Ideal Data Release for Theorists

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For the Standard Oscillation Analysis

Data + results

- Event histogram
- Chi-square map

*Not apply to e.g., cross section measurements

Analysis procedure

- Flux
- Detectors
- Tuning
- Unfolding

Please release everything in codes!

Why? – The Life of A Meddling Theorist

Part of theorists' job…

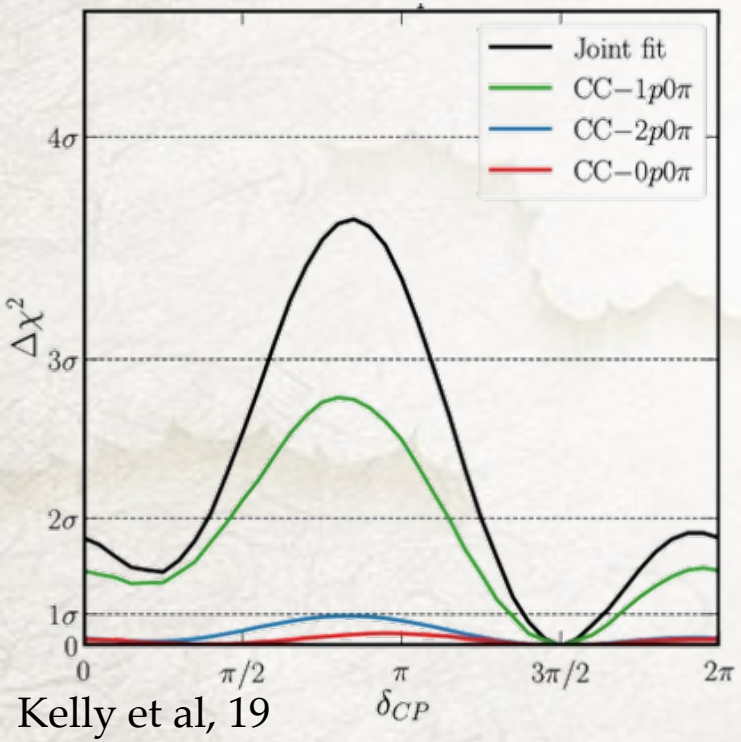
$$\gamma_{T,qq}^{(2)} = \left(112\zeta_5 + 48\zeta_2\zeta_3 - \frac{2083}{3}\zeta_4 + \frac{16153}{18}\zeta_3 - \frac{13105}{72}\zeta_2 - \frac{3049531}{31104}\right) C_F C_A^2$$
$$+ \left(-432\zeta_5 - 208\zeta_2\zeta_3 + \frac{8252}{3}\zeta_4 - \frac{19424}{9}\zeta_3 - \frac{16709}{27}\zeta_2 + \frac{20329835}{15552}\right) C_F^2 C_A$$
$$+ \left(416\zeta_5 + 224\zeta_2\zeta_3 - \frac{6172}{3}\zeta_4 + \frac{10942}{9}\zeta_3 + \frac{11797}{18}\zeta_2 - \frac{17471825}{15552}\right) C_F^3$$
$$+ \left(\frac{68}{3}\zeta_4 - \frac{5803}{45}\zeta_3 + \frac{146971}{2700}\zeta_2 - \frac{25234031}{1944000}\right) C_A C_F n_f + \left(-\frac{136}{3}\zeta_4 + \frac{8176}{45}\zeta_3 - \frac{9767}{225}\zeta_2 - \frac{4100189}{64800}\right) C_F^2 n_f$$
$$- \frac{105799}{162000} C_F n_f^2 ,$$
$$\gamma_{T,gq}^{(2)} = \left(\frac{196}{3}\zeta_4 - \frac{2791}{90}\zeta_3 - \frac{50593}{600}\zeta_2 - \frac{17093053}{777600}\right) C_F C_A^2 + \left(\frac{511}{3}\zeta_4 - \frac{3029}{9}\zeta_3 + \frac{123773}{900}\zeta_2 + \frac{63294389}{388800}\right) C_F^2 C_A$$
$$+ \left(-308\zeta_4 + \frac{2533}{9}\zeta_3 + \frac{3193}{54}\zeta_2 - \frac{647639}{3888}\right) C_F^3 + \left(\frac{182}{9}\zeta_3 - \frac{73}{27}\zeta_2 + \frac{246767}{60750}\right) C_A C_F n_f$$
$$+ \left(-\frac{28}{9}\zeta_3 + \frac{4}{9}\zeta_2 - \frac{419593}{81000}\right) C_F^2 n_f ,$$
$$\gamma_{T,qg}^{(2)} = \left(-\frac{252}{5}\zeta_4 + \frac{343}{45}\zeta_3 + \frac{239959}{13500}\zeta_2 - \frac{1795237}{1944000}\right) C_A^2 n_f + \left(-\frac{42}{5}\zeta_4 + \frac{6208}{75}\zeta_3 + \frac{34127}{1350}\zeta_2 - \frac{3607891}{38880}\right) C_A C_F n_f$$
$$+ \left(\frac{448}{15}\zeta_4 - \frac{26102}{225}\zeta_3 - \frac{2042}{225}\zeta_2 + \frac{9397651}{97200}\right) C_F^2 n_f + \left(-\frac{28}{9}\zeta_3 - \frac{554}{135}\zeta_2 + \frac{1215691}{121500}\right) C_A n_f^2$$
$$+ \left(\frac{2738}{675}\zeta_2 - \frac{10657}{4050}\right) C_F n_f^2 - \frac{172}{1125} n_f^3 ,$$

Dixon, Moult, Zhu, 19

Why? – The Life of A Meddling Theorist

But also:

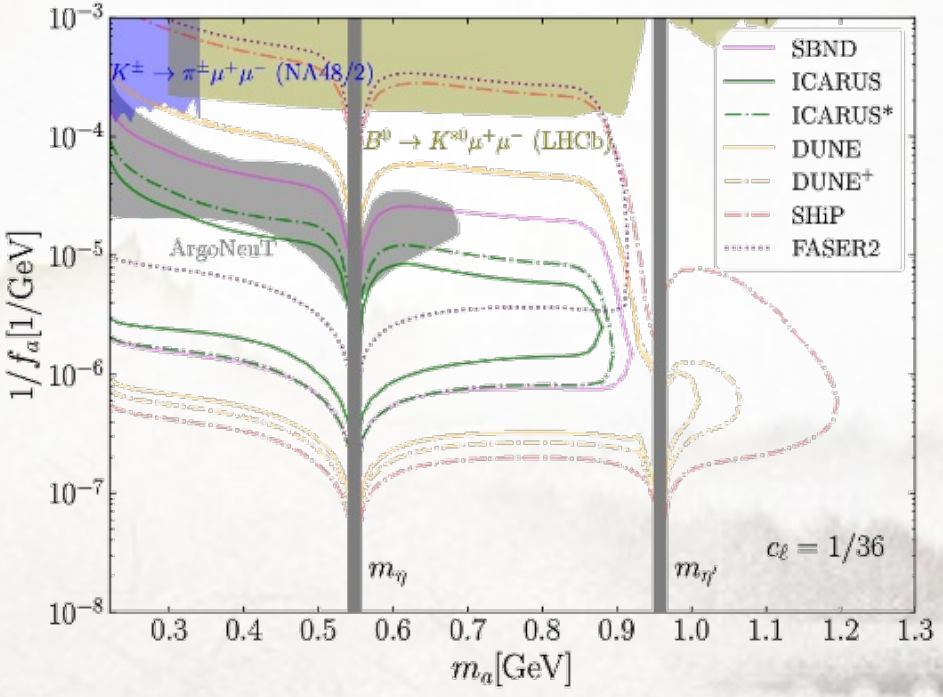
Sub-GeV atmospheric neutrinos



Kelly et al, 19

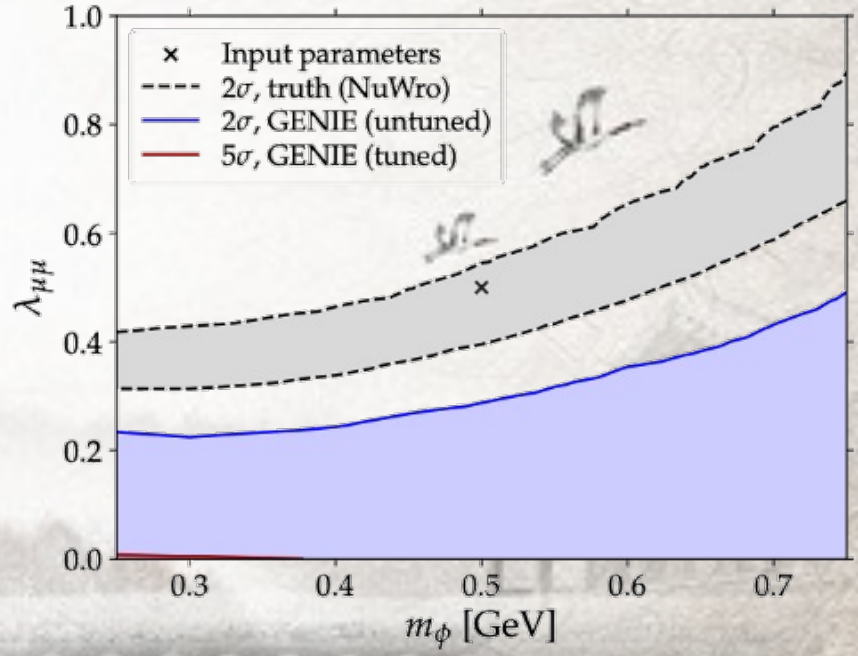
Axions

Co, Kumar, Liu, 22



Near detector tuning

See N. Coyle's talk



Propose new analyses, enriching physics program

Propose new analysis techniques/strategies

How We Use the Analysis Procedure

Theorists look for a middle ground between

toy efficiency + toy reconstruction + naïve/no background	vs.	full LArSoft MC

- Test if an analysis is at all plausible
- Semi-realistic sensitivity estimates (within an order of magnitude?)
- Capture the key physics impacting a result

The Specifics

- Flux
  - Central value + covariance matrix (especially for PRISM-type fluxes!)
- Detectors
  - Cuts
  - Efficiencies (for different particles, muon, electron, proton, etc)
  - Smearing
- Tuning
  - Central value + uncertainties
- Unfolding, statistics, etc

None of these needs to be perfect, but reasonable proxy would be great!

Please release everything in codes!

An Aside on Near Detector

- Should near detector measure true cross sections?
  - My answer: yes, there is no other choice
- Is this the same or a separate step from near detector tuning?
  - My answer: they have to be at least related
- Should all experiments/analyses converge to a same or similar tunes?
  - My answer: yes, the tuned cross sections should be close to truth. This may not be possible now, but should be the goal