

Astroparticle physics and QCD

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Astroparticle physics

When? Why?

- F. Cornet, J.I. Illana, M. Masip, **TeV strings and the neutrino nucleon cross section at ultrahigh energies**, Phys. Rev. Lett. 86 (2001) 4235.
- R. Emparan, M. Masip, R. Rattazzi, **Cosmic rays as probes of large extra dimensions and TeV gravity**, Phys. Rev. D 65 (2002) 064023.

What?

- Air showers (Sergio Sciutto, AIRES). **Heavy quark production and propagation, muons from unflavored mesons, production of PeV muons, ultraperipheral collisions**
- Neutrino telescopes. **Exotic interactions of neutrinos, interpretation of IceCube data, neutrino signal in downgoing events at telescopes, long lived particles**
- Astrophysical neutrinos and gammas. **Cosmic ray showers on the solar surface, diffuse flux from collisions with galactic gas, CR background in indirect DM searches**

Some recent work

- P. de la Torre, M. Gutiérrez, M. Masip, A. Oliver, **High-energy gamma rays and neutrinos from the Sun, Jupiter and Earth**, *Astrophys. J.* 995 (2025) 2, 154.
- R. Cepedello, P. de la Torre, M. Masip, **Monochromatic neutrinos from scotogenic dark matter**, in preparation.
- A.J. Cuesta, J.I. Illana, M. Masip, **Photon to axion conversion during Big Bang Nucleosynthesis**, *JCAP* 11 (2023) 103.
- J. de Cruz, A.J. Cuesta, J. García-Farieta, J.I. Illana, M. Masip, **The 0.5 eV axion-like majoron**, in preparation.

Lattice QCD

When? Why?

- E. Gámiz, S. Collins, C. Davis, G.P. Lepage, J. Shigemitsu, M. Wingate, **Unquenched determination of the kaon parameter B_K from improved staggered fermions**, Phys. Rev. D 73 (2006) 114502. (HPQCD Collaboration)
- C. Bernard, A.X. El-Khadra, E. Gámiz et al., **The $\bar{B} \rightarrow D^* \ell \bar{\nu}$ form factor at zero recoil from three-flavor lattice QCD: A model independent determination of $|V_{cb}|$** , Phys. Rev. D 79 (2009) 014506. (Fermilab Lattice and MILC Collaborations)

What?

- SM parameters. **Quark masses, CKM matrix elements ($|V_{us}|$, $|V_{ub}|$, $|V_{cb}|$)**
- Flavour phenomenology from lattice QCD. **CP violation (mixing parameters), CKM unitarity, decay constants and semileptonic form factors, rare processes, LFU tests**
- Technical developments in lattice QCD. **Scale setting, staggered chiral PT, spectral reconstruction methods.**

Some recent work

- A. Bazavov, E. Gámiz et al., **D-meson semileptonic decays to pseudoscalars from four-flavor lattice QCD**, Phys. Rev. D 107 (2023) 094516.
- R. Merino, A. Bazavov, E. Gámiz et al., **Kaon leptonic and semileptonic decays with $N_f = 2 + 1 + 1$ HISQ fermions**, Lattice 2025, 2603.02994.
- A.D. Valois, M. Dai, A. El-Khadra, E. Gámiz, S. Lahert, R. Merino, **Towards a formalism for $\pi\pi$ scattering from staggered lattice QCD**, Lattice 2025, 2603.28967.
- E. Gámiz, F. de Soto, R. Merino, D. Valois, **Analysis of systematics in spectral reconstruction methods**, in preparation