COSMOPOWER: emulating cosmological power spectra for accelerated Bayesian inference from next-generation surveys

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with D. Piras, J. Alsing, B. Joachimi, M. Hobson

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Based on ASM+, 2106.03846

COSMOPOWER

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We introduce a suite of
neural cosmological power spectrum emulators
covering both CMB (temperature, polarization and lensing),
and large-scale structure power spectra

EMULATION

- Boltzmann solvers: computational **bottleneck** for 2pt stats analysis

- ***emulation*** of power spectra speeds up theory predictions

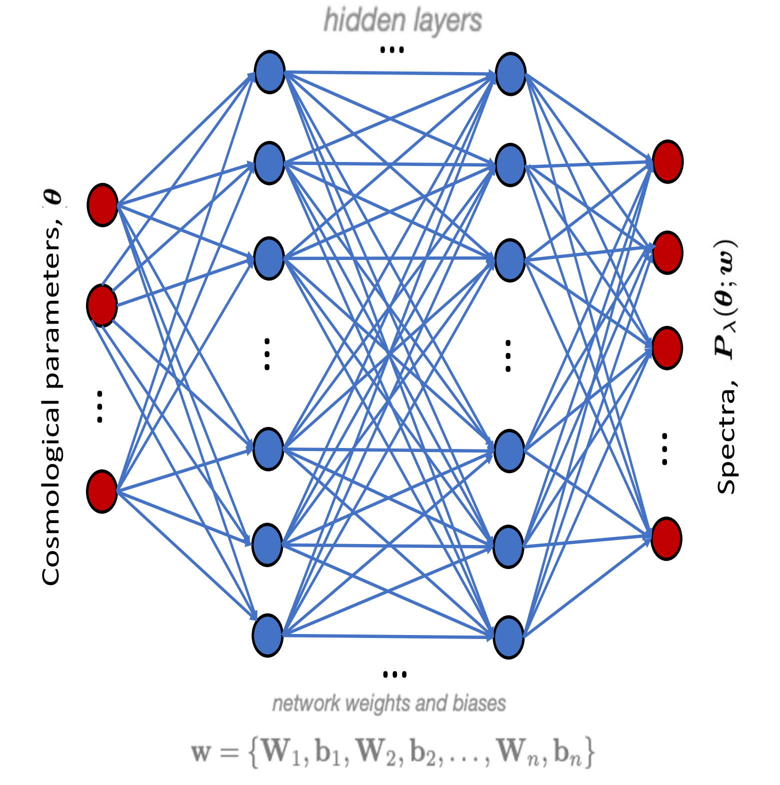
(Fendt & Wandelt 07, Auld+08, Agarwal+12..., Aricò+21, Mootoovaloo+21)

- a "simple" Machine Learning problem ...
- ... with exceptionally high levels of **accuracy** required!

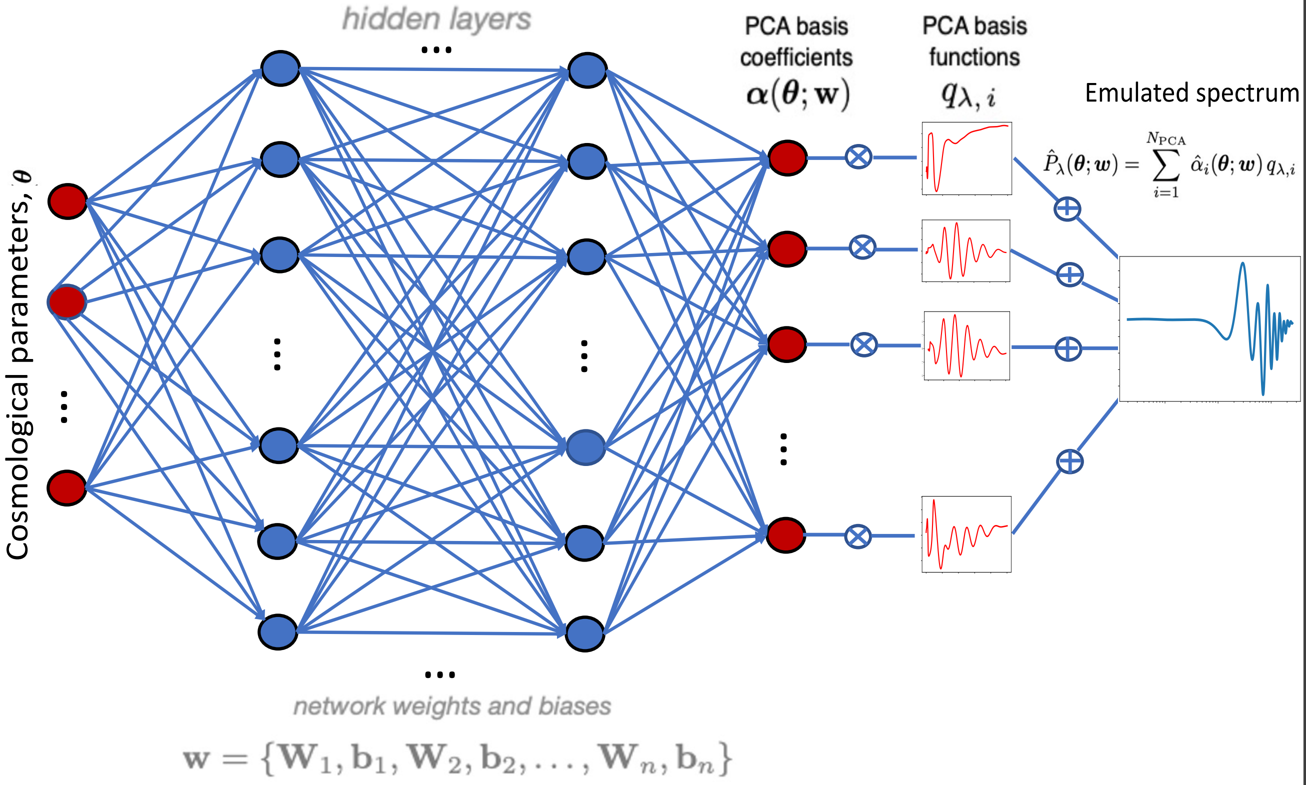
→ need **flexible** and **well tested** tool. CosmoPower emulates

- P(k,z) (LIN+NL BOOST)
- CMB TT, TE, EE, $\phi\phi$

METHODS



NEURAL NETWORK



NEURAL NETWORK + PCA

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TensorFlow

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KIDS-450+GAMA 3X2PT

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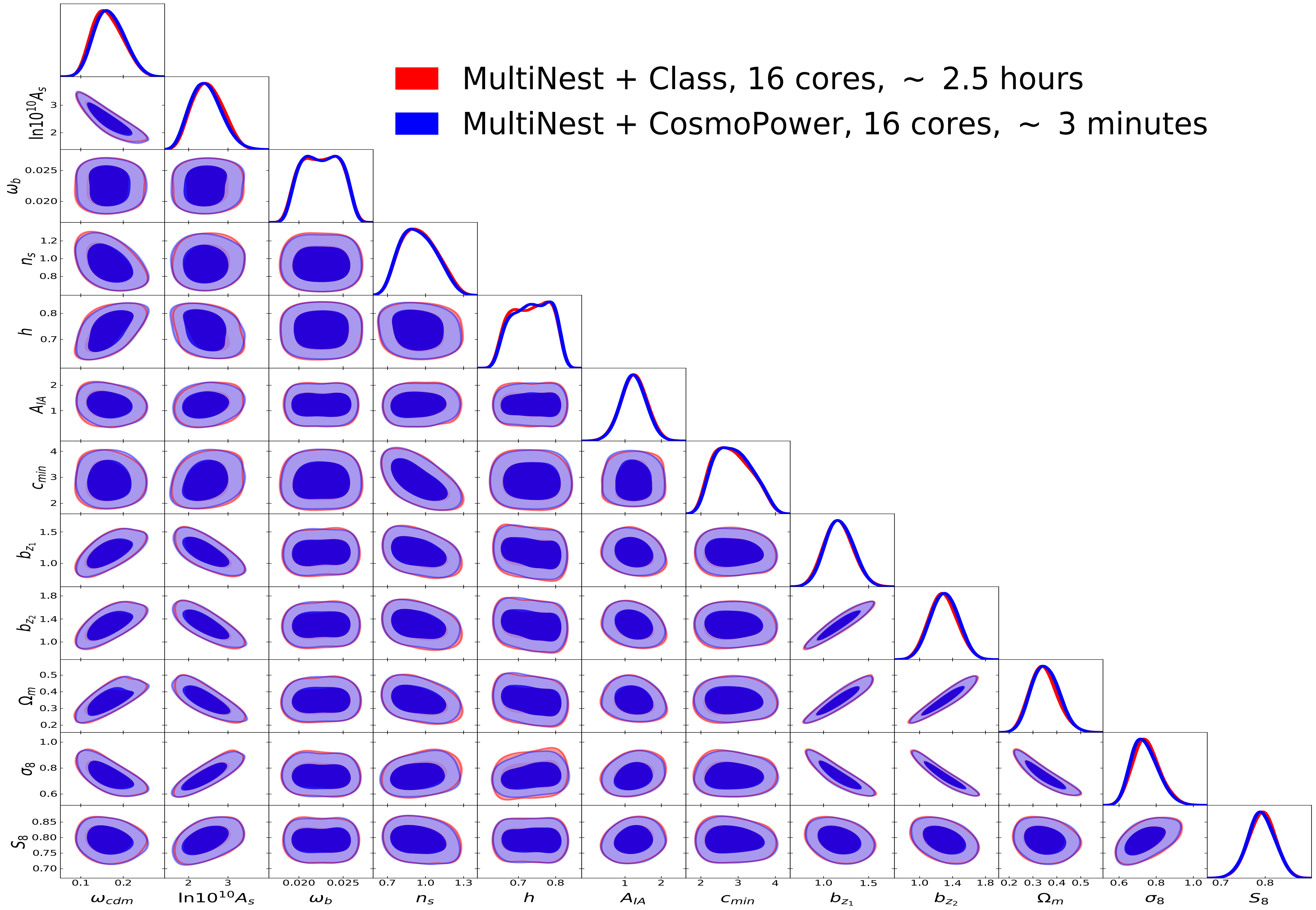

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KIDS-1000 COSMIC SHEAR

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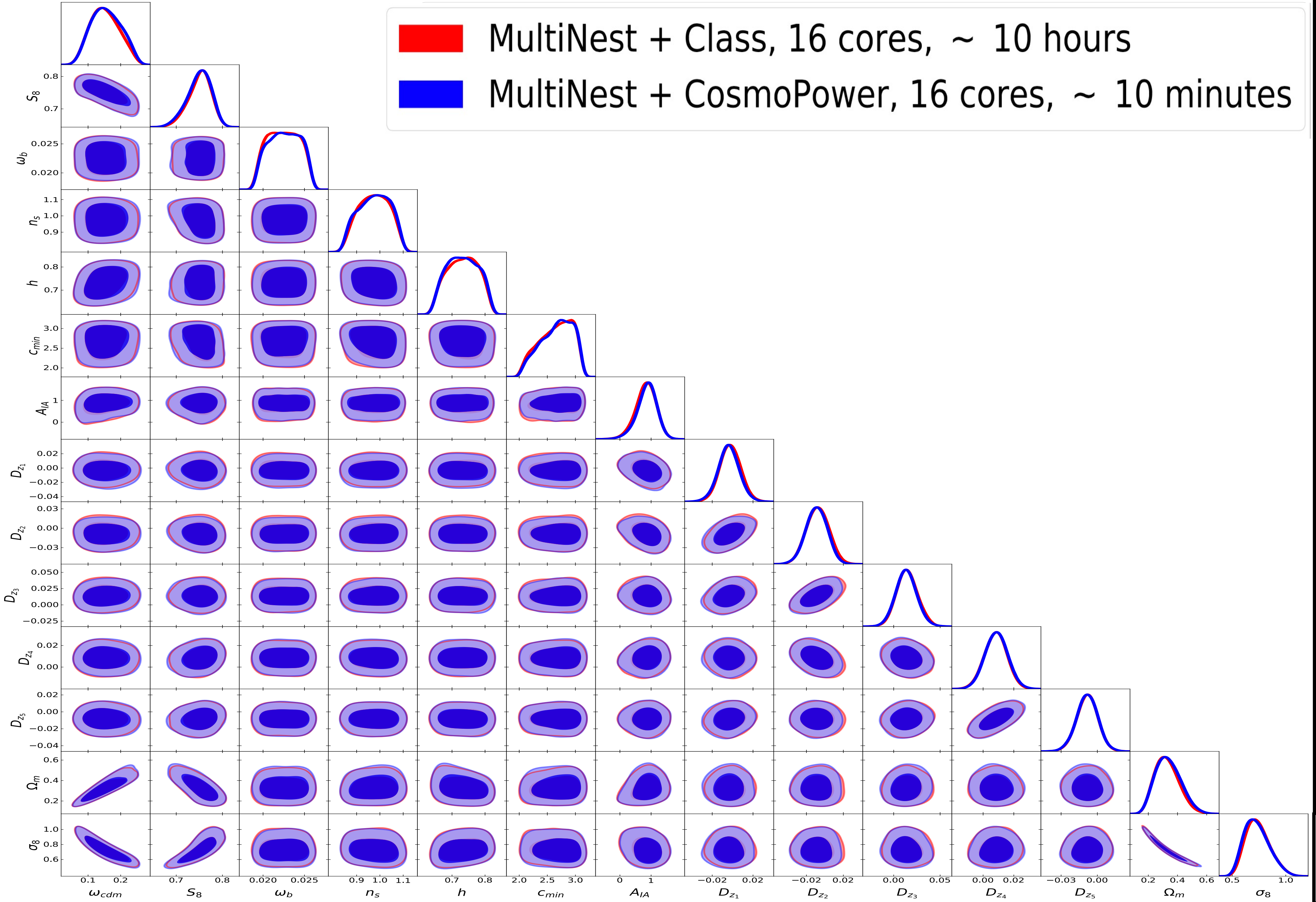

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EUCLID-LIKE COSMIC SHEAR

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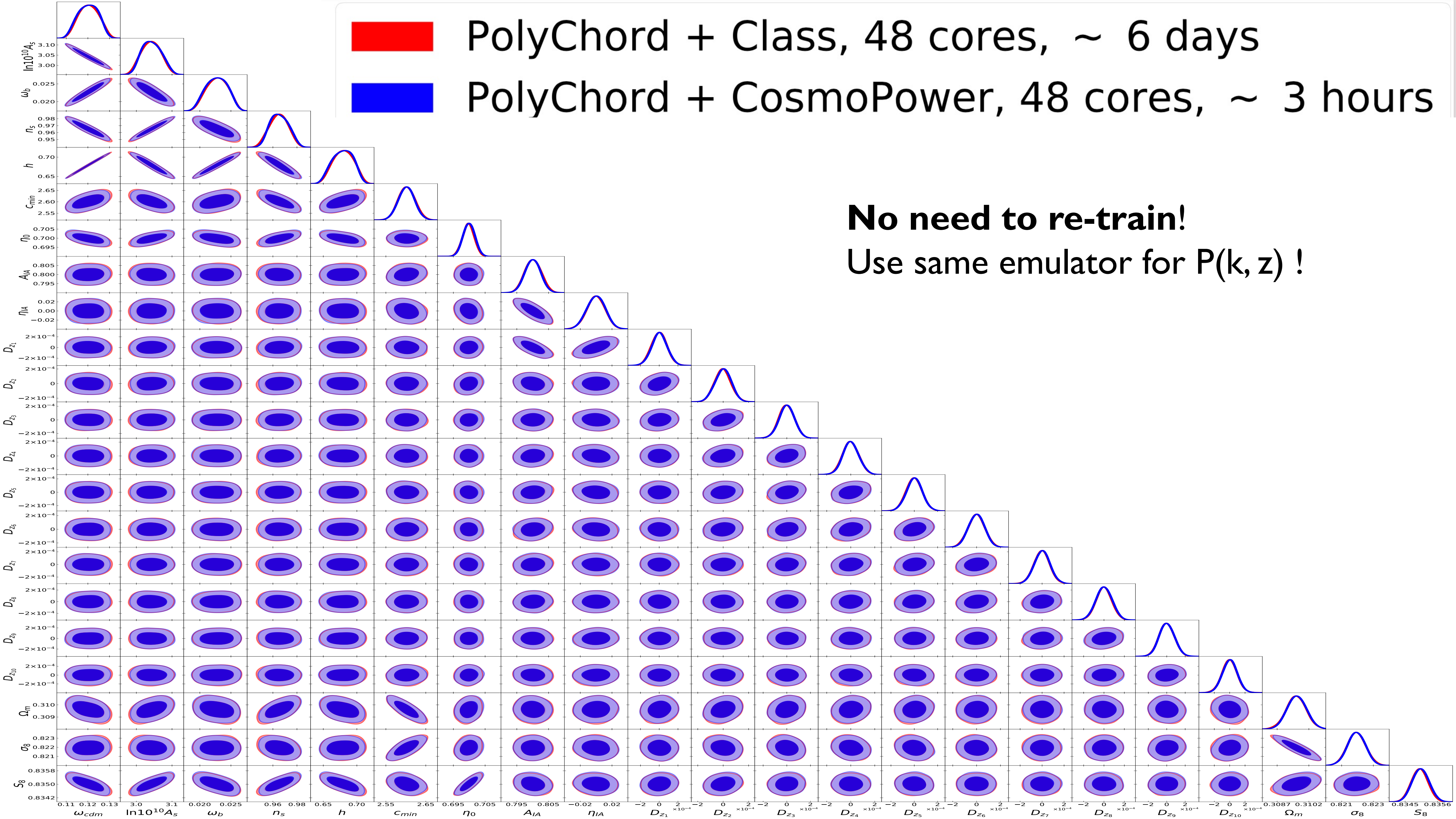

No need to re-train!

Use same emulator for P(k, z) !

PLANCK 2018 TTTEEE

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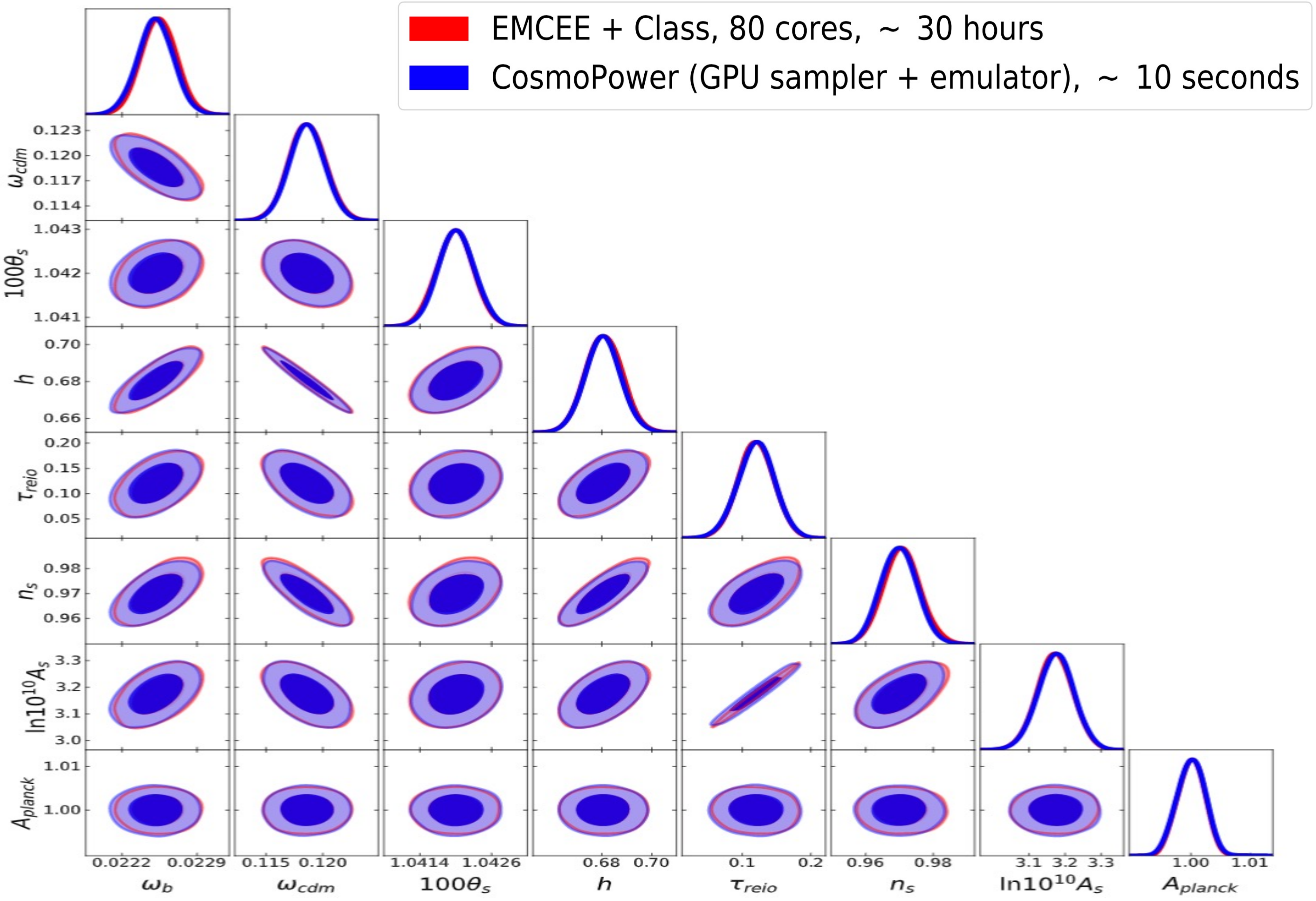

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BEYOND ΛCDM

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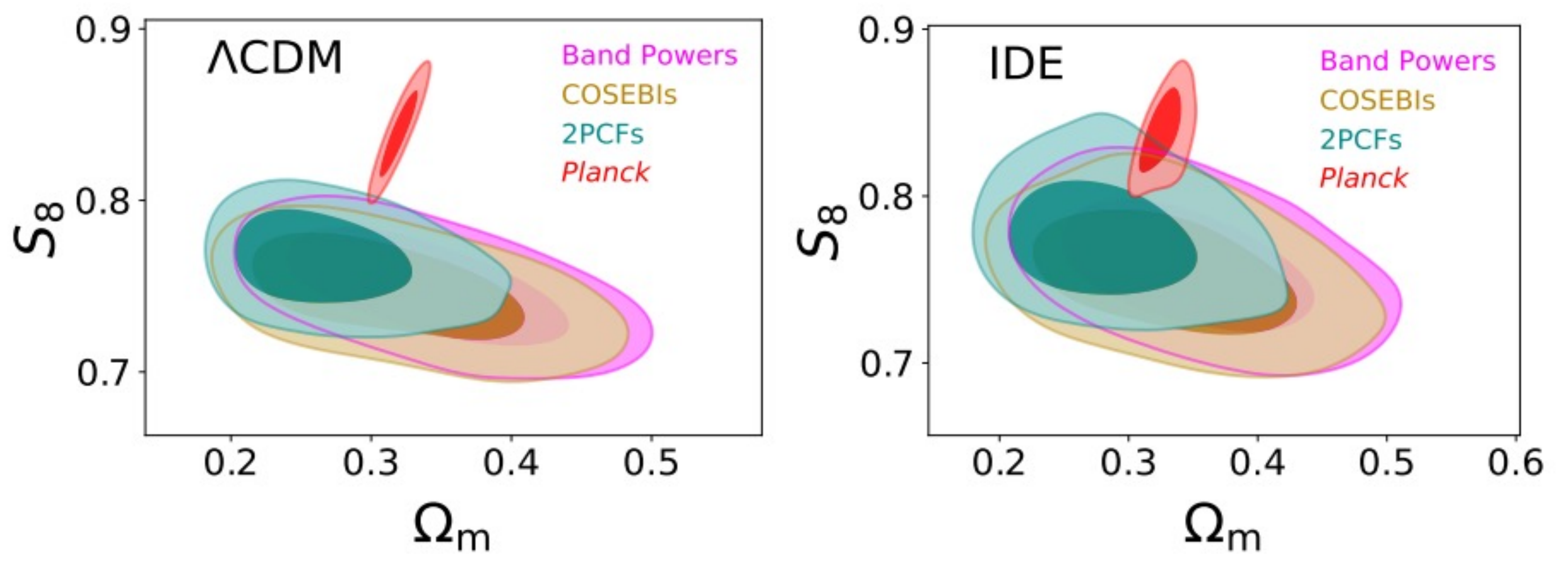
KIDS-1000 COSMOLOGY: MACHINE LEARNING - ACCELERATED CONSTRAINTS ON **INTERACTING DARK ENERGY** WITH COSMOPOWER



ASM & Pourtsidou, 2110.07587

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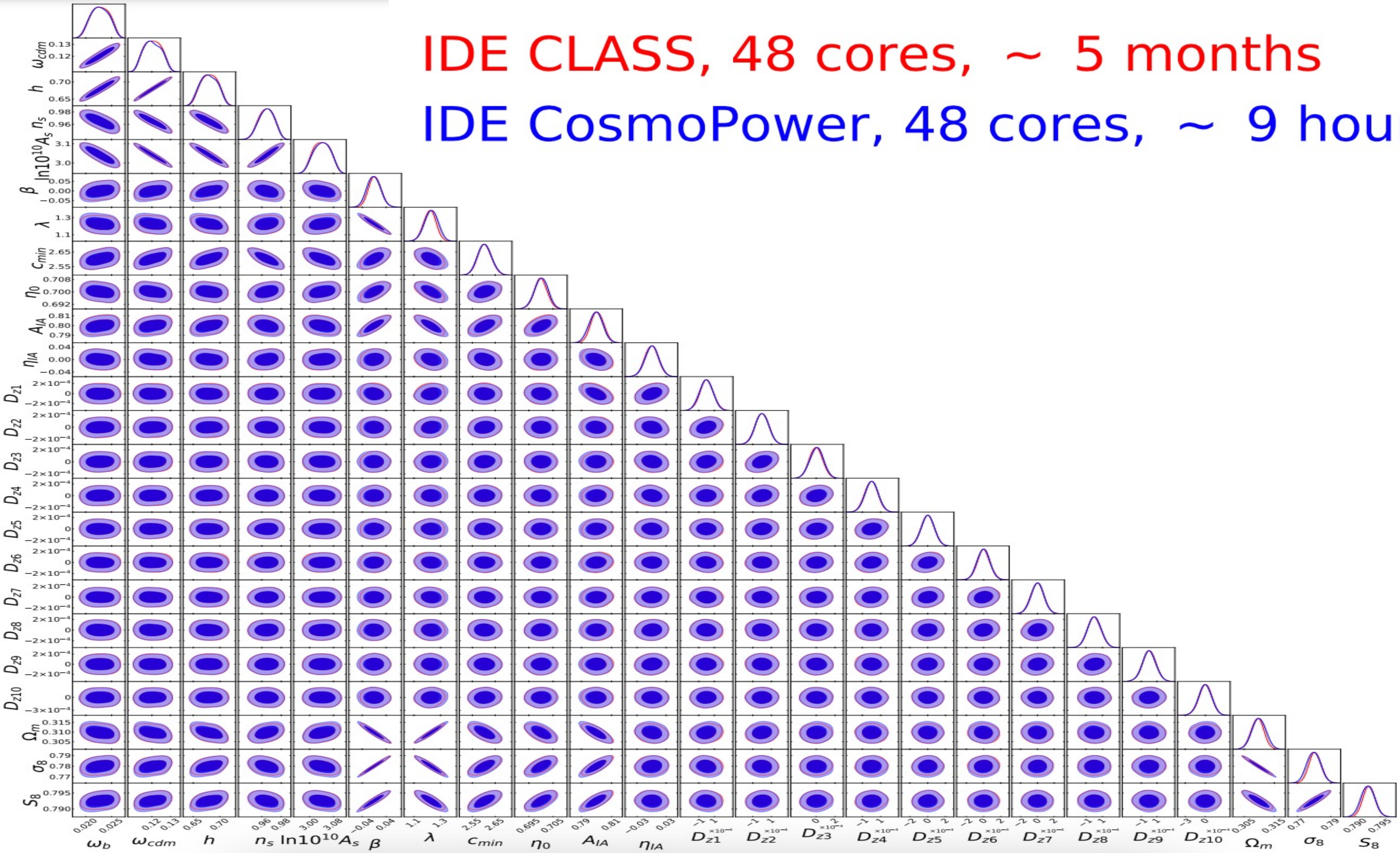
IDE CLASS, 48 cores, $\sim$ 5 months

IDE CosmoPower, 48 cores, $\sim$ 9 hours



COSMOPOWER: MAIN FEATURES

- **<u>Tested</u>** at inference level + evidence, on **large parameter ranges**
- Massive **<u>speed-up</u>**: up to $O(10^4)$ on inference (even more beyond ΛCDM!)
- **<u>Flexible</u>**, no need to re-train e.g. for different n(z)'s
- Get derived parameters without re-training/re-running
- Training infrastructure provided
- Compatible with all cosmological samplers: COBAYA, MONTEPYTHON…
- **GPU**/TPU: additional speed-up
- Fully **<u>differentiable</u>**

COSMOPOWER: FUTURE WORK

A fully differentiable library for cosmology:

- Beyond ΛCDM
- Beyond-Limber
- Higher-order statistics
- Systematics
- … and more!

https://github.com/alessiospuriomancini/cosmopower

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THANK YOU!