iTHEMS Cosmology Forum n°4 - Evolving Cosmos: new physical insights from new spectroscopic data

Report of Contributions

https://indico2.riken.jp/e/5264

Contribution ID: **1** Type: **not specified**

Keynote Talk - Dark energy and cosmology from DESI Data Release 2

Monday 4 August 2025 10:00 (1h 15m)

More than 25 years after the discovery of the accelerated expansion of the Universe, the physical nature of dark energy remains elusive. The Dark Energy Spectroscopic Instrument (DESI) is the first of a new generation of "Stage-IV"cosmology survey experiments aiming to improve this understanding. By precisely mapping the positions of over 50 million galaxies and quasars, DESI is measuring the expansion history of the Universe over the last 11 billion years. I will describe the experiment and discuss the cosmological results from the first 3 years of data, from baryon acoustic oscillations (BAO) and the full shape of the clustering power spectrum. These include exciting hints of an anomaly in the cosmological constant model of dark energy, and unprecedented constraints on the neutrino mass scale. I will describe the nature of the data constraints and comment on the implications for fundamental physics models.

Presenter: Dr NADATHUR, Sesh (University of Portsmouth)

Contribution ID: **2** Type: **not specified**

Invited Talk - The Cosmological Constant Problem, Time-Varying Dark Energy, and DESI

Monday 4 August 2025 13:30 (1 hour)

The cosmological constant problem, the most serious fine-tuning problem for the standard model parameters, remains a major puzzle, especially in light of Weinberg's no-go theorem, which forbids natural solutions if dark energy is constant.
Recent DESI observations suggest time variation in dark energy, opening a possible loophole. I present a model that realizes this idea to make the tuning technically natural.
Interestingly the prediction points to a dark energy evolution consistent with DESI DR1 and DR2.

Presenter: Dr YIN, Wen (Tokyo Metropolitan University)

Contribution ID: **3** Type: **not specified**

Poster Session (with Discussion & Coffee!)

Monday 4 August 2025 14:30 (1 hour)

Yu Komiya - The phenomenology of domain walls and PBHs as probes of early universe dynamics
Tomoki Katayama - Bi-Horndeski Theory

Presenters: KATAYAMA, Tomoki (Sokendai); KOMIYA, Yu (Yukawa Institute for Theoretical Physics, Kyoto University)

Contribution ID: **4** Type: **not specified**

Invited Talk - Detecting clustering dark energy using cosmological observations

Monday 4 August 2025 15:30 (1 hour)

Clustering dark energy is a class of models in which the speed of propagation of the perturbations in the dark energy component is small compared to the speed of light, causing the perturbations to collapse on scales inside the horizon and affecting the process of cosmic structure formation. This presentation will go over the effects we expect to detect in cosmological observations and how we can use them to constrain the speed of sound of dark energy perturbations. I will then present a numerical approach to simulate such scenarios using the effective fluid description and I will show some preliminary results of the implementation of these methods in a cosmological simulation code.

Presenter: Dr BLOT, Linda (Kavli IPMU)

Contribution ID: **5** Type: **not specified**

Invited Talk - Baryon Acoustic Oscillations from DESI DR2

Tuesday 5 August 2025 10:00 (1 hour)

The Dark Energy Spectroscopic Instrument (DESI) is conducting a 5-year redshift survey of 40 million extra-galactic sources over 14,000 square degrees of the northern sky. One of its primary goals is to measure the cosmic expansion history across a wide range of redshifts using baryon acoustic oscillations (BAO). In this talk, I will present the latest DESI BAO results, which are based on the first three years of data. I will begin with an introduction to DESI and walk through the various steps of the analysis, from collecting galaxy spectra to making accurate and precise BAO measurements.

Presenter: Dr CUCEU, Andrei (LBNL)

Contribution ID: **6** Type: **not specified**

Invited Talk - Untangling multi-probe hints for beyond-ΛCDM physics

Tuesday 5 August 2025 13:00 (1 hour)

I will discuss the evidence for beyond-ΛCDM physics arising from the combination of different cosmological probes including DESI BAO, primary CMB and CMB lensing. I will review the information that can be extracted from the different probes. The tension between the parameters, particularly the matter fraction, inferred from individually fitting ΛCDM to each probes hints at the potential for new physics. However, I will show that although evolving dark energy is the only model found to fit the data when supernovae observations are included, several model extensions provide viable fits when these contested observations are excluded. Furthermore, it was recently pointed out that within the ΛCDM model a systematic error in the optical depth inferred from the primary CMB is also able to explain the observed discrepancies. Finally, I will look towards future avenues for untangling the complex picture arising from the combination of different probes and making headway in constraining a consistent cosmological model.

Presenter: Dr FARREN, Gerrit (LBNL)

Contribution ID: **7** Type: **not specified**

Invited Talk - Spacetime & gravity after/during Planck/DESI/SH0ES

Tuesday 5 August 2025 14:30 (1 hour)

Recently, there has been considerable debate regarding potential evidence for the dynamical nature of dark energy (DE), particularly in light of Baryon Acoustic Oscillations (BAO) measurements released by DESI survey. In this work, we propose an agnostic test that simultaneously constrains the dark energy (DE) equation of state (EoS) and probes the possibility of a transition between the quintessence and phantom regimes, or vice versa. Our initial approach is independent of physical priors, allowing the data to determine which behavior best fits the parameters. We then consider a minimally modified gravity theory known as VCDM, into which we can map our initial approximation, placing it within a theoretically stable framework. To this end, we incorporate the most up-to-date datasets available, including BAO measurements from DESI-DR2, Type Ia Supernovae from the PantheonPlus, DESY5, and Union3 samples, as well as Cosmic Microwave Background (CMB) data from Planck. Our analysis reveals strong and statistically significant evidence for a quintessence-phantom transition across various data combinations. \textit{The strongest evidence is found for Planck+DESI+DESY5, with a significance exceeding ~5σ in favor of a quintessence-phantom transition at z_†=0.493_{−0.081}^{+0.063}}. Beyond this redshift, the EoS remains within the phantom regime, whereas for z<z†, it favors the quintessence regime. Despite this strong indication, we find that such transitions do not resolve the H0 tension.

Presenter: Dr DE FELICE, Antonio (YITP)

Contribution ID: **8** Type: **not specified**

Panel Discussion

Tuesday 5 August 2025 15:45 (1 hour)