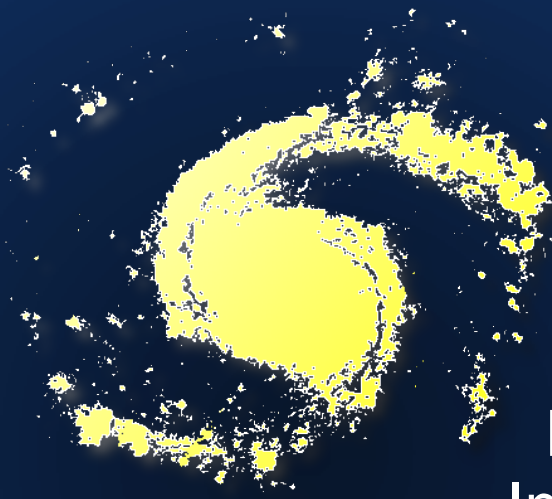


Modeling the Sub-mm Population: Challenges and Prospects

Andrew Benson

California Institute of Technology



Physical models (“forward evolution”)
Inference from large, statistical samples

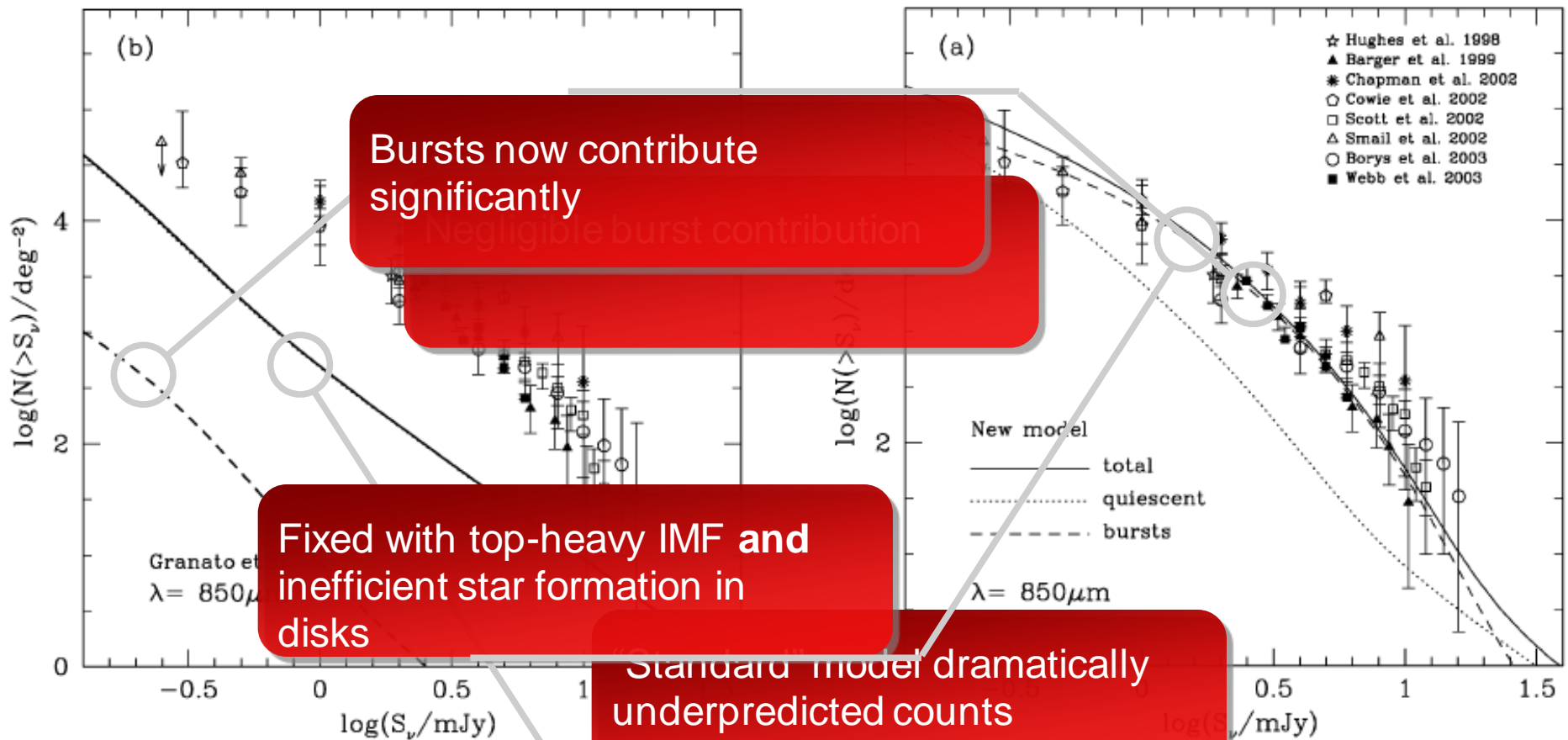


Overview

- ❖ What We All Know:
 - ❖ Infrared/sub-mm observations have the potential to teach us a lot about galaxy formation
- ❖ Past
- ❖ Present Models with top-heavy IMF
- ❖ Future Creating virtual Universes
 - ❖ Constraints, predictions and physics inference

Baugh, AJB et al. (2005) Model

Overview | Past | Present | Future | Summary

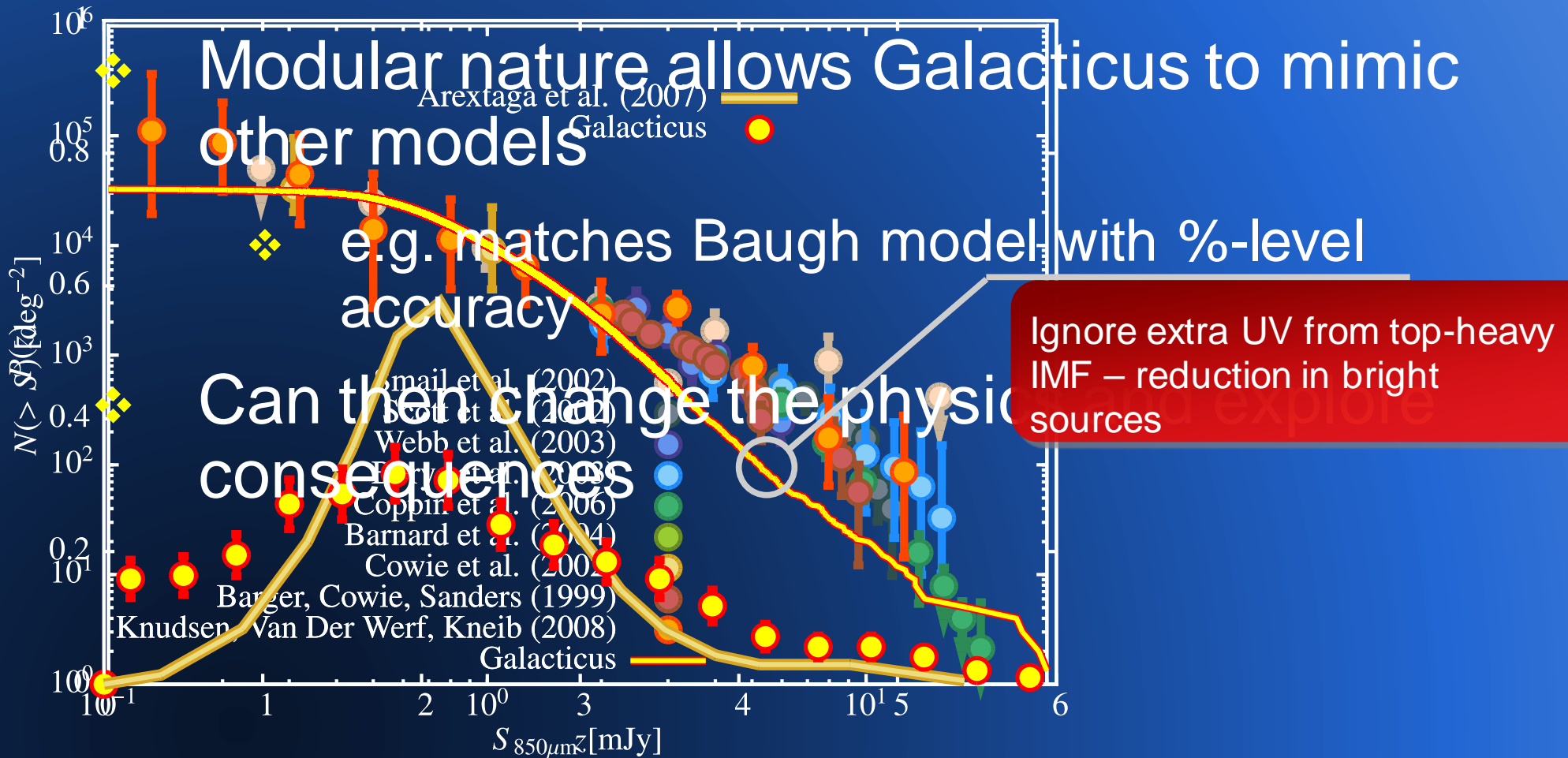


The Galactus SAM

- ❖ Highly Modular
 - ❖ Physical components
 - ❖ Functions
- ❖ Open Source
 - ❖ You can run it yourself
 - ❖ Algorithms are transparent, open to inspection
- ❖ Predicts full SED
 - ❖ Uses Grasil for radiative transfer calculations

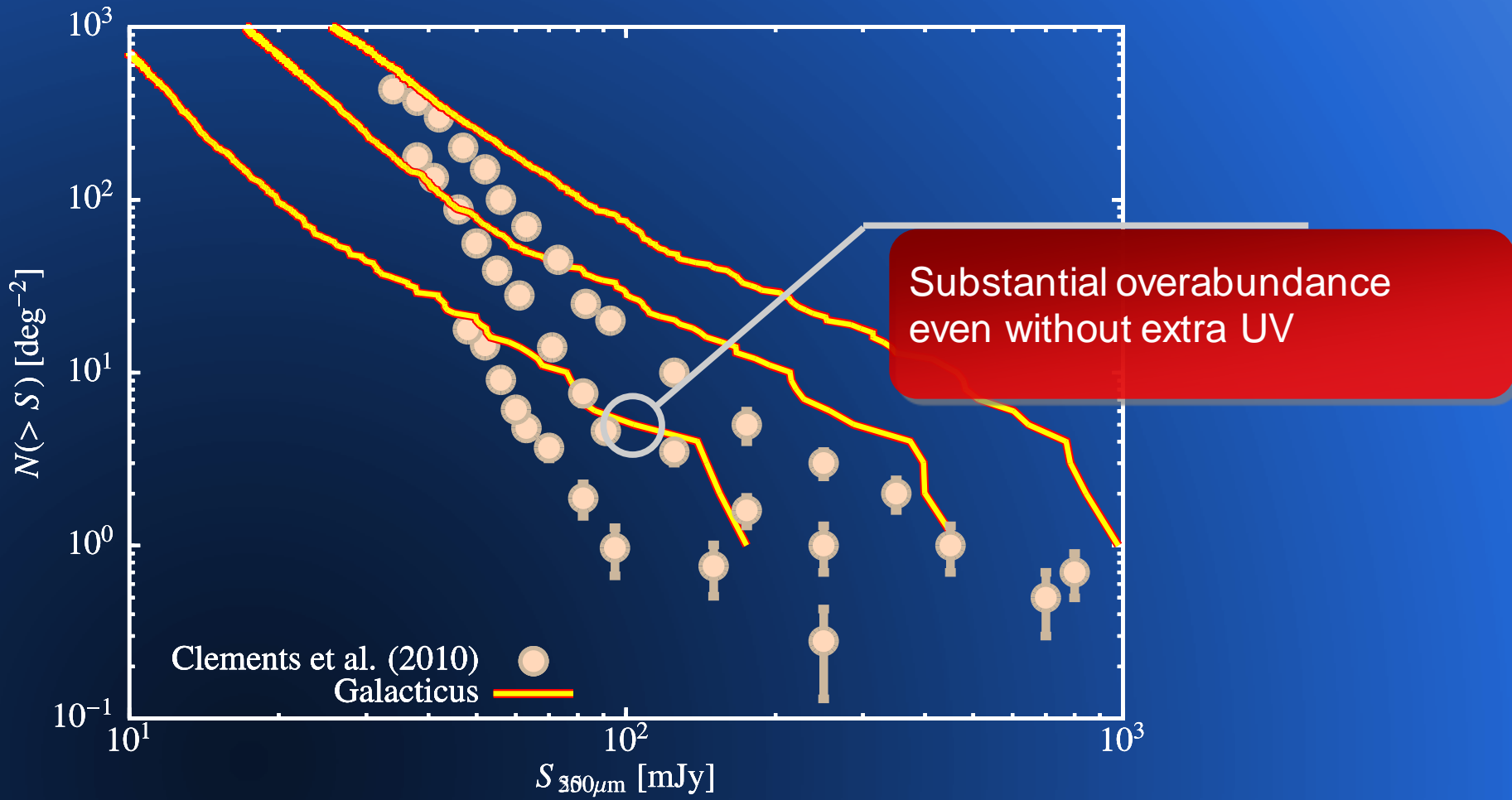


Baugh2005 from Galacticus

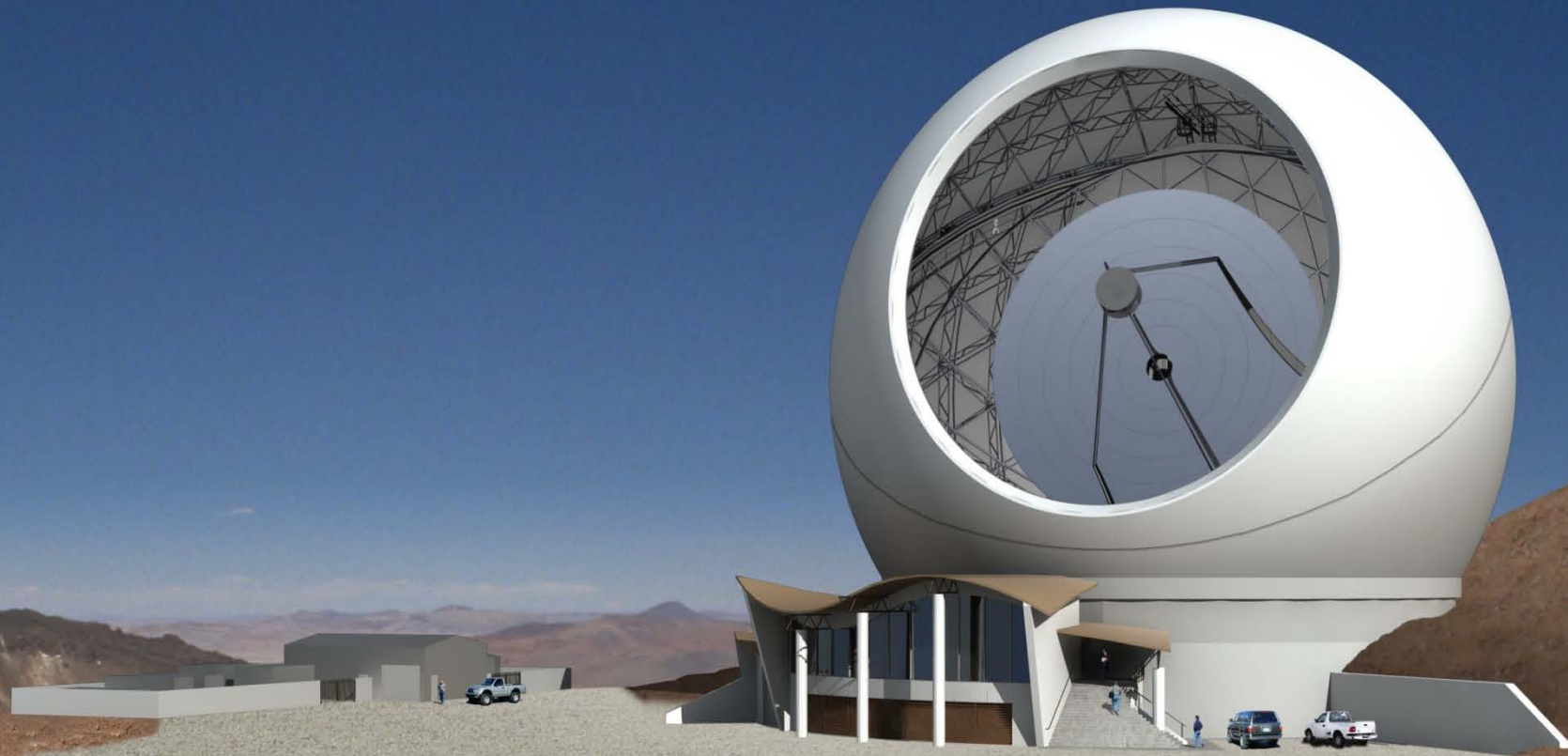


Baugh2005 from Galacticus

Overview | Past | Present | Future | Summary



- ❖ 25 m sub-mm telescope
- ❖ Up to 1 square degree field of view
- ❖ 200 μ m to 3mm wavelength range

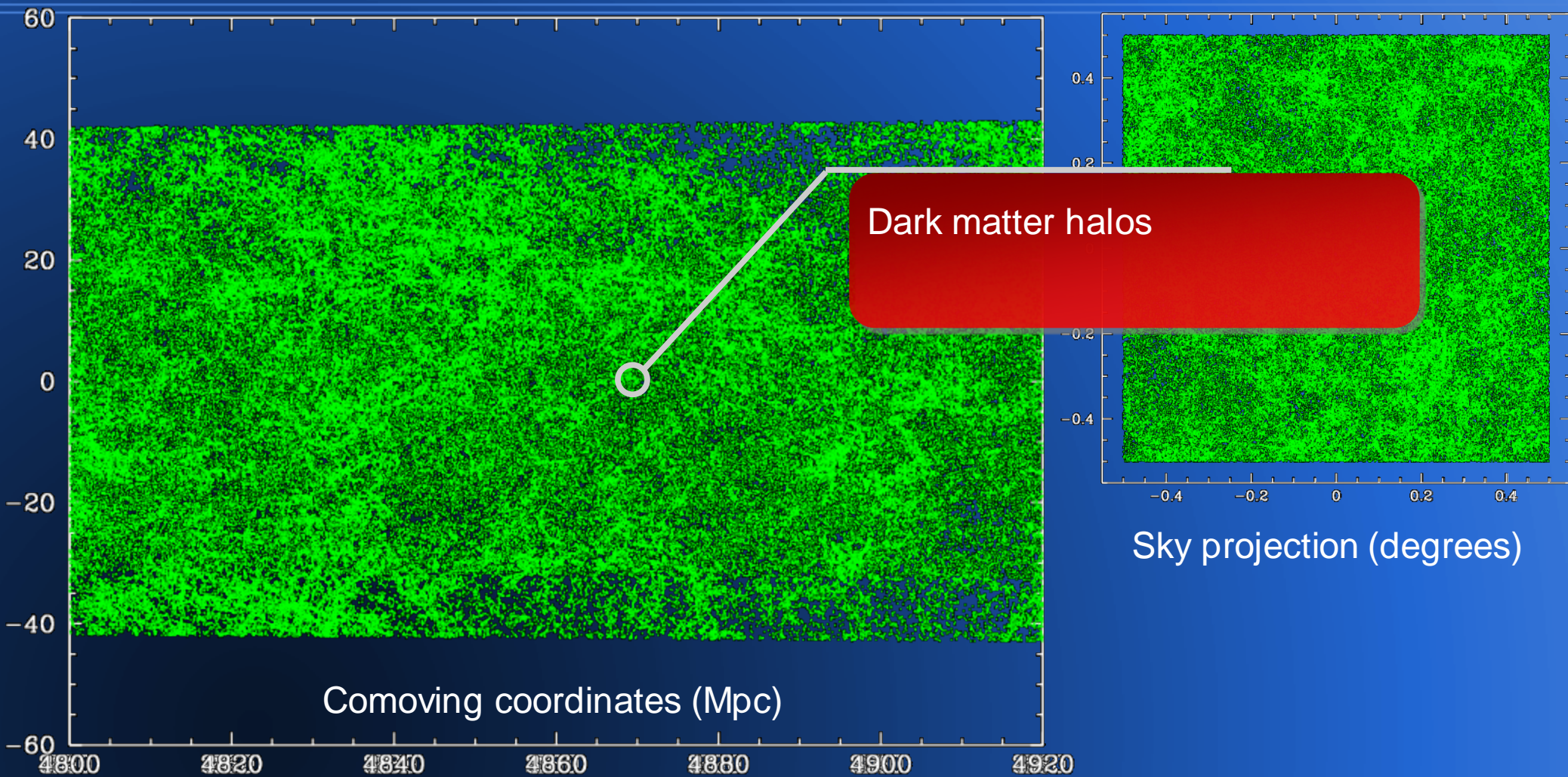


Caltech-Cornell Atacama Telescope

<http://www.submm.org>

CCAT Virtual Universes

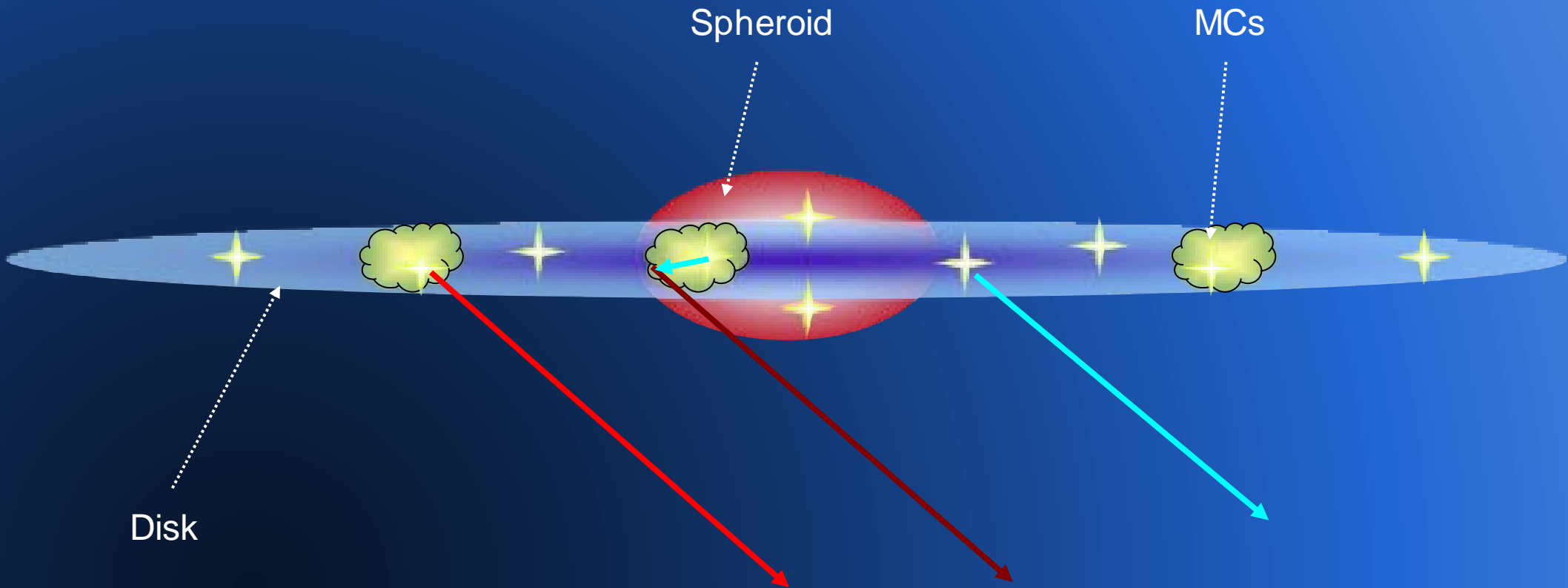
Overview | Past | Present | Future | Summary



Ray Trace

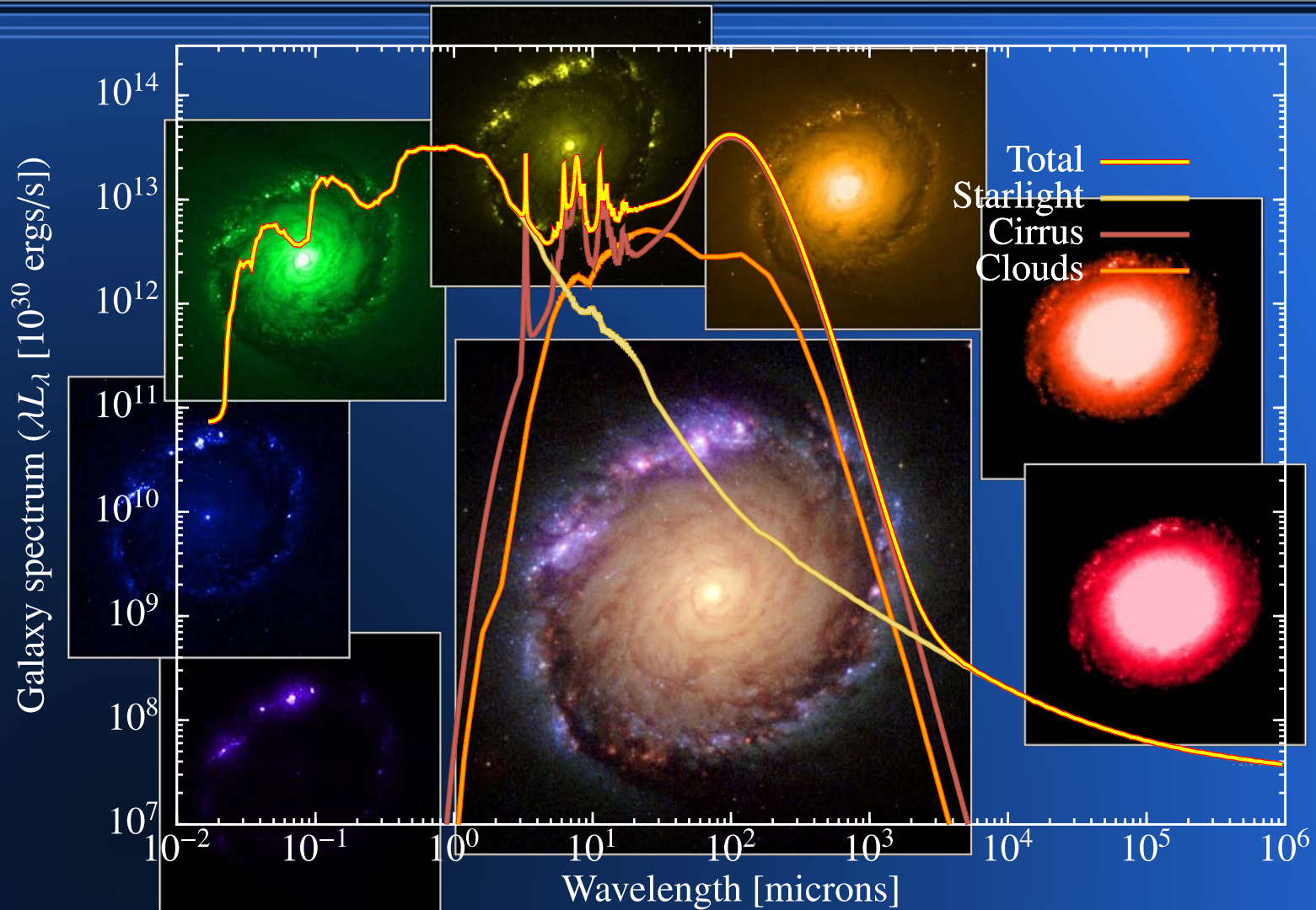
Overview | Past | **Present** | Future | Summary

GRASIL code



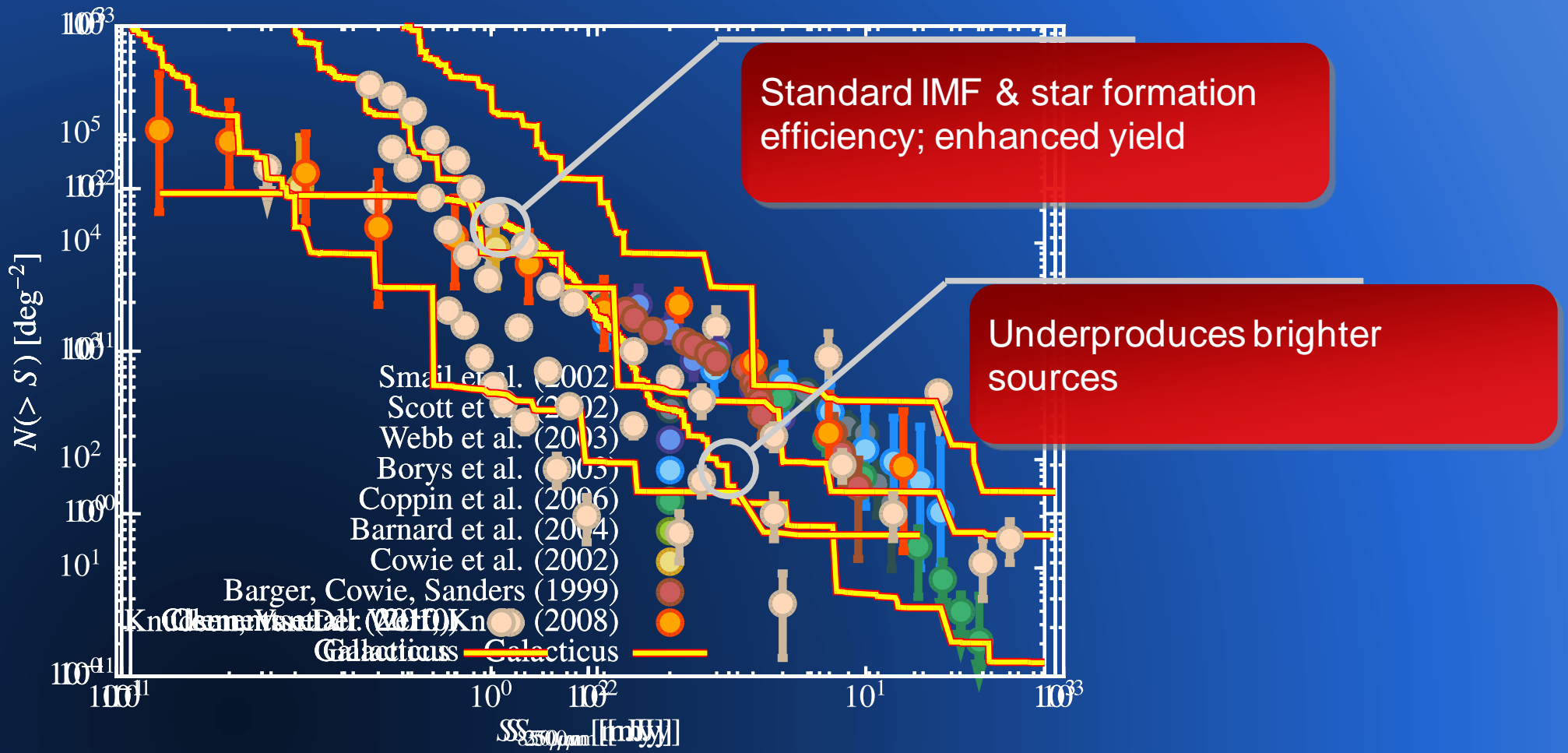
Example SED

Overview | Past | Present | Future | Summary



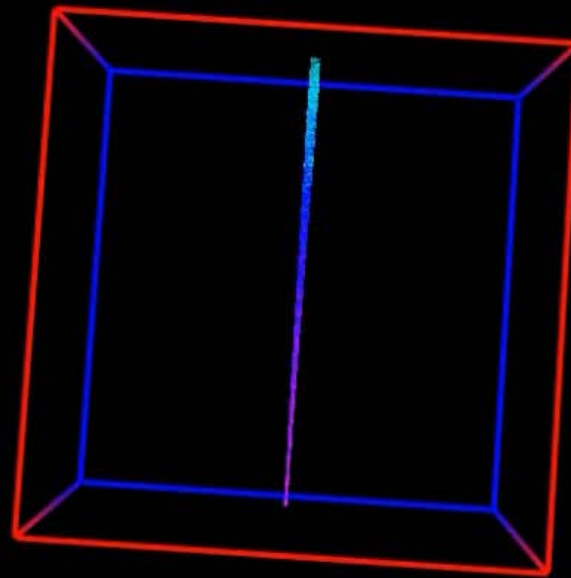
Sub-mm Galaxy Properties

Overview | Past | Present | Future | Summary



Sub-mm Universe Lightcone

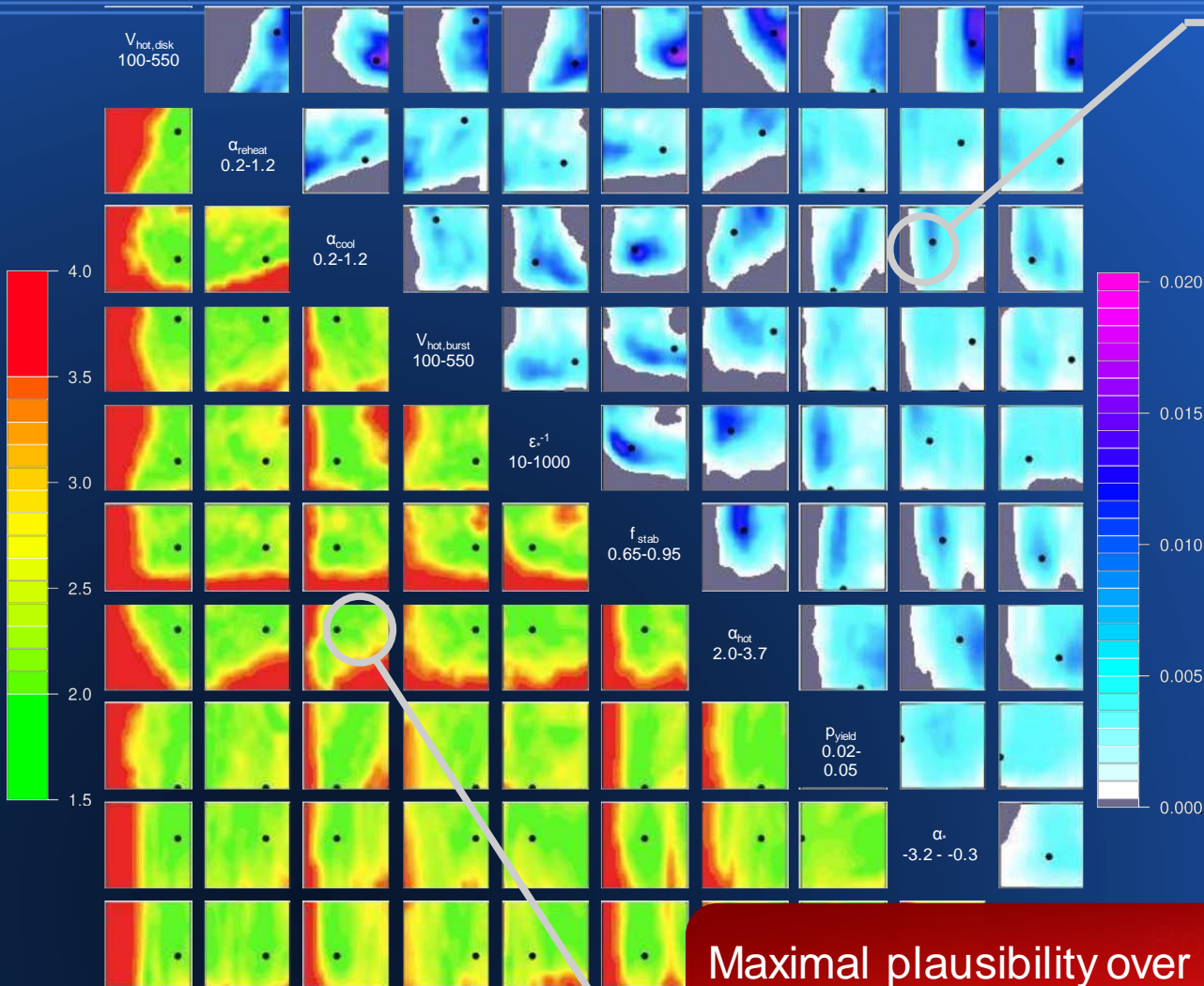
Overview | Past | Present | Future | Summary



Galacticus - © Andrew Benson 2011

Bayesian Parameter Constraints

Overview | Past | Present | Future | Summary



“Optical depth” through plausible regions

- ❖ Parameter space search
- ❖ 10 parameters
- ❖ 2 datasets
- ❖ Time consuming

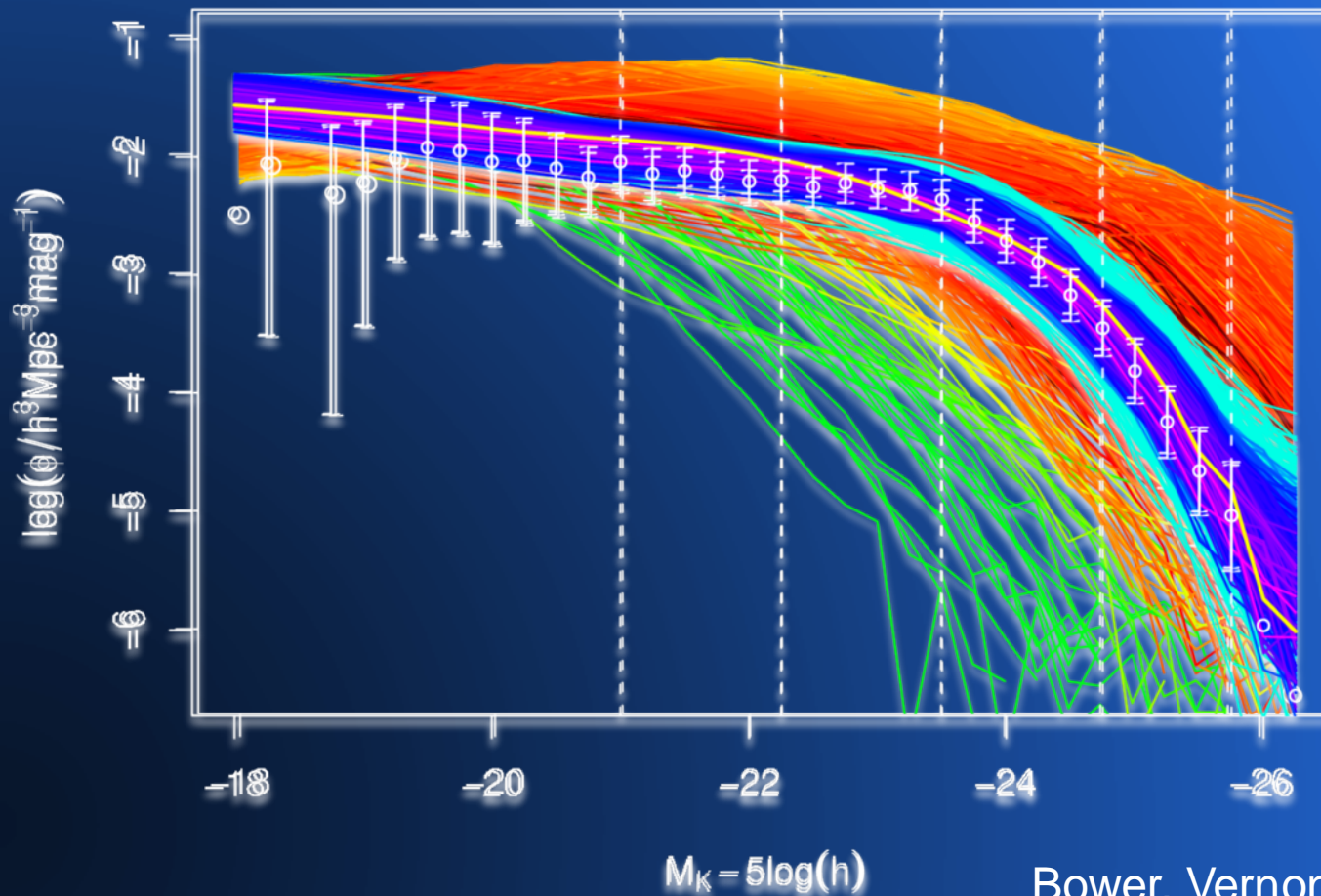
Maximal plausibility over projected parameters

...on, AJB + (2010)

Constraining Model Parameters

Overview | Past | Present | Future | Summary

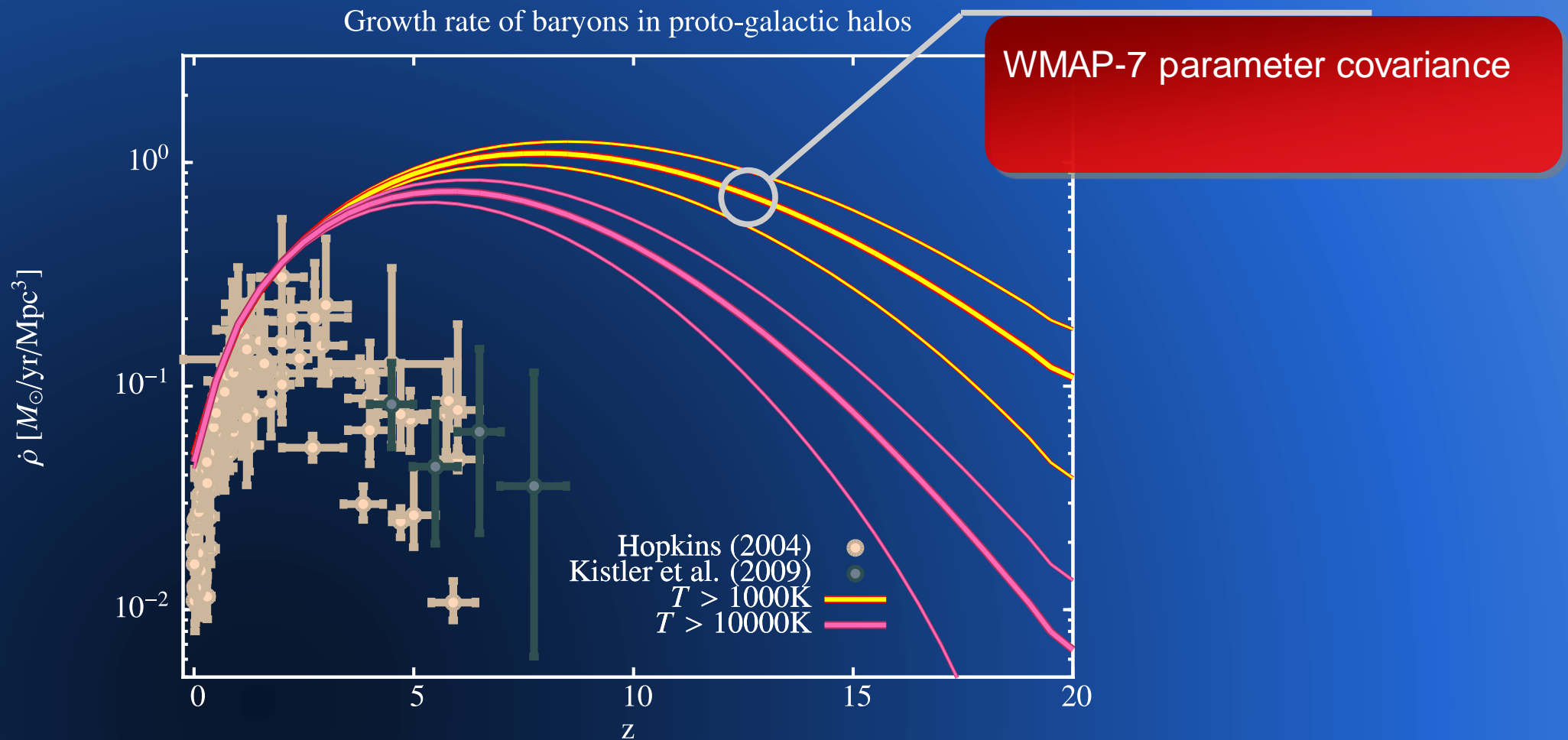
K-band Luminosity Function; $z=0$; Wave 1



Bower, Vernon, AJB et al. (2010)

Assessing Robustness of Models

Overview | Past | Present | **Future** | Summary



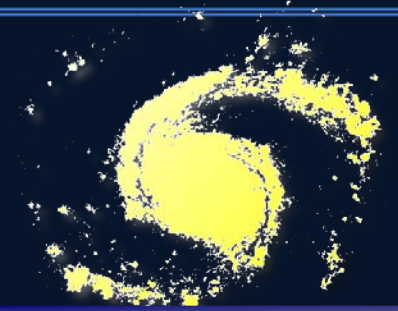
Challenges: Inferring Physics

Overview | Past | Present | **Future** | Summary

- ❖ Are models consistent with current data?
 - ❖ Requires extensive parameter space search
- ❖ How robustly can we predict future data?
 - ❖ What are the uncertainties in model predictions?
- ❖ What physics is necessary?
 - ❖ AGN? Dust evolution?
- ❖ What physics can we constrain?
 - ❖ Merger rate? IMF?



Bayesian Inference Engine
Weinberg



Summary



Overview | Past | Present | Future | **Summary**

- ❖ Galaxy formation is complex
 - ❖ Infrared predictions even more complex.....
- ❖ Detailed physical models for large surveys exist
- ❖ Don't match current data perfectly
- ❖ Challenges
 - ❖ Rapid exploration of parameter space/physics
 - ❖ Make predictions (before the experiment....)
 - ❖ Quantify ability to infer physics