The Astroparticle Road to New Physics

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Finding Beyond the Standard Model (BSM) Physics

A story of complementarity...

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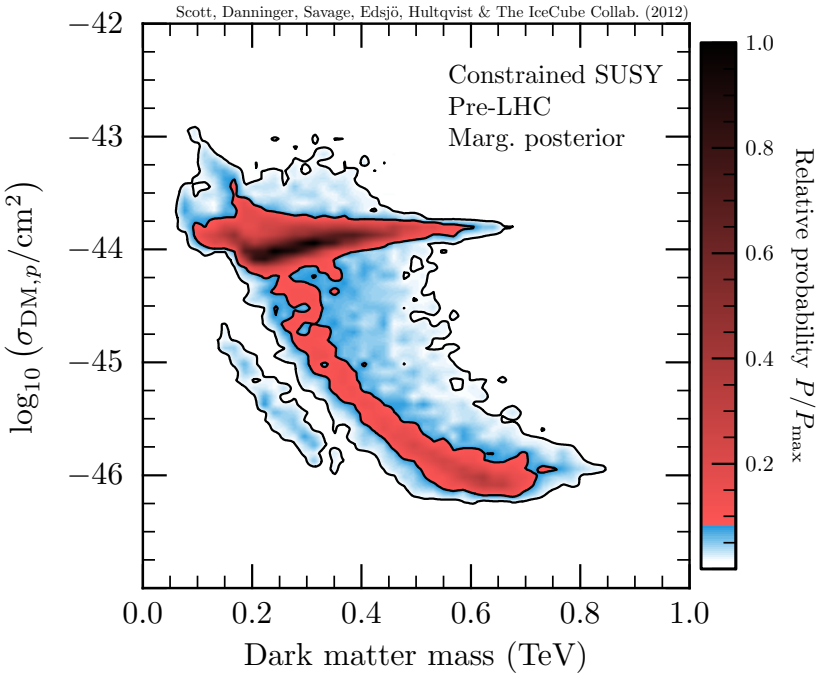

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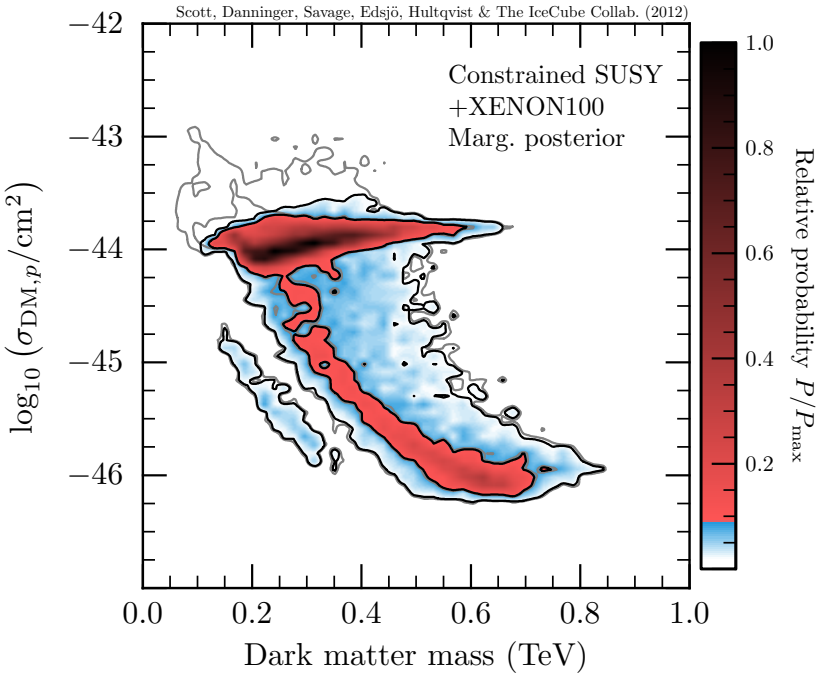

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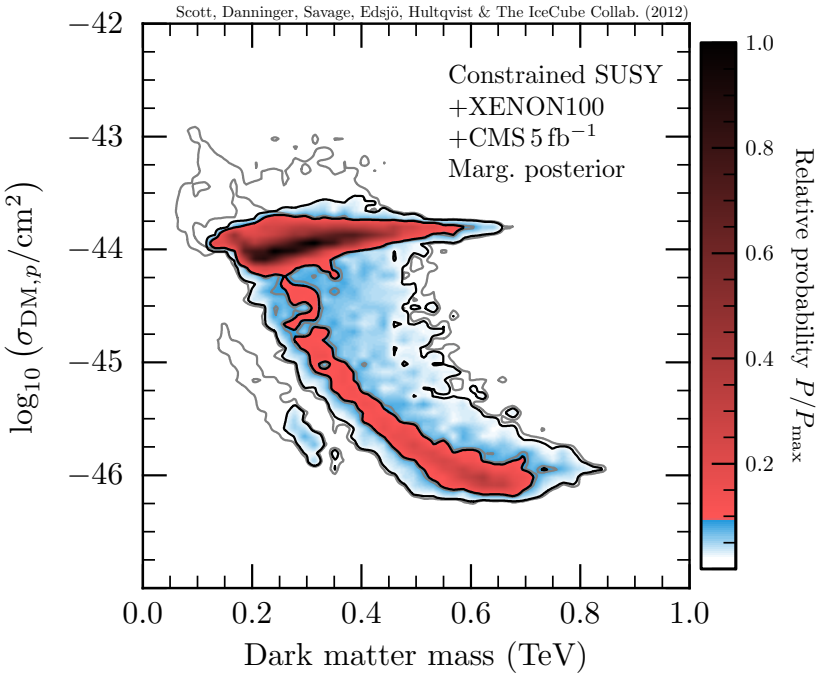

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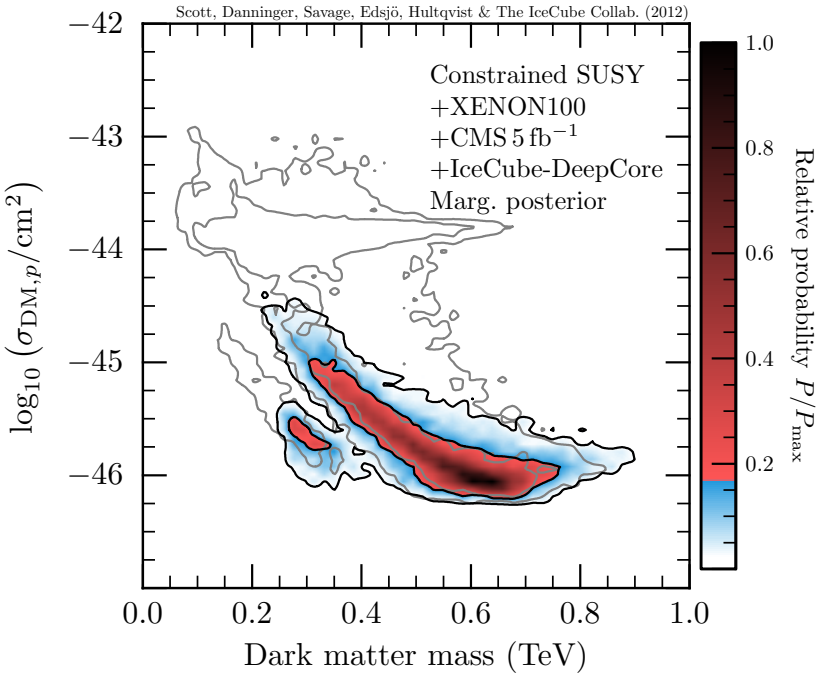

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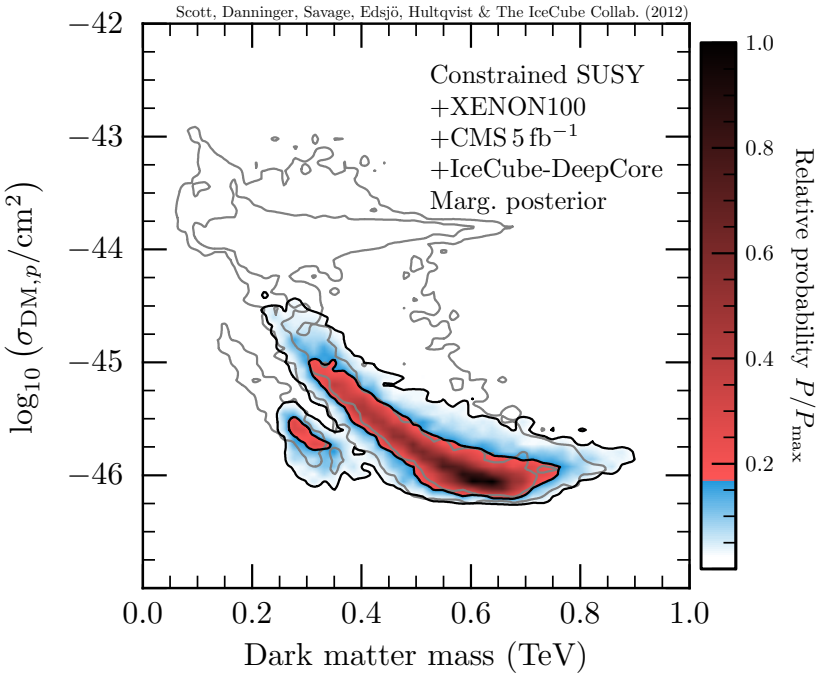

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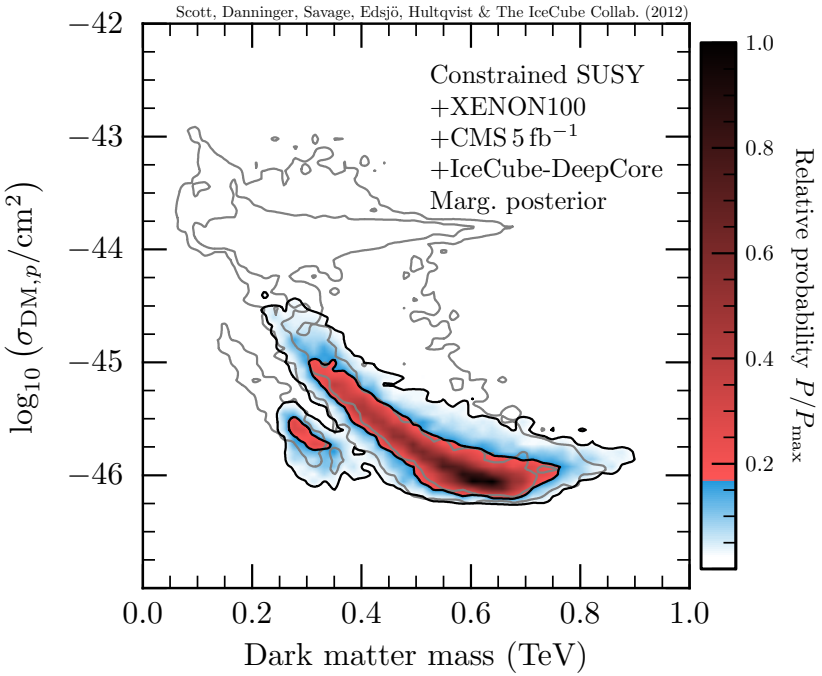

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This example is a gross simplification – the devil is in the detail.

Many talk about complementarity, far fewer walk the walk quantitatively → global BSM fits

Global fits in the current era

Lots of data flowing from LHC, direct and indirect dark matter detection experiments
$\rightarrow$ new "Implications of $\langle$*data X*$\rangle$ for supersymmetry" fit update every few months

Issues with current global fit codes:

- Strongly wedded to a few theories (e.g. constrained minimal SUSY Standard Model)
- Strongly wedded to a few theory calculators
- All datasets and observables basically hardcoded
- Rough or non-existent treatment of most experiments (astroparticle + collider especially)
- Sub-optimal statistical methods / search algorithms
- $\Longrightarrow$ *already hitting the wall on theories, data & computational methods*

GAMBIT: a *second-generation* global fit code

GAMBIT: Global And Modular BSM Inference Tool

Overriding principles of GAMBIT: flexibility and modularity

- General enough to allow fast definition of new datasets and theoretical models
- Plug and play scanning, physics and likelihood packages
- Extensive model database – not just small modifications to constrained MSSM (NUHM, etc), and not just SUSY!
- Extensive observable/data libraries (likelihood modules)
- Many statistical options – Bayesian/frequentist, likelihood definitions, scanning algorithms
- A smart and *fast* LHC likelihood calculator
- Massively parallel
- Full open-source code release

The GAMBIT Collaboration

23 Members, 12 Institutes
8 Experiments, 3 major theory codes

Fermi-LAT	P. Scott, J. Conrad, J. Edsjö, G. Martinez
IceCube	P. Scott, J. Edsjö, C. Savage
ATLAS	A. Buckley, C. Clement, P. Jackson, A. Saavedra, M. White
CMS	C. Rogan,
HESS	J. Conrad, H. Dickinson
AMS-02	A. Putze
CTA	T. Bringmann, J. Conrad, H. Dickinson
DARWIN	J. Conrad
Theory	P. Scott, C. Balázs, T. Bringmann, L.-A. Dal, J. Edsjö, B. Farmer, A. Krislock, A. Kvellestad, N. Mahmoudi, A. Raklev, C. Savage, C. Weniger

The GAMBIT Collaboration – the future

28 Members, 14 Institutes
10 Experiments, 3 major theory codes

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LUX/LZ	+1 (Imperial)
LHCb	2 members approached

The GAMBIT Collaboration – the future

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Plans – GAMBIT and the Rutherford Fellowship

The point is not just to write code – but to ***use*** it. . .

- Aiming for first comprehensive 25-parameter MSSM global analysis
- Extensive SUSY-breaking model comparison
- Global fits to many non-SUSY models (2 Higgs Doublet, extra dimensions, isospin-violating dark matter, etc)
- Model comparison of different BSM scenarios
- Each physics module, + scanner module, will have dedicated paper and code release
- GAMBIT code will become the go-to package, and GAMBIT papers the go-to results, for combined interpretation of BSM physics searches in the future