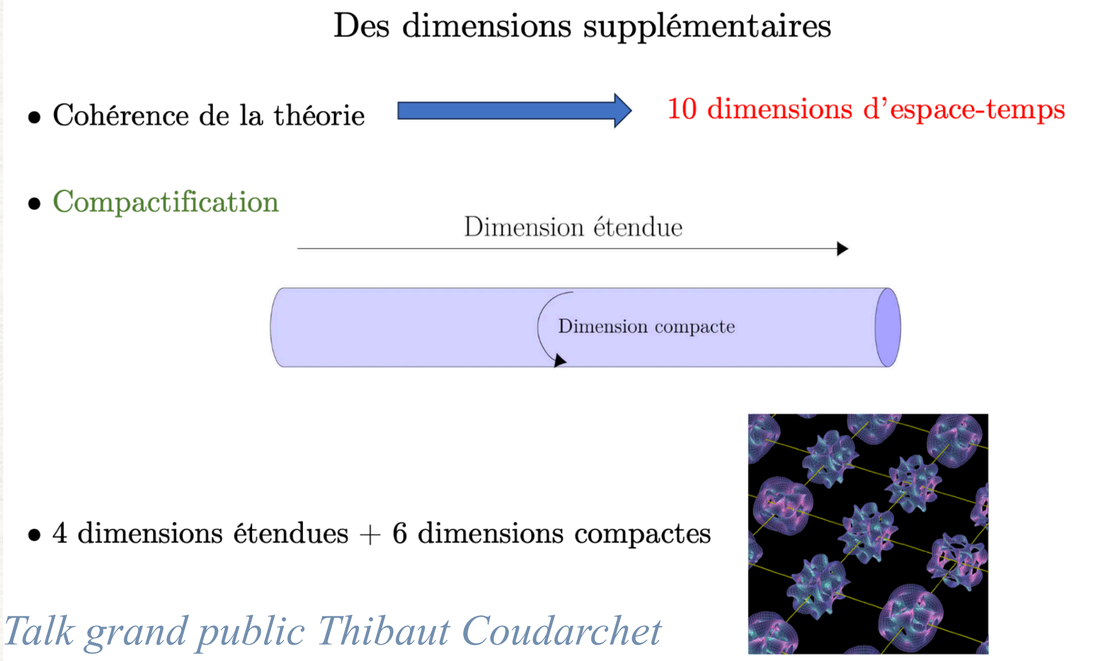
- Getting informed about string theory attempts/constraints on models

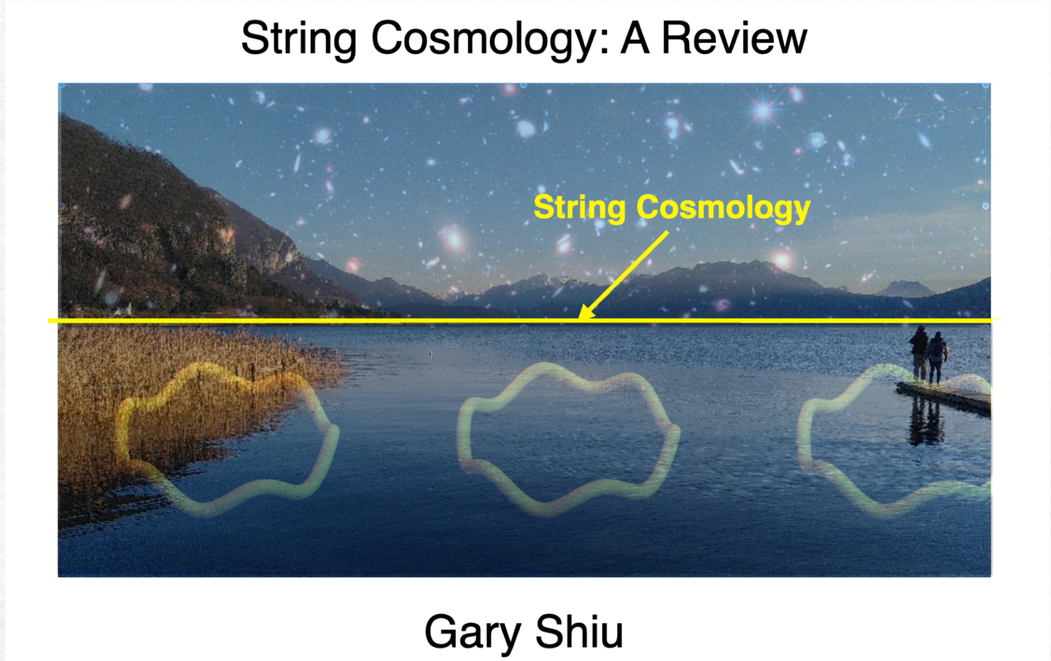
  —> can we motivate specific models for inflation/DE/tensions?

- General questions and curiosity

String Cosmology: why?

A UV completion of gravity: it should contain cosmology !





- **Generic new ingredients:** compactifications naturally produce moduli, axions, hidden sectors, cosmic strings/branes and dark radiation.
- **Swampland program:** use quantum-gravity consistency to test which inflation and dark-energy EFTs can actually arise from string theory.

Can String Theory explain Dark Energy?

Andriot 2603.25797

The Elephant in the Room

Susha Parameswaran

University of Liverpool

String Cosmology Workshop
Annecy, 10th December 2025

erc European Research Council Established by the European Commission

SCUOLA NORMALE SUPERIORE

New Vacua in Heterotic Sting Compactifications

Nicole Righi

based on work with
Jacob M. Leedom, Alexander Westphal

Strings & Cosmology Meeting, 10/12/25

Finding Dark Energy

in the Riemann-Flat Landscape

ift

Miguel Montero
IFT Madrid

CSIC Consejo Superior de Investigaciones Científicas

***Transient* acceleration in *asymptotic* regimes of string theory?**

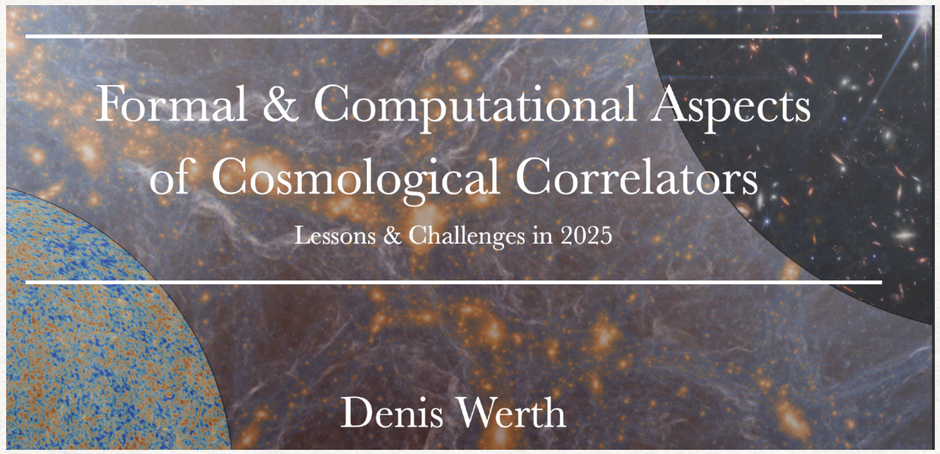
Based on work in progress with **Gonzalo F. Casas**
Ignacio Ruiz, CERN

- **Problems:** is de Sitter controlled? why does vacuum energy gravitate so little?

$$\frac{|\nabla V|}{V} \geq \frac{c}{M_{\rm Pl}}, \quad c \sim \mathcal{O}(1)$$

- **String angle:** dark energy could be dynamical/transient; stringy solutions to the old CC problem?

Connection between string theory and inflation



Geometry of Kinematic Flow
Differentiation for Cosmological Correlators

Harry Goodhew

Constraints on inflation from the gravitational path integral?

Oliver Janssen
EPFL

Lucas Pinol
CNRS researcher, LPENS, Paris

the primordial curvature perturbation

ONE-LOOP FREEZING OF ζ
AND RENORMALIZATION OF THE EFT OF INFLATIONARY FLUCTUATIONS

- **Inflation probes UV physics** through primordial fluctuations.
- **Correlators encode signatures** of heavy fields and quantum gravity.
- **EFT control:** quantum corrections, renormalization and gravity effects must not spoil predictions.

CMB, DESI & Cosmic Tensions

Cosmological constraints from DESI observations

Rodrigo Calderón
Institute of Physics (FZU), Czech Academy of Sciences

Tensions in Cosmology

The role of Type Ia Supernovae

Mickael Rigault | m.rigault@ipnl.in2p3.fr

Tensions in Cosmology

Ali Rida Khalife
Strings & Cosmology Meeting | December 2025

- DESI constraints and possible evolving dark energy
- SNe Ia systematics, host correlations, dataset agreement
- CMB/ACT and broad cosmological tensions

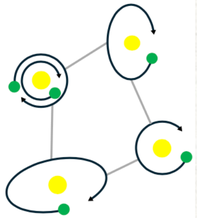
$$c \sim \sqrt{\frac{3(1+w_0)}{\Omega_{\mathrm{DE},0}}} \sim 0.9$$

(Naive, single field slow-roll estimate after DESI)

Models for cosmic tensions

Axion-dilaton interactions in the dark sector

Adam Smith



Adam Smith,[a] Maria Mylova,[b,c,d] Philippe Brax,[e] Carsten van de Bruck,[a] C.P. Burgess[d,f,g] and Anne-Christine Davis[h,i]

The search for new physical degrees of freedom and the dark sector of cosmology

Jean-Philippe UZAN

Early Dark Energy and Phantom Crossing in axio-dilaton Systems

Philippe Brax
Institut de Physique Théorique
Université Paris-Saclay

2310.02092

MODELS OF INTERACTING DARK ENERGY

Illustrations: Inês Viegas Oliveira (ivoliveira.com)

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(elsa.teixeira@umontpellier.fr)
Laboratoire Univers et Particules de Montpellier
CNRS & Université de Montpellier

Based on:
- [arxiv:2503.01961] with: Saba Rahimy and Ivonne Zavala
- [arxiv:2211.13653] with: Carsten van de Bruck and Gaspard Poulot
- [arxiv:2412.14139] with: Carsten van de Bruck, Gaspard Poulot, Vivian Poulin and Eleonora Di Valentino

- Axion/Dilaton, SM/DM/DE couplings are string inspired
  => light scalar field and couplings to matter ubiquitous in string theory

Discussions

- 3 discussions led by string theorist/cosmologist

  Some discussion hook

- Can we prove String theory?
- Can we trust cosmological measurements?
- Can string theory help explain DESI ? H0?

"There are no stupid questions!"

Interface between string theory and cosmology

An open discussion

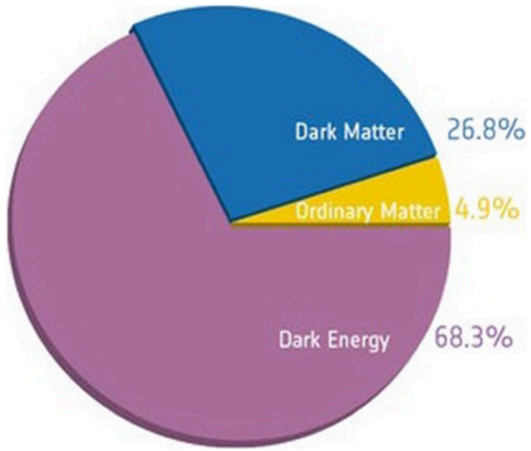
Discussion
Shaking LCDM, not stirring

William Giare & Miguel Escudero

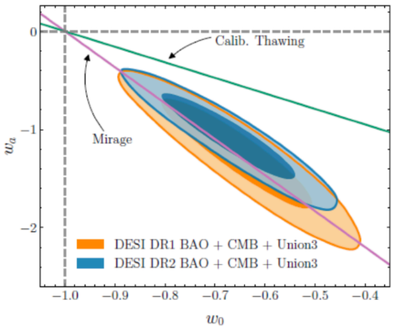
Discussion —Lessons, Connections, Constraints

The views of Anne and Thomas!

The Dark Universe;
(Embarrasing)



DESI



TUG: Theory Universe Gravitation

- The TUG initiative brings together theoretical physicists from French institutes working cosmology, gravitation, and high-energy / astroparticle physics

- One annual national meeting covering string/quantum gravity/amplitudes <—> GR, cosmology, GW. Dark universe
- Discuss current research topics, develop interfaces, and promote young scientists

- String/Cosmo meeting: “String theory for cosmologists … Cosmology for String Theorists”
- Help cosmologists understand “string cosmology”, swampland, model building
- Help string theorists understand/trust cosmological results.
- Strong international participation. Every other year (?)