Sensitivity of the Cherenkov Telescope Array to the Detection of a Dark Matter Signal in comparison to Direct Detection and Collider Experiments

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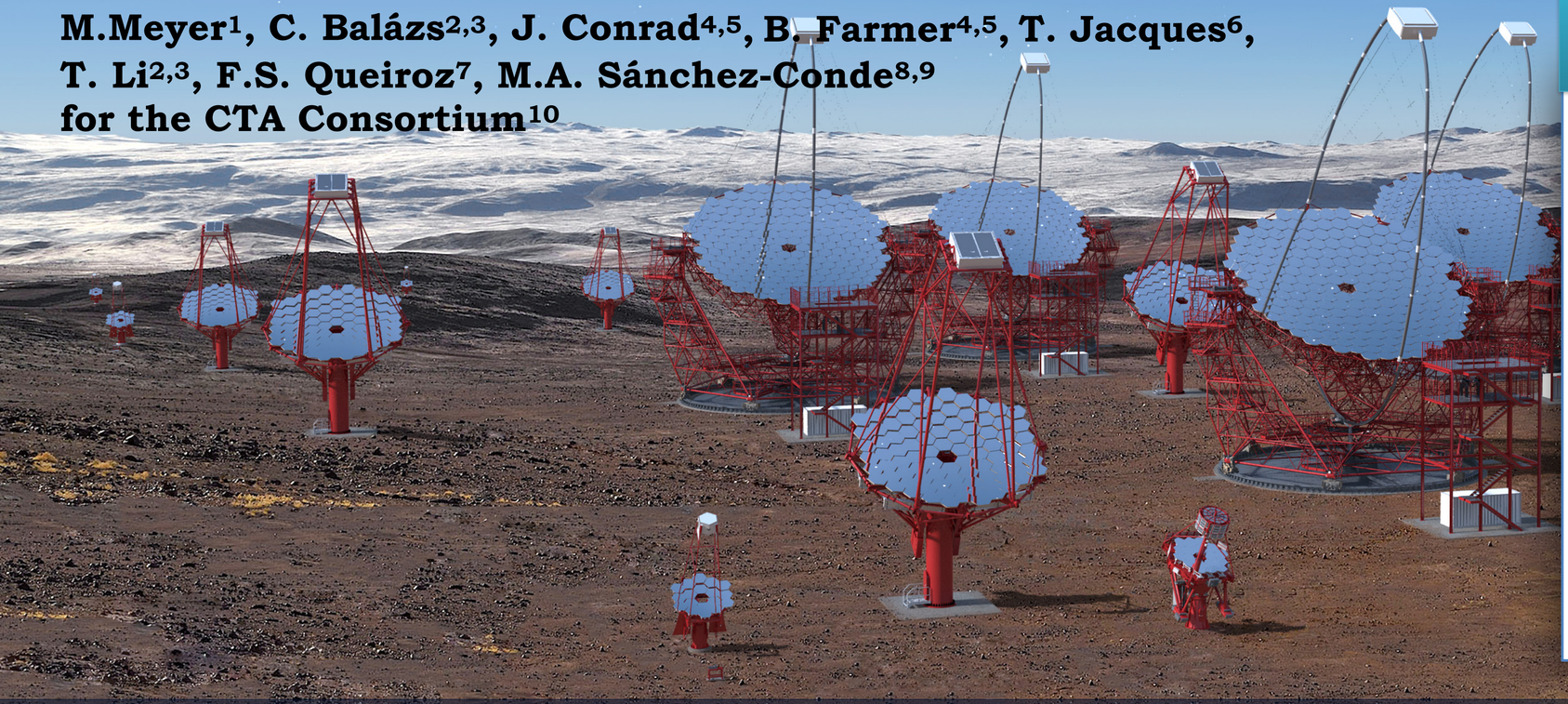
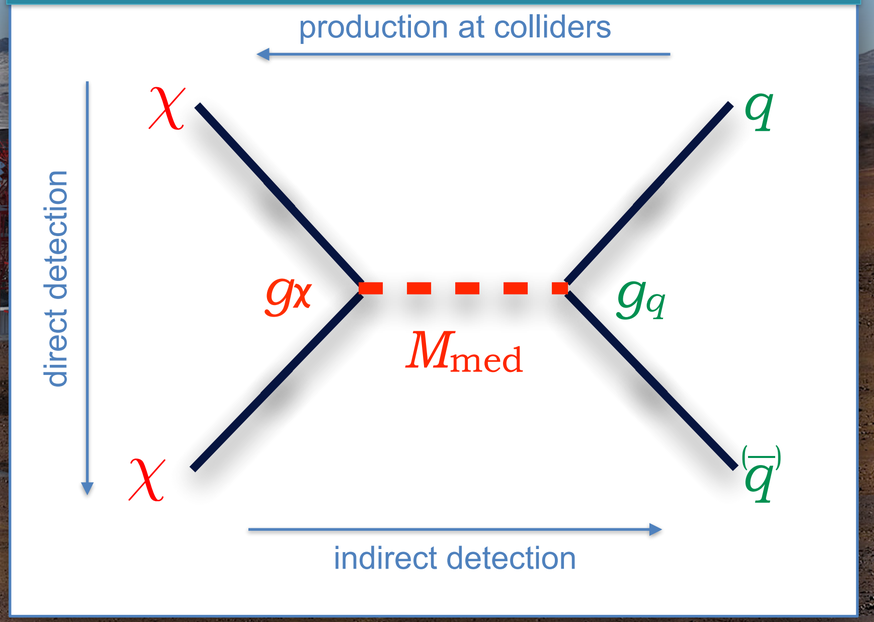
cherenkov telescope array



Only combined effort of all experimental techniques can unravel the nature of dark matter



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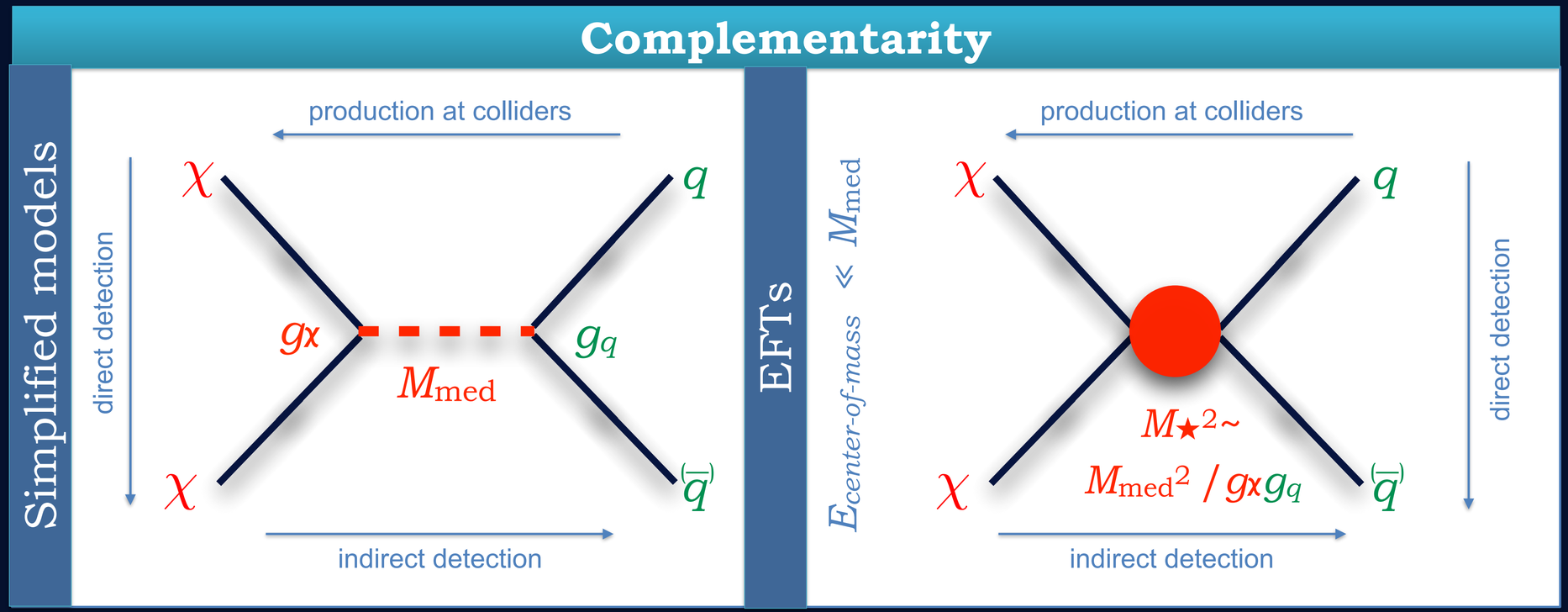
- Weakly interacting massive particles among best dark matter (DM) candidates
- Goal: compare CTA sensitivity for DM annihilation signal to LHC and direct detection
- Do so in framework of simplified models and effective field theories (EFTs)



We consider: Dirac fermion DM that interacts with SM quarks through scalar, pseudo-scalar, vector, or axial-vector interactions (*S,P,V,A*). The DM-SM interactions of such models exhibit different levels of suppression for direct and indirect detection. In EFTs, the only additional degree of freedom is the DM particle. Any fields mediating between the DM and SM are assumed to be heavy compared to the energy of the interactions. Where the EFT fails one can use simplified models in which at least one additional particle is introduced that mediates between the DM and SM sectors. For some recent reviews, see e.g. Refs. [1,2]. We calculate the resulting ɣ-ray spectra from these EFTs and simplified models using PPPC4DMID [3].

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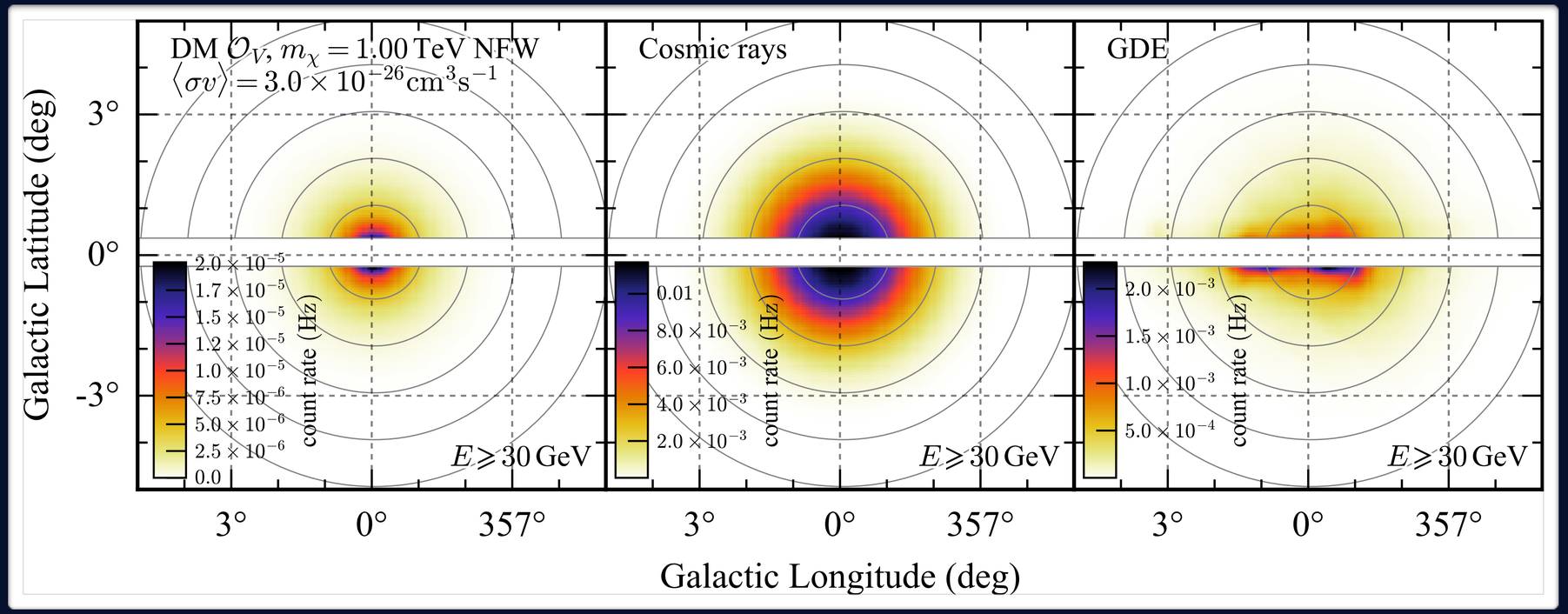
References:
[1] Abdallah et al., Phys. Dark Univ. 9-10, 8 (2015)
[2] De Simone & Jacques, Eur. Phys. J. C76, 367 (2016)
[3] Cirelli et al., JCAP 1103, 051 (2011)

Simulations of CTA observations of the Galactic center

- Galactic center: close and high DM density → ideal target for DM searches
- DM density modeled here with NFW / Einasto profiles fitted to Galactic rotation curves [4]
- Simulations include DM signal, cosmic-ray background, and Galactic diffuse emission



We simulate 100 hours of CTA observations including astrophysical backgrounds from cosmic rays (CRs) and Galactic diffuse emission (GDE). We use the GDE template derived from *Fermi*-LAT observations and extrapolate it to higher energies [5]. Fitting both the spectrum and spatial morphology of the simulated observations with templates for CRs, GDE, and DM allows us to place expected limits on the DM annihilation cross section.

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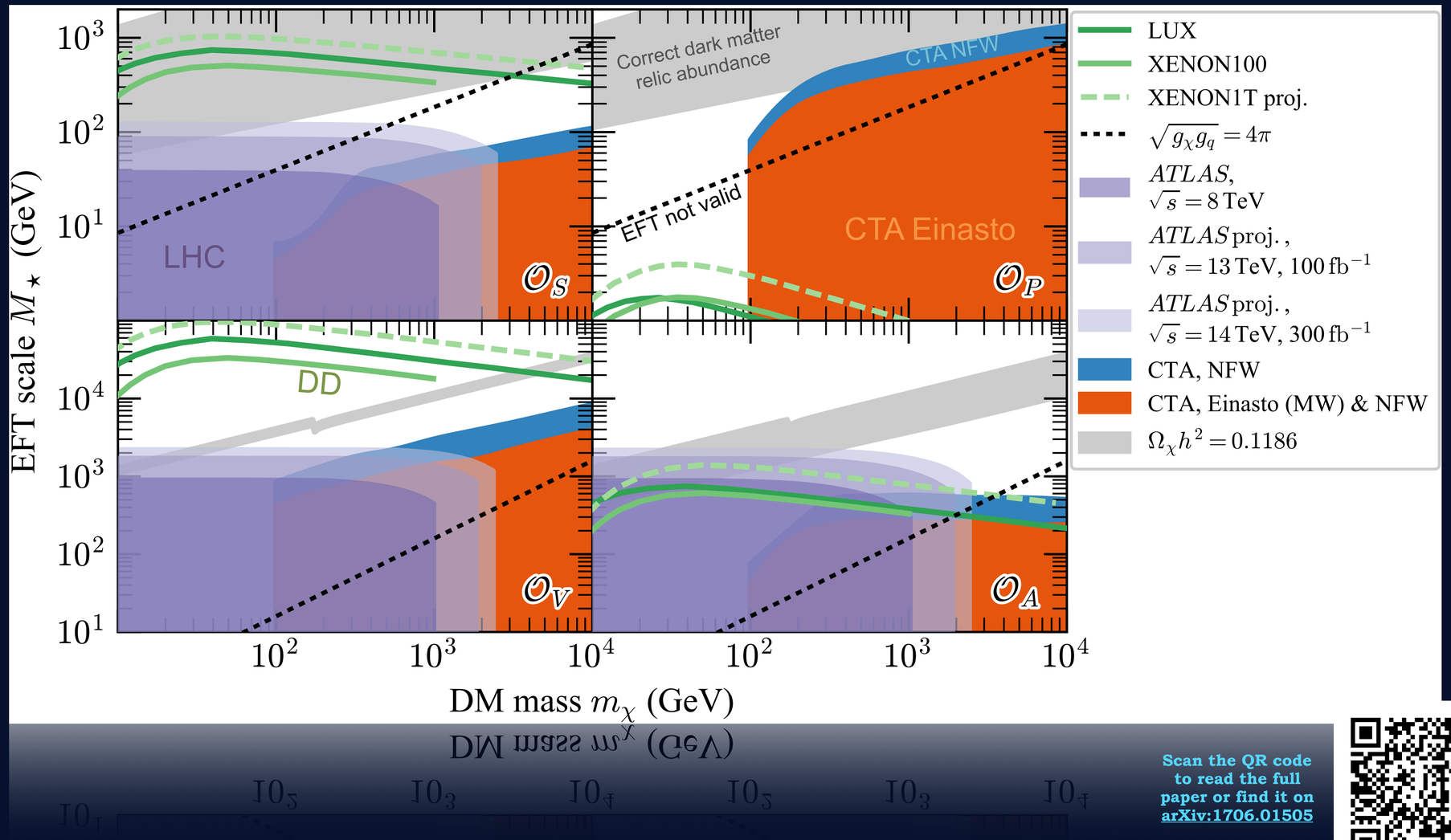
References:

[4] Pato et al., JCAP 1512, 001 (2015)
[5] Silverwood et al., JCAP 1503, 055 (2015)

Results for EFT case: only combined effort of all experiments can unravel dark-matter nature

- Lower limits on EFT scale
- Limits valid above black dashed line
- Vector and pseudo-scalar case: CTA probes DM masses partially out of reach for LHC and direct detection (DD)



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