Borrowing Statistical Strength: Methods from the Great Observatories for the New Challenges of GLAST

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and

California-Harvard Astrostatistics Collaboration (CHASC)

What is the Purpose Of this Session?

- Understand statistical issues of GLAST data analysis.
- What solutions do exist?
- Start discussion and collaborations between astro- and statistics groups.

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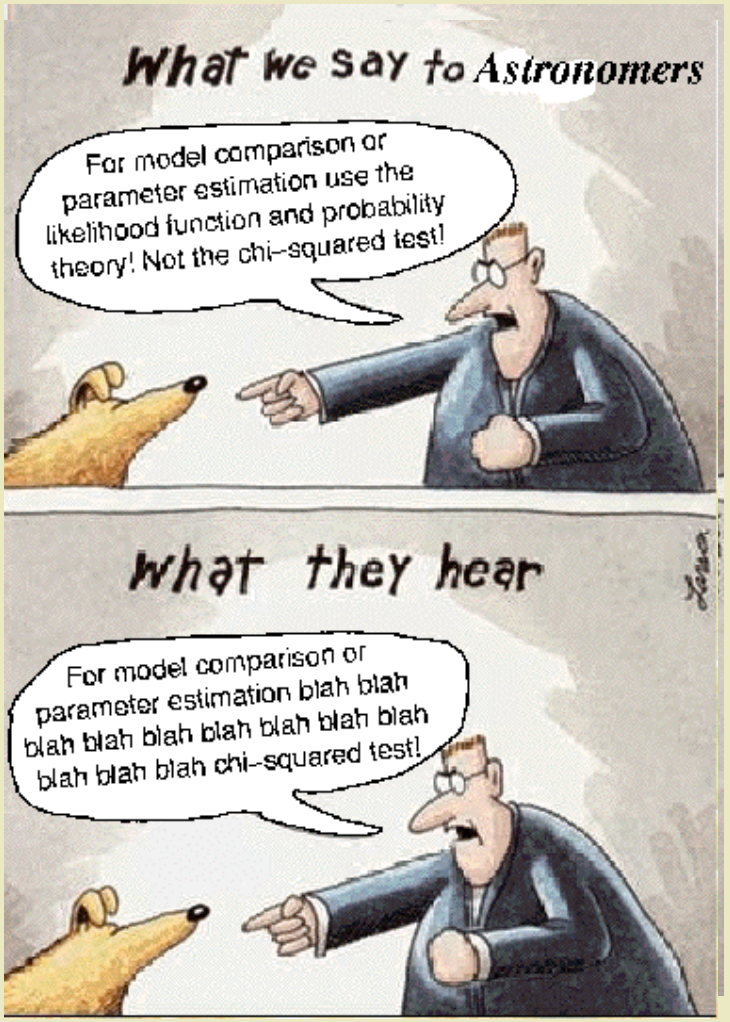

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PAST:
Chandra (AXAF) Challenges at SCMA II, 1996

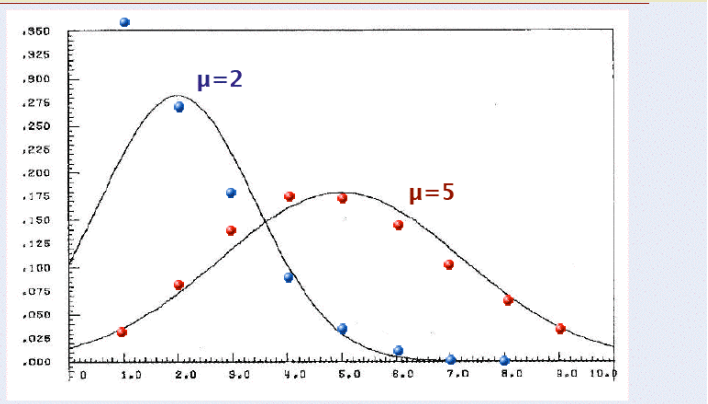
AXAF Data Analysis Challenges

Aneta Siemiginowska[1], Martin Elvis[1], Alanna Connors[2], Peter Freeman[3], Vinay Kashyap[3], and Eric Feigelson[4]

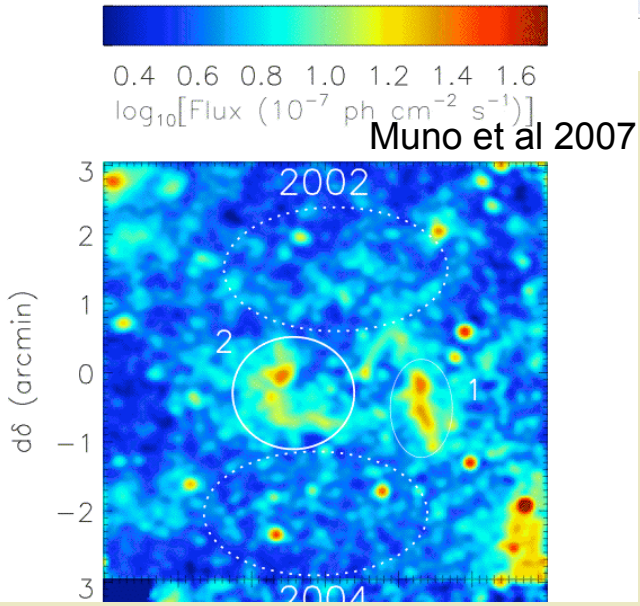
ABSTRACT The high quality of the AXAF X-ray data provides new challenges for the X-ray data analysis. It is clear that an "old" approach is not enough to fully exploit the capabilities of the AXAF instruments. We describe a few of the statistical and computational problems that we have so far identified. Some of them appear to be theoretically solvable

PAST:
Chandra (AXAF) Challenges at SCMA II, 1996

1) Modeling the data:
   - X-ray data => low counts Poisson
   - chi2 does not work - how good is my fit
   - Correlated residuals
2) Instrumental Issues:
   - Pileup
   - Calibration uncertainties - non-linear
   - Complex Instrumental response
3) Source Detection:
   - Feature significance
   - Boundaries/edges of a feature
   - Upper Bounds



Comparison of Poisson distributions (dotted) of mean μ = 2 and 5 with normal distributions of the same mean and variance (Eadie *et al.* 1971, p. 50).



Muno et al 2007

Detecting Light Echo from SgrA*

CHANDRA X-ray Images

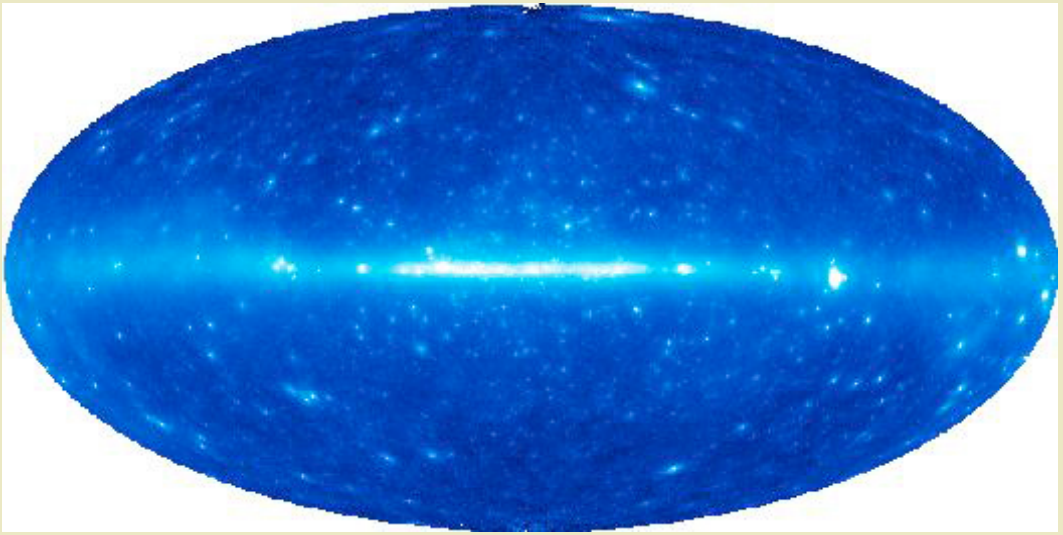
Credit: NASA/CXC/Caltech/M.Muno et al.

TODAY:
Have we solved any Challenges?

- Data Analysis in Poisson Regime - modeling, testing for additional known component (line or point source)
- Goodness of Fit
- Correlated Residual
- Calibration uncertainties
- Feature Detection
- References:
  - Connors & van Dyk at SCMA 2006 "How to win with non-gaussian data"
  - Park et al 2006, ApJ: "Bayesian Estimation of Hardness Ratios"
  - Drake et al 2006 SPIE: Monte Carlo Processes for Including Chandra Response uncertainties.
  - Protassov et al 2002 ApJ, "Statistics Handle with Care"
  - Van Dyk et al 2001 ApJ, "Analysis of Energy Spectra with Low Counts"
- CHASC Web page:
  - http://hea-www.harvard.edu/AstroStat/

FUTURE:
Do we have solutions for GLAST?

- GLAST Challenges
  - Gamma-Rays => Poisson data
  - High background
  - Complex Instrumental Response
- Detection issues
- Confidence Bounds
- Hypothesis Testing



Web Resources:

- CHASC Web page:
  - http://hea-www.harvard.edu/AstroStat/
- Center for Astrostatistics, Penn State:

  http://astrostatistics.psu.edu/statcodes/
- Other

  http://www.ee.duke.edu/~willett/software.html

Astrostatistic Session

* *Statistical Challenges for GLAST LAT Data* – **James Chiang**
* *Multi-Scale Image Reconstruction with Low-Count Poisson Data* – **David van Dyk**
* *Low-Count Poisson Goodness-of-Fit and Feature Detection: An EGRET Example with EMC2* – **Alanna Connors**
* *Computing Upper Bounds for Contaminated Weak Sources: The Banff Challenge* – **Xiao-Li Meng**
* *Modern Statistical Methods for GLAST Event Analysis* – **Robin Morris**
* *Algorithms for Detection and Modeling of Sources, GRBs, Quantum Gravity and Dark Matter Signatures* – **Jeff Scargle**