Calibration Uncertainty Working Group

IACHEC 2016, IUCAA

Vinay Kashyap

To recap

1. RMF parameterization
2. `rmodel` in `xspec`
3. Strategic Monte Carlo
4. The Cal Concordance Project

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RMF parameterization

Konrad Dennerl

A scheme to parameterize RMFs such that they can be tweaked during a fit to minimize features in residuals.

Potentially promising method to incorporate uncertainties in RMF calibration.

Requires: evaluation of consistency of best-fit parameters, and some way to incorporate within standard spectral analysis platforms

xspec

Keith Arnaud

Implement scheme to incorporate calibration uncertainties as task "`rmodel`", parameterized just like source models.

Keith asks two questions (send him feedback):

- Are there any models for calibration uncertainties which could not be handled by such an interface?
- Is there anything else which should be included in the function input or output?

Strategic Monte Carlo

David van Dyk, Jeremy Drake, Vinay Kashyap

Monte Carlo randomization of subsystem uncertainties to generate many realizations of possible EAs (and RMFs), tied together over segments of passbands to make a *Calibration Sample*.

Three ways to brute force (all require that a representative sample be generated FIRST):

1. Multiple Imputation -- when you have "a few" samples, but corresponding fit parameters with error bars (see Lee et al 2011)

2. MCCal -- when fitting cost is low, generate 1000s of samples, look at how best-fit parameters are distributed (see also next slide)

3. `pyBLoCXS` -- essentially same as MCCal, but lets MCMC replace Jeremy as the optimization method. PragBayes for when calibration sample is treated as a fixed prior, FullBayes for when data are strong enough to "prefer" a subset of the calibration sample. Latter is in github.

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Strategic Monte Carlo: MCCal

Jeremy Drake, Kristin Madsen

Draws from Calibration Sample are used to generate distributions of best-fit parameters from Poisson deviant counts spectra to evaluate the effect and magnitude of systematic uncertainty.

Simulations show that by ≈10^4 counts, systematic uncertainties become comparable to statistical uncertainties for both Chandra and XMM.

Applied to G21.5 data as test cases for Chandra and Crab for Chandra +NuSTAR+XMM. Comparing EAs that produce better and worse fits allows rejection of EA space that is objectively bad, thus narrowing calibration range.

Next: finish paper, compare with `pyBLoCXS` FullBayes version, incorporate other instruments (Astrosat), improve NuSTAR model, improve spectral models

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Concordance

Meng Xiao-Li, Wang Xufei, Chen Yang, Herman Marshall, Matteo Guinazzi, Vinay Kashyap

Goal: leverage the scatter in count rates of a variety of sources observed with many different instruments to estimate how much the nominal EAs of the different instruments should be adjusted.

Preliminary results based on E0102 line fluxes, and blazars observed with XMM EPIC. Proof of concept analysis produces results that are consistent with expectations.

Next steps: better error models, informative priors on instrument errors, cross-passband correlations, compare with MCCal.

Also, MOAR DATA!

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All the talks

in chronological order

- Vinay Kashyap: http://www.iucaa.in/iachec/talkmaterials//11/vlk_IACHEC2016.pdf
- Herman Marshall: http://www.iucaa.in/iachec/talkmaterials//20/IntroAndProcess.pdf
- Meng Xiao-Li/Wang Xufei/Chen Yang: http://www.iucaa.in/iachec/talkmaterials//28/presentation_Mar1_2016_final.pdf
- Konrad Dennerl: http://www.iucaa.in/iachec/talkmaterials//35/IACHEC2016_RMF_movie_KD.pptx (see also http://www.iucaa.in/iachec/talkmaterials//12/IACHEC2016_RMF_KD.pdf)
- Keith Arnaud: http://www.iucaa.in/iachec/talkmaterials//18/xspec.ppt
- Jeremy Drake: http://www.iucaa.in/iachec/talkmaterials//51/mc_cal_constraints.pdf
- Kristin Madsen: http://www.iucaa.in/iachec/talkmaterials//50/IACHEC2016_CalUncertainties.pptx

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