DISTINGUISHING BETWEEN SPIN-ALIGNED AND ISOTROPIC BINARY BLACK HOLE POPULATIONS USING GRAVITATIONAL WAVE OBSERVATIONS

Will M. Farr, Simon Stevenson, *M. Coleman Miller*, *Ilya Mandel,*
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Rates & Populations Telecon
23 March 2017

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Not LVC

Basic Idea

- Interesting Tension:
  - EM Spin Measurements tend to high spins
  - LIGO Measurements have small chi_eff.
- Possible Explanations:
  - LIGO: large spins, but isotropic angles => small chi_eff
  - LIGO: different population, so small spins.
- How much can we learn from existing and near-future observations?

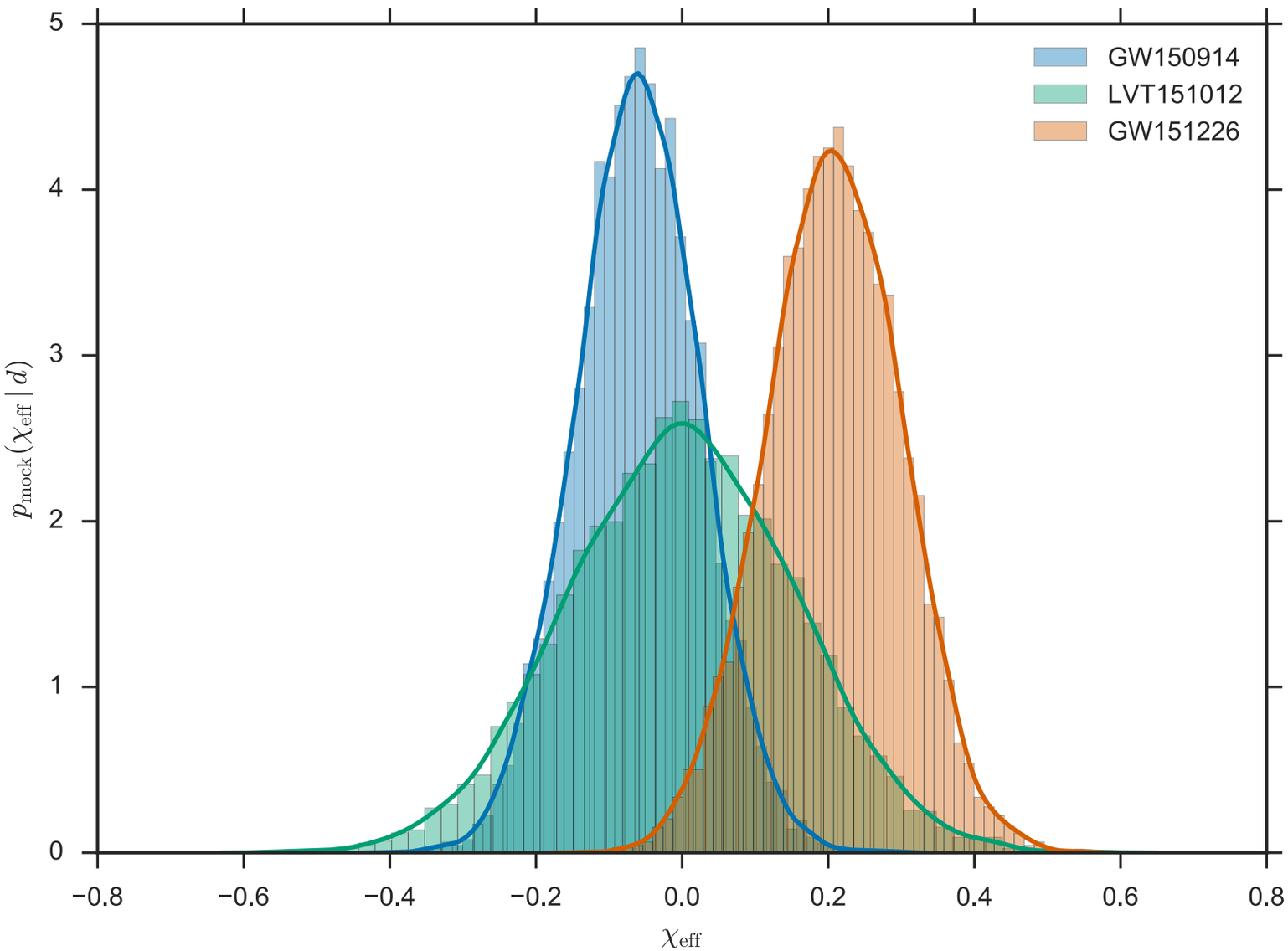
B.L.U.F.

- O1 observations have 1.7σ preference for isotropic over aligned distributions based on chi_eff.

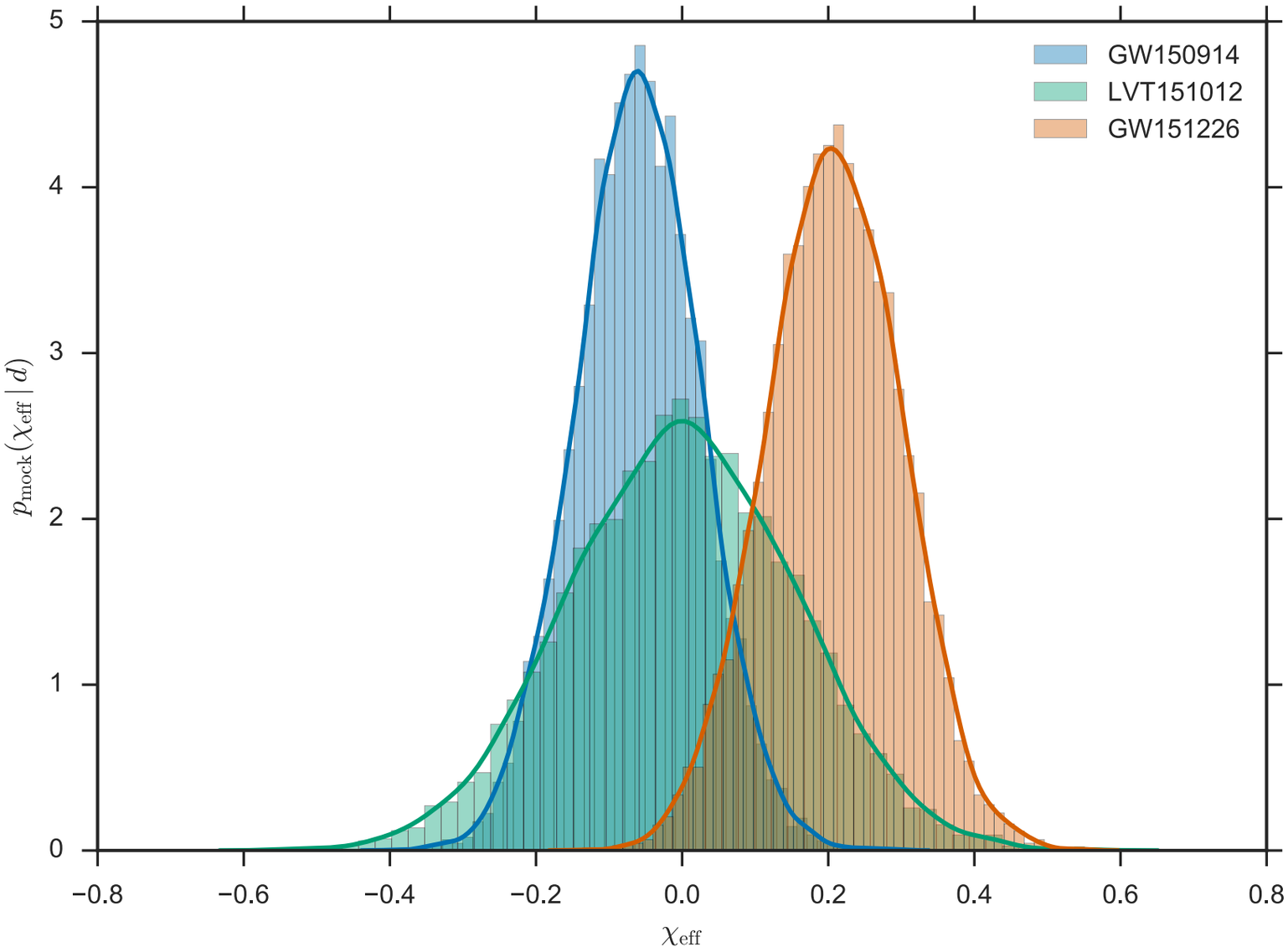
- With 10 more observations, get at least 3σ, more probably 5σ angular distribution

- Isotropic **probably** implies dynamical origin => maybe we are seeing a dynamical-formation population?

The 2.9 Events



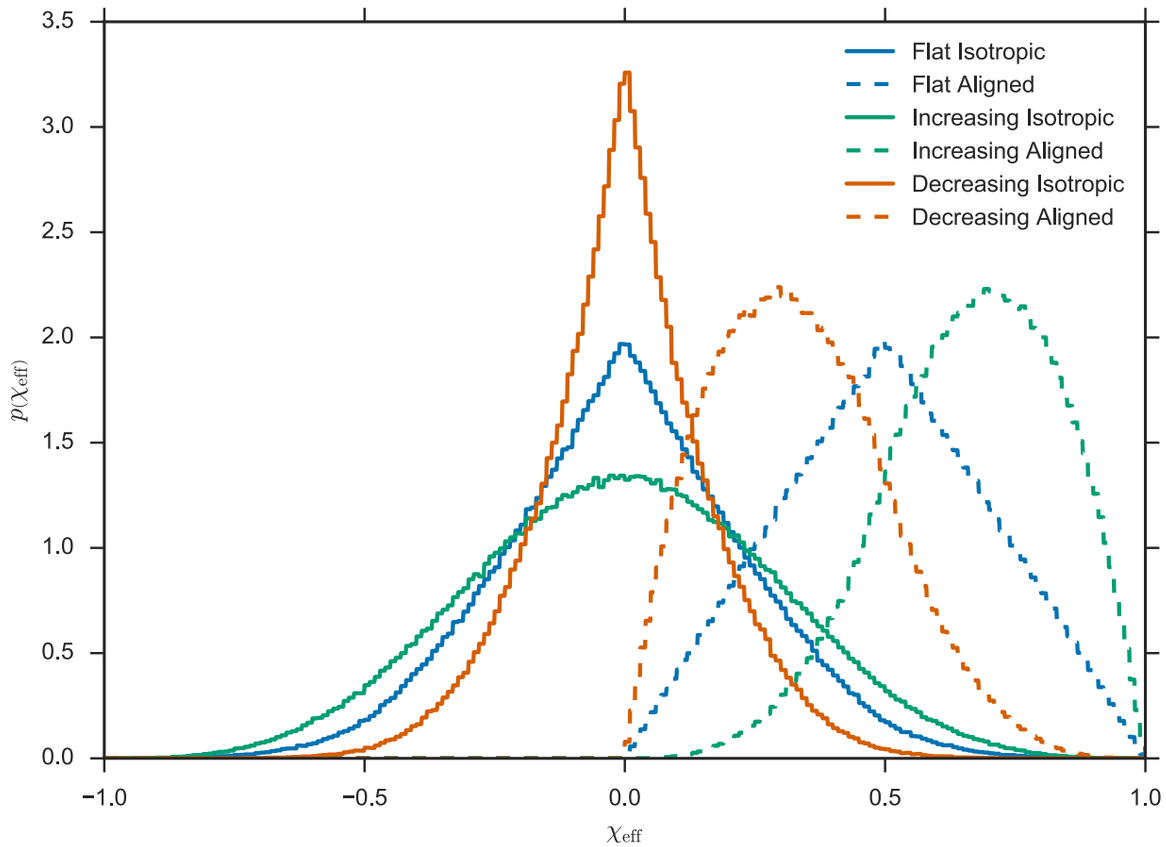
The 2.9 Events



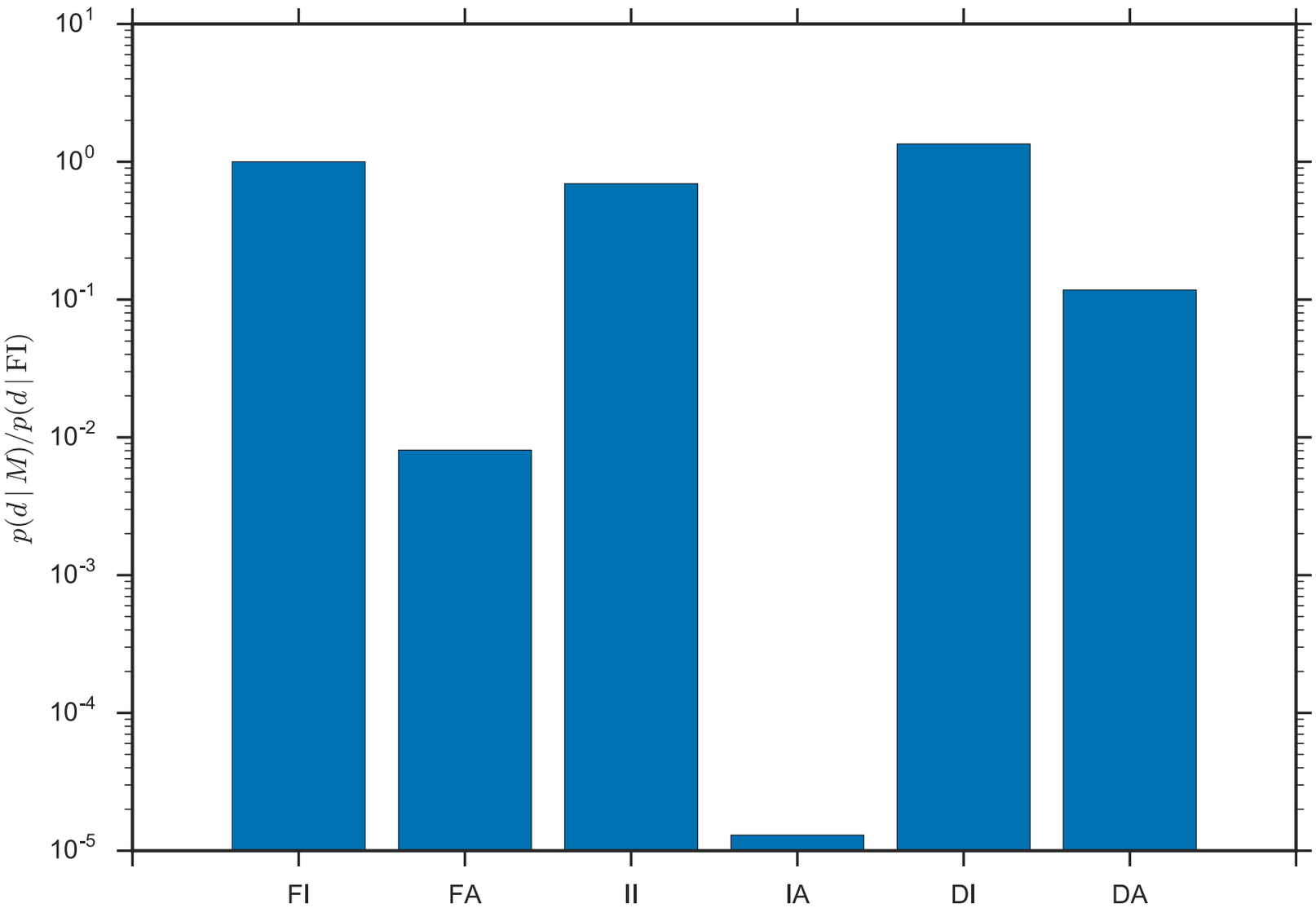
Mock Observations: Same mean and 90% as LIGO Quotes

Some Simple Models

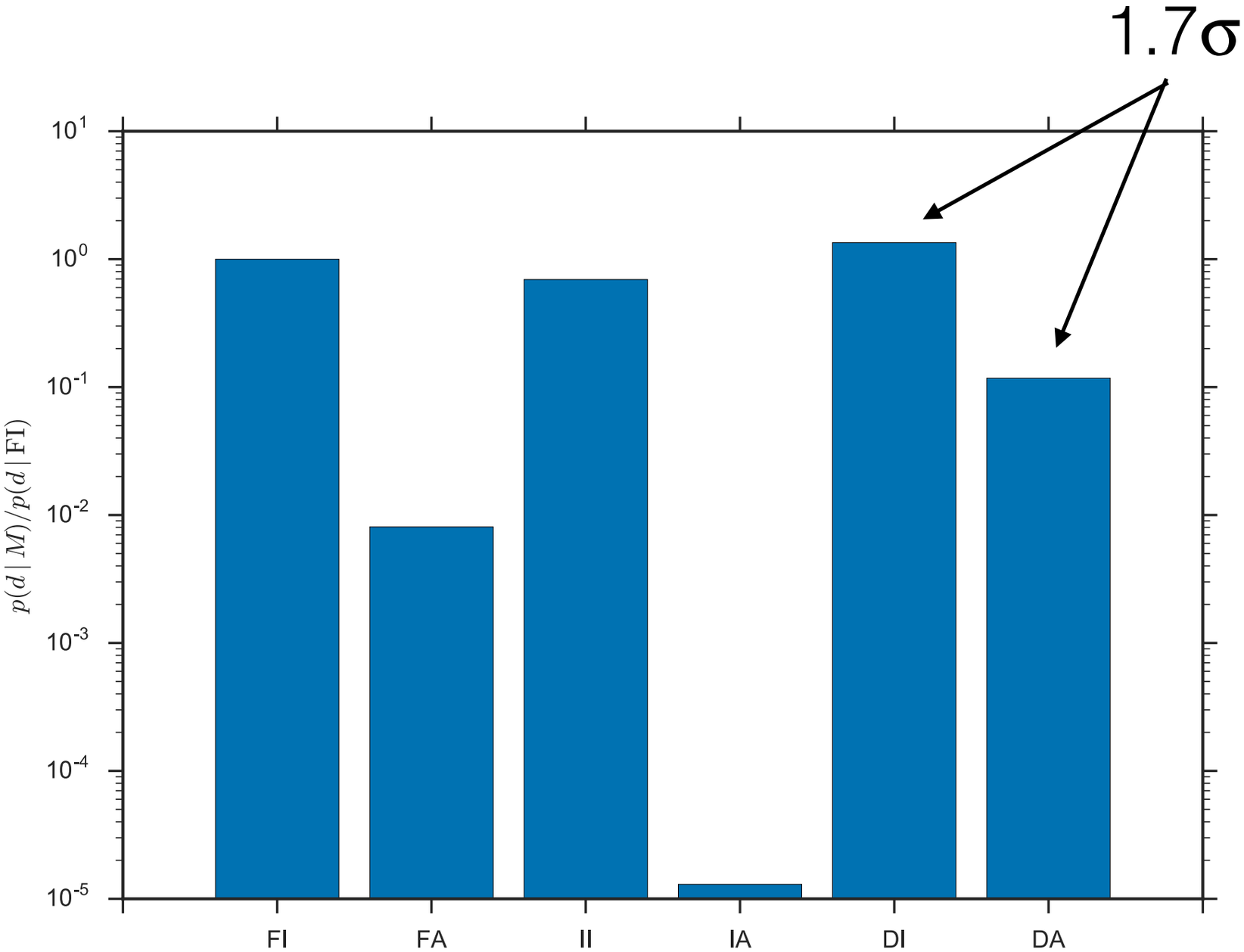
- p(chi_eff) comes from p(a)*p(angles)
- q = 1 (marginally consistent with existing observations)
- Aligned => tilt angles == 0
- p(a) is:
  - Flat
  - Linearly increasing
  - Linearly decreasing



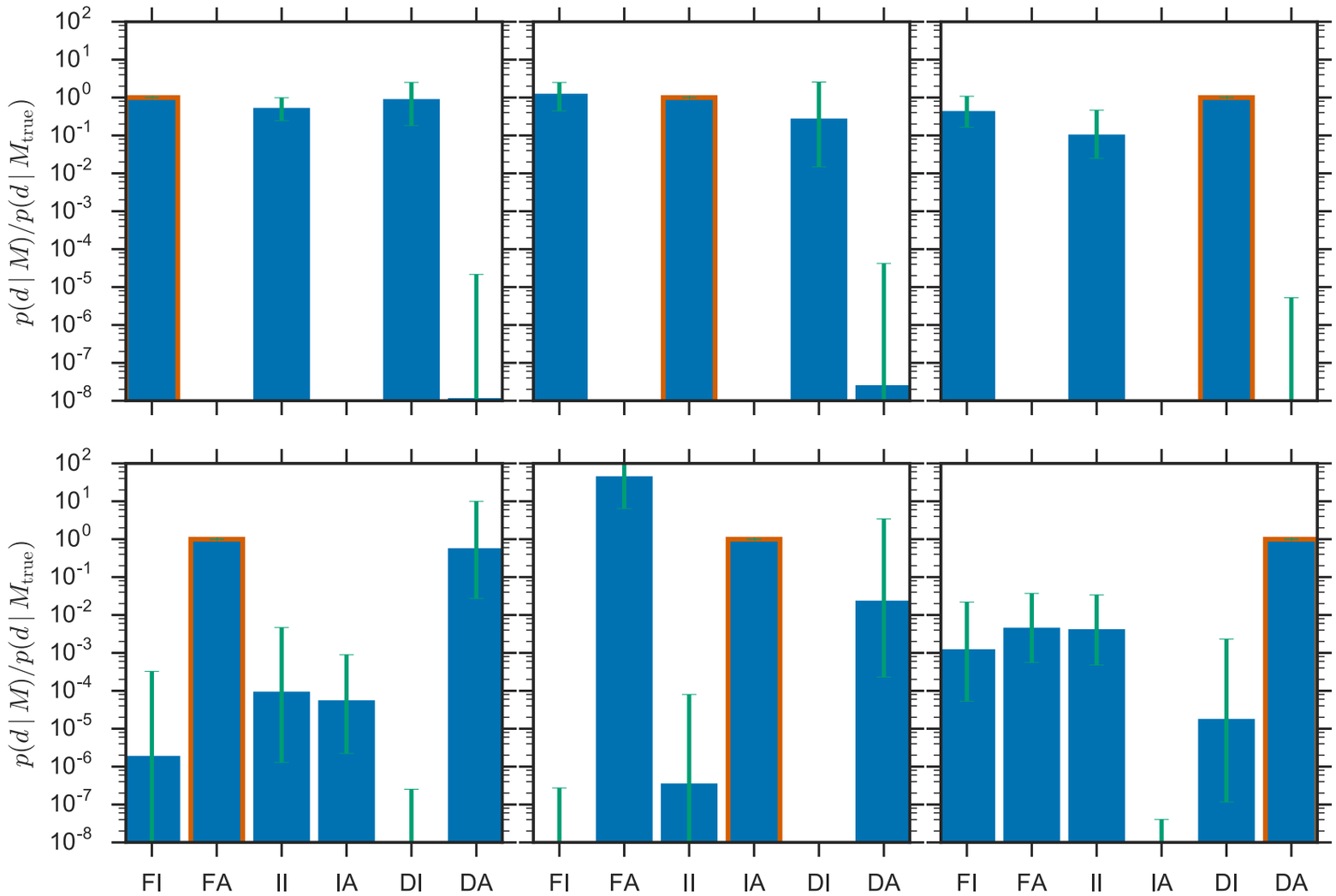
Current Evidence



Current Evidence

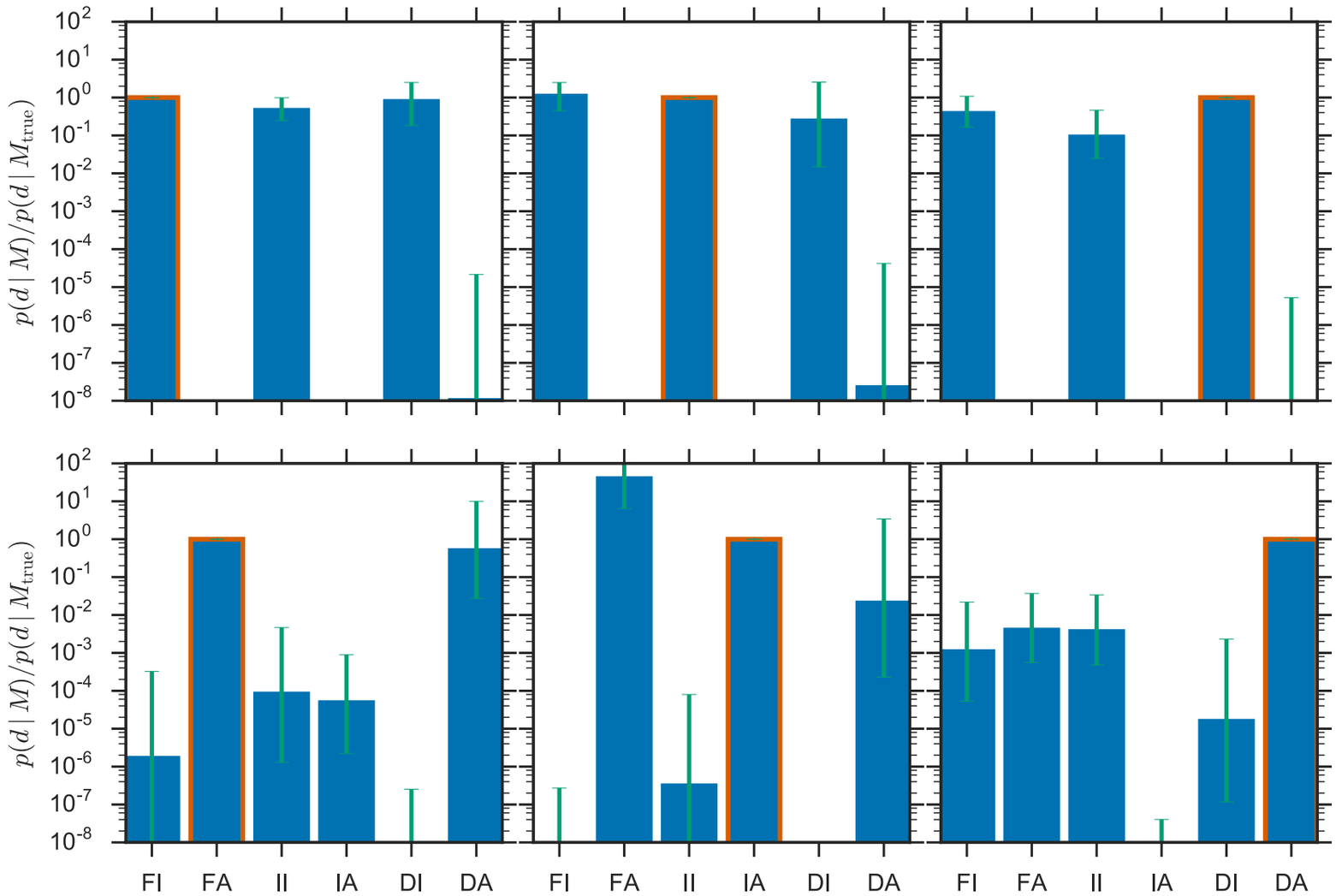


With 10 More Detections



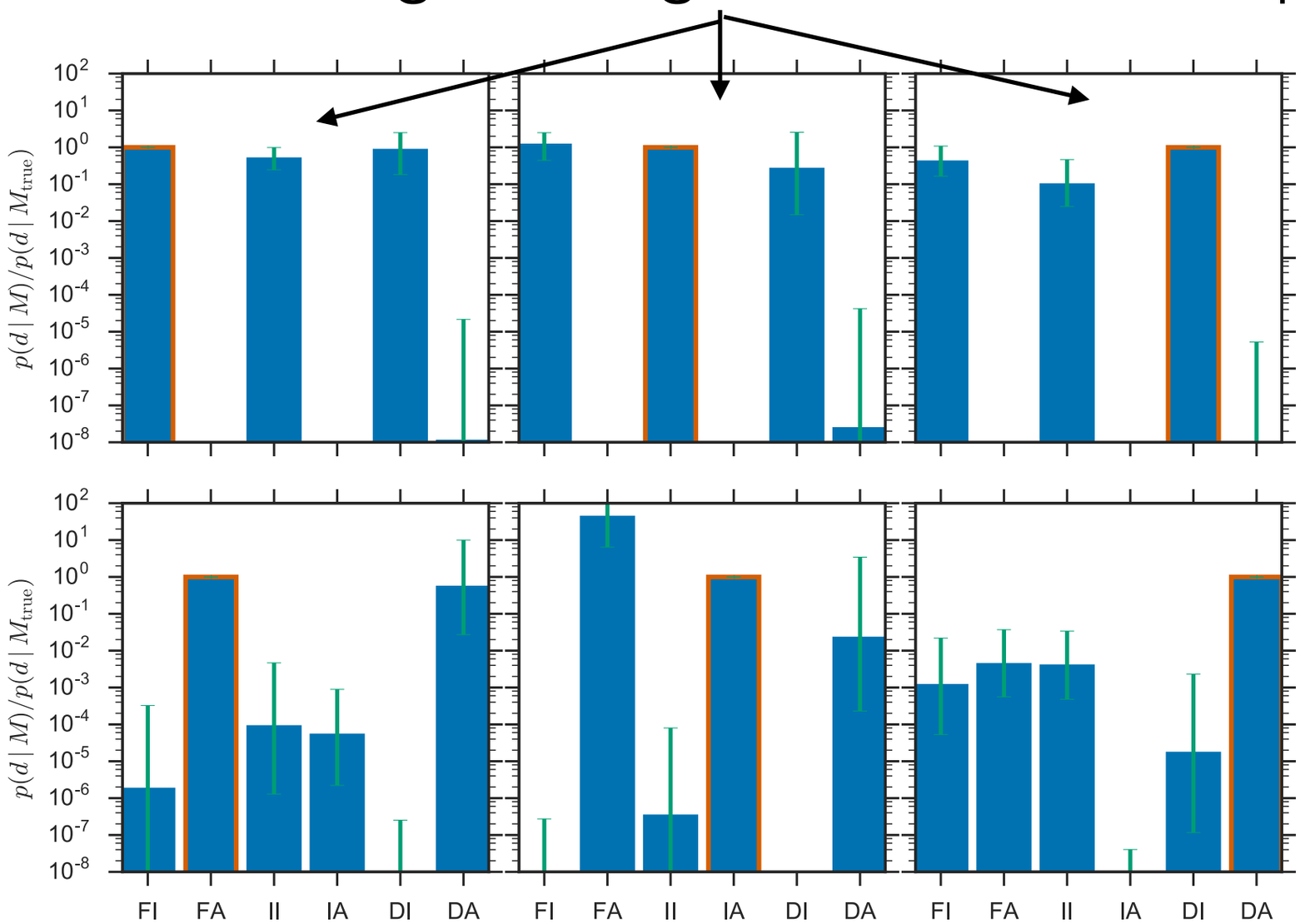
With 10 More Detections

Mostly > 5σ, all > 3σ



With 10 More Detections

We know angles long before we know p(a):



Extra: Even Mixture Models Prefer All-Isotropic After O1