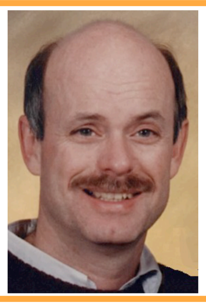

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Updating the ACIS Contaminant Model

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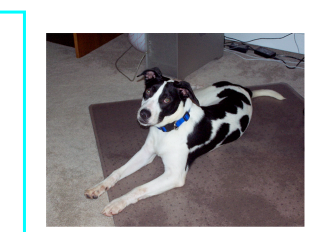
Abstract

the spectral model of the contaminant that is building up on the Chandra ACIS detector was based primarily on one high signal/noise observation of Mk 421. This one observation was obtained late in 2002. The time-dependence was modeled using the data from the ACIS external calibration source (ECS) up to mid-2004. Observations with the LETG/ACIS and the ECS over the past few years show that the contaminant model should be updated in order to continue correcting for its absorption at the 5% level.

Data are used from 28 LETG/ACIS observations of blazars and one bright Galactic X-ray binary. The observations were obtained between December 1999 and July 2007.

Summary of Results

- Global spectral model (Red outlined box)
  - ECS and LETGS still disagree without adding "fluffium"
  - Spectral model could be in error by 20% of the optical depth
  - A spectral feature between C-K and 400 eV may appear in LETGS/ACIS fits
- Fits to resonance edges (Green outlined box)
  - There's a clear C-K featured associated with the contaminant.
- Composition indicators from spectral features (Violet outlined box)
  - O-K, F-K and a C-K resonance vary with the contaminant optical depth
  - The O-K resonance feature seems unrelated to the contaminant
  - The spectral model from 2002 holds through 2007



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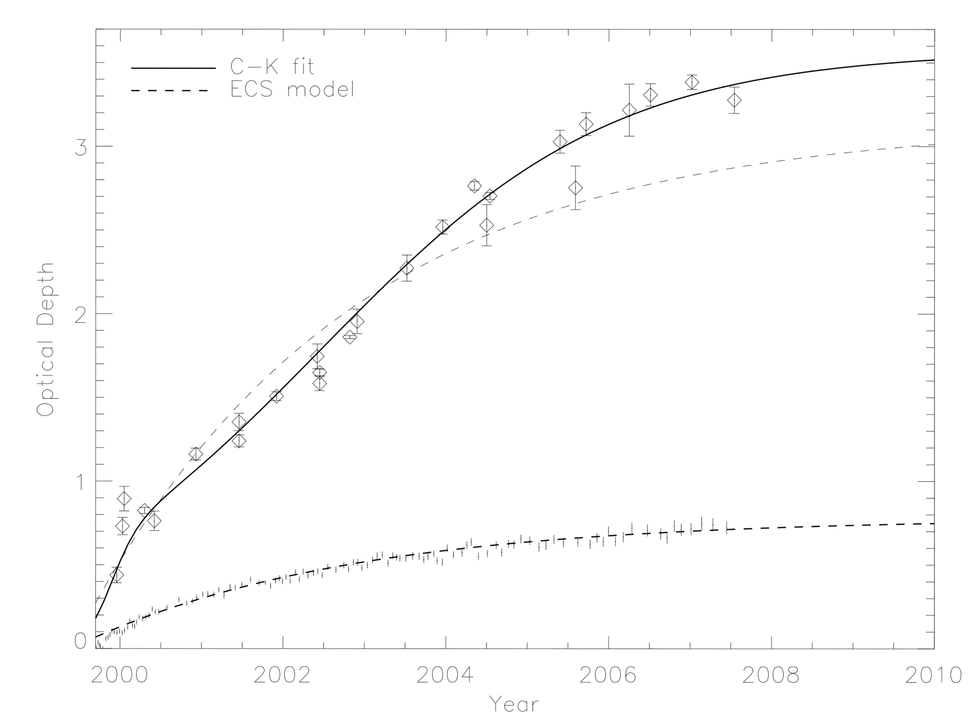


Fig. 1: Optical depths at the C-K edge (diamonds) and at 700 eV (vertical lines) from the ECS data. The heavy dashed line is a fit tc the ECS data using the (3-parameter) Tennant parametrization and rescaled to the light dashed line for comparison to the C-K data. The solid line is a 5-parameter fit to the C-K data. The C-K edge data are systematically low comapared to the scaled ECS model by ‹ small amount in 2002 but deviate by over 15% in 2006. There is no a priori model, so extrapolation is uncertain by ~20% by 2009.

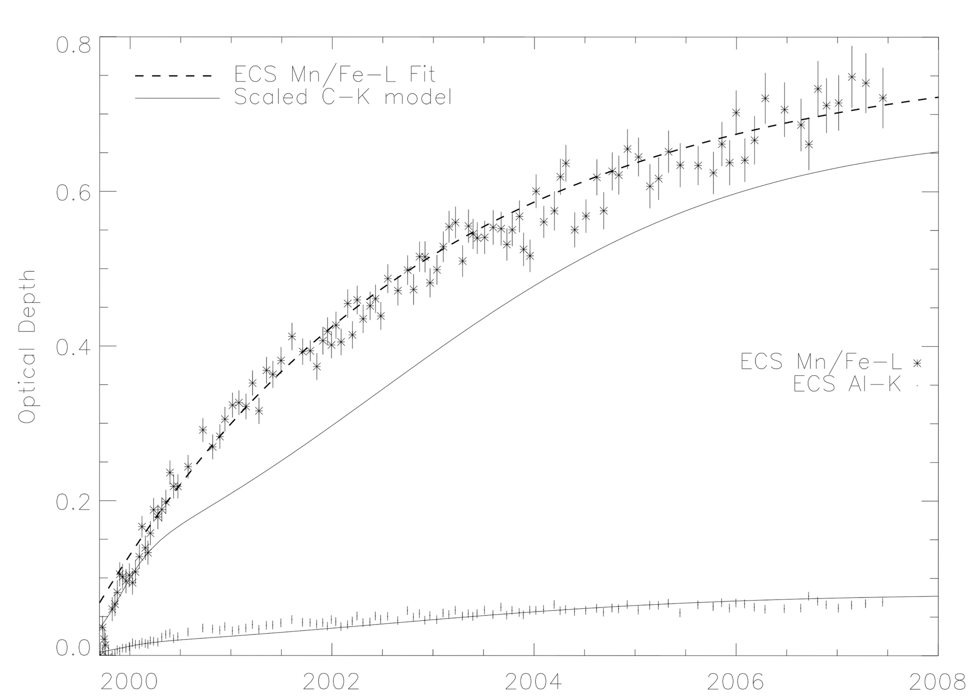


Fig. 2. Demonstration of the ECS-edge discrepancy. ECS data from about 700 eV (stars) and 1.486 keV (vertical lines) are compared to the prediction of a model fitted to C-K optical depths (solid line, from Fig. 1). The spectral model assumes constant fractions of O and F relative to C, based on a measurement in late 2002. The 700 eV discrepancy is over 30% in 2002 but drops to about 10% in 2006. The Al-K data agree very well for a period in 2004. In order to force agreement between ECS and C-K edge measurements, the contaminant model has a fictitious 4th component, "fluffium", to mimic the behavior of a fluffy contaminant.

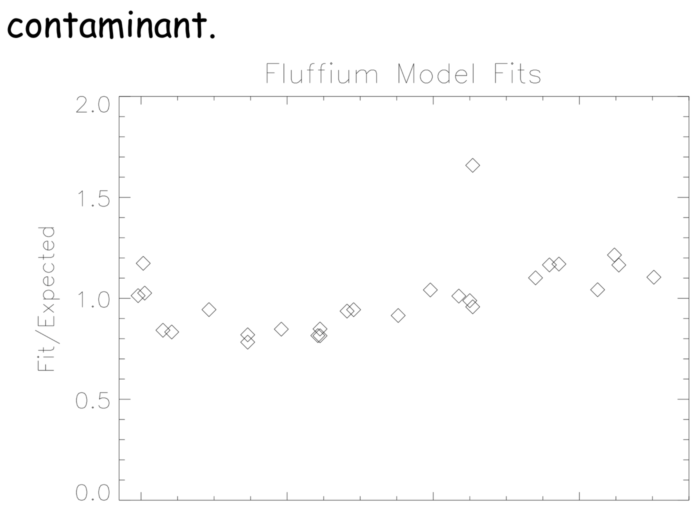


Fig. 3. Fits to LETG/ACIS blazar spectra using a model that rescales the contaminant's spectrum to obtain the best fit. The data are best fi by an amount of contaminant that varies ± 20% from the expected value This deviation represents possible systematic error in the contamination correction model.

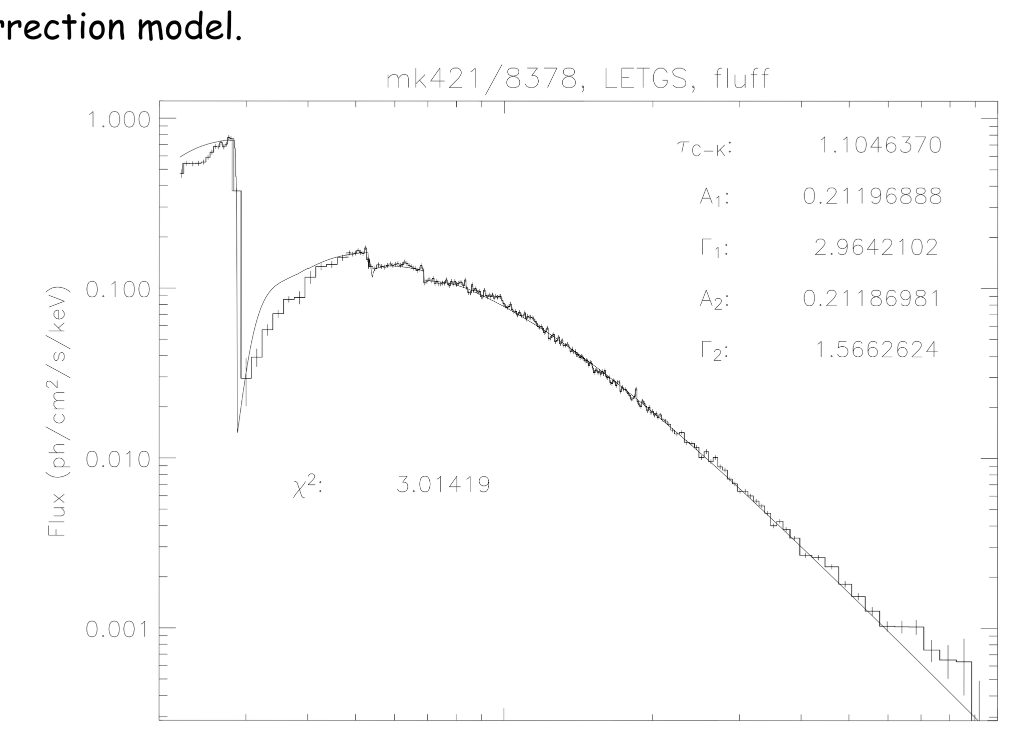
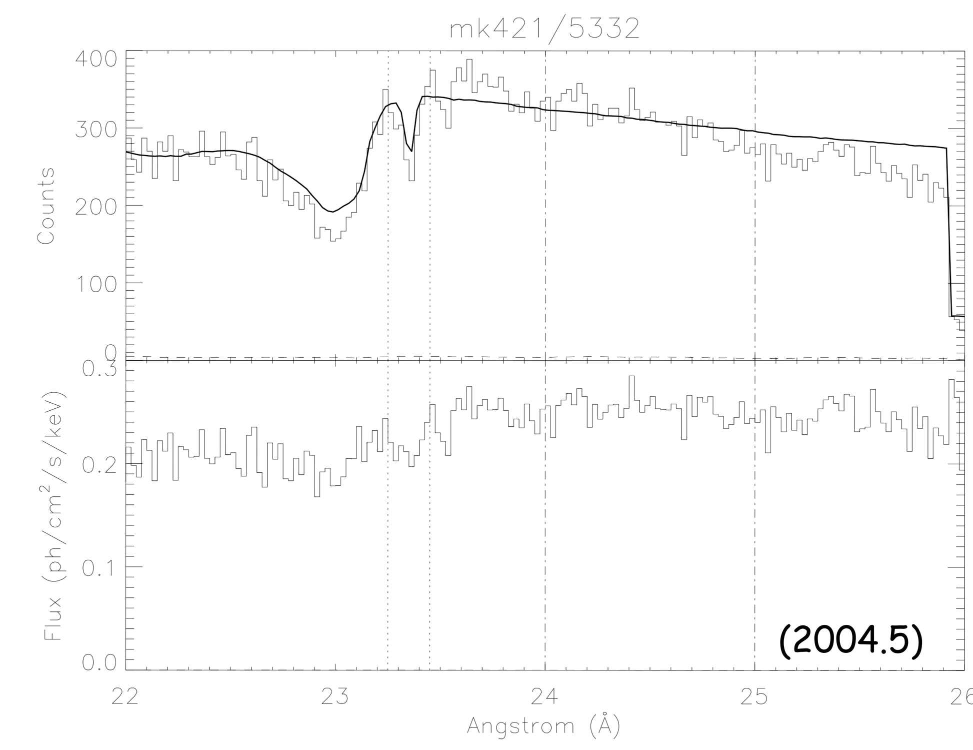
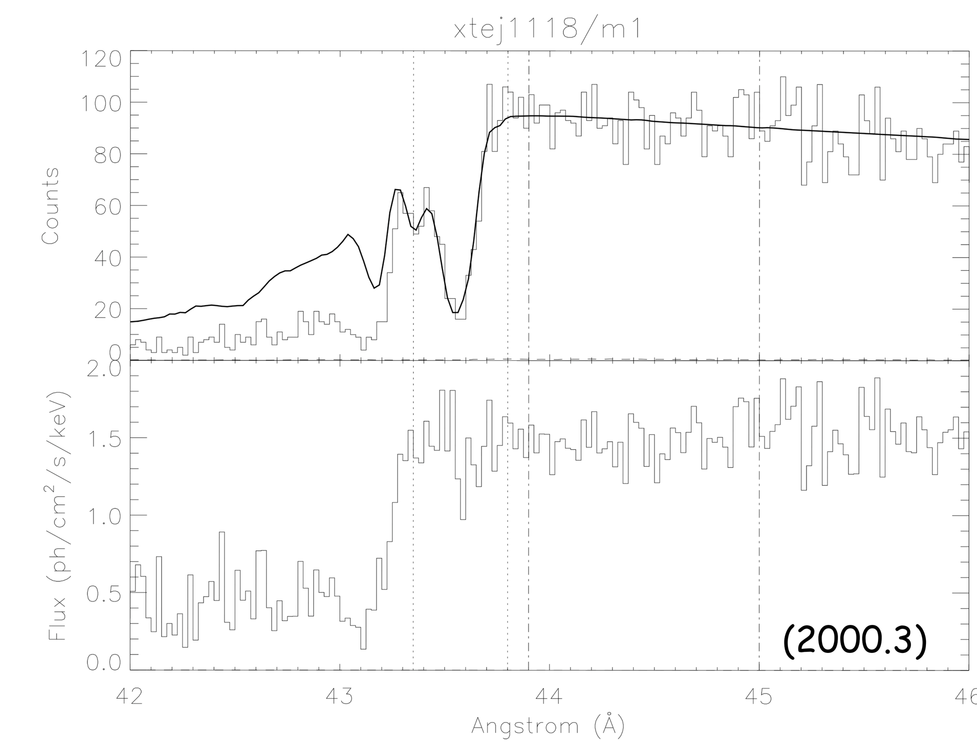
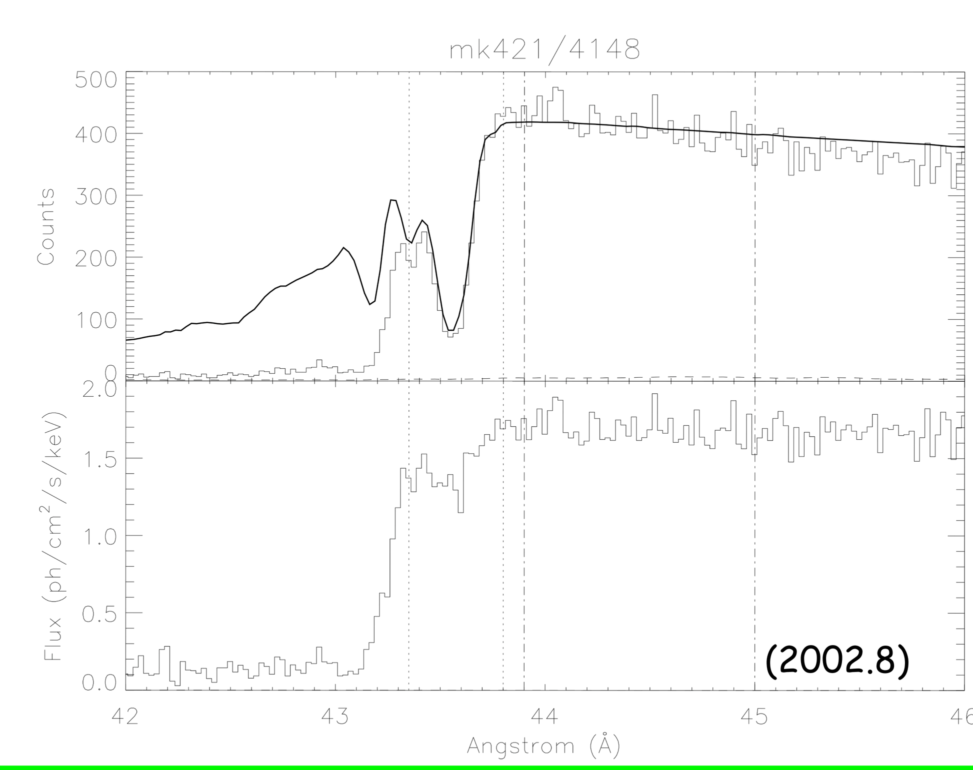


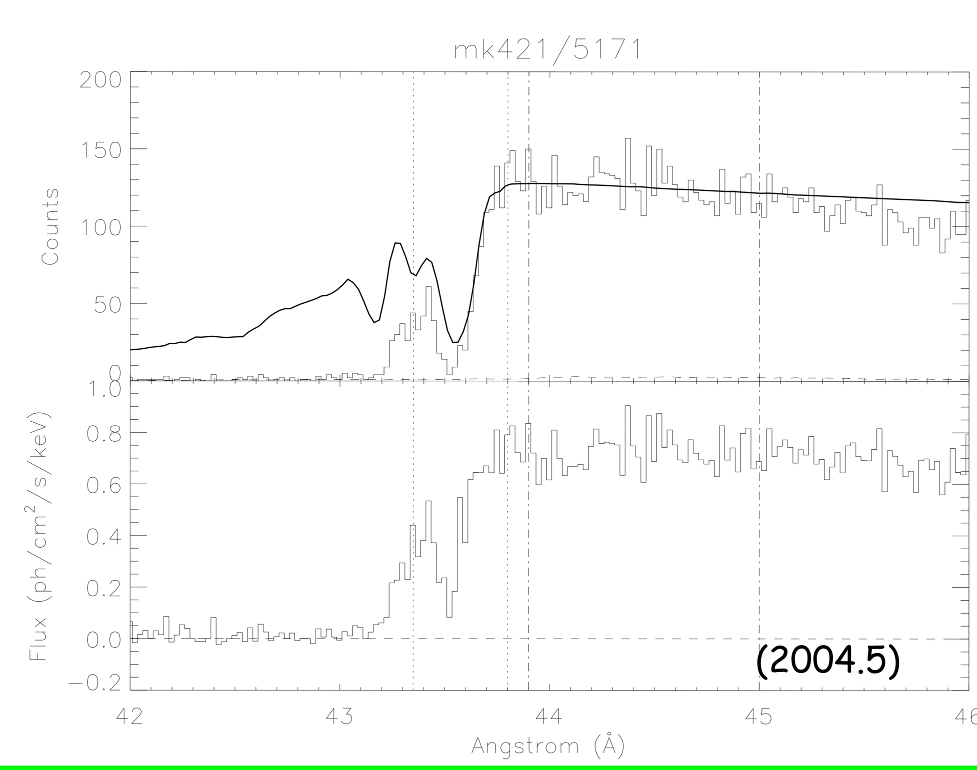
Fig. 4. Fitting the current contaminant model to a recent LETG/ACIS observation of Mk 421 gives large residuals in the 280-400 eV range.





Figs. 5-8. Details of calculations of the optical depths in the O-K (23.35 Å) and C-K (43.55 Å) resonance features. Resonance features are important because they indicate chemical bonding and can be used to identify compounds.The data ar shown as histograms and the (scaled) effective area is shown as the thick curve. Vertical dotted lines give the range of the data used to estimate the resonance optical depth relative to a continuum region marked by vertical dashed-dotted lines. In the O-K region, much of the edge structure is instrumental and there is a small edge shortward of 23.3 Å that is due to the contaminant. In the C-K region, there is a deep edge due to the contaminant at 43.25 Å that varies with time and a residual ‹ the resonance feature that varies with contaminant depth. ObsID 4148 (at 2002.8) was used as the spectral reference.





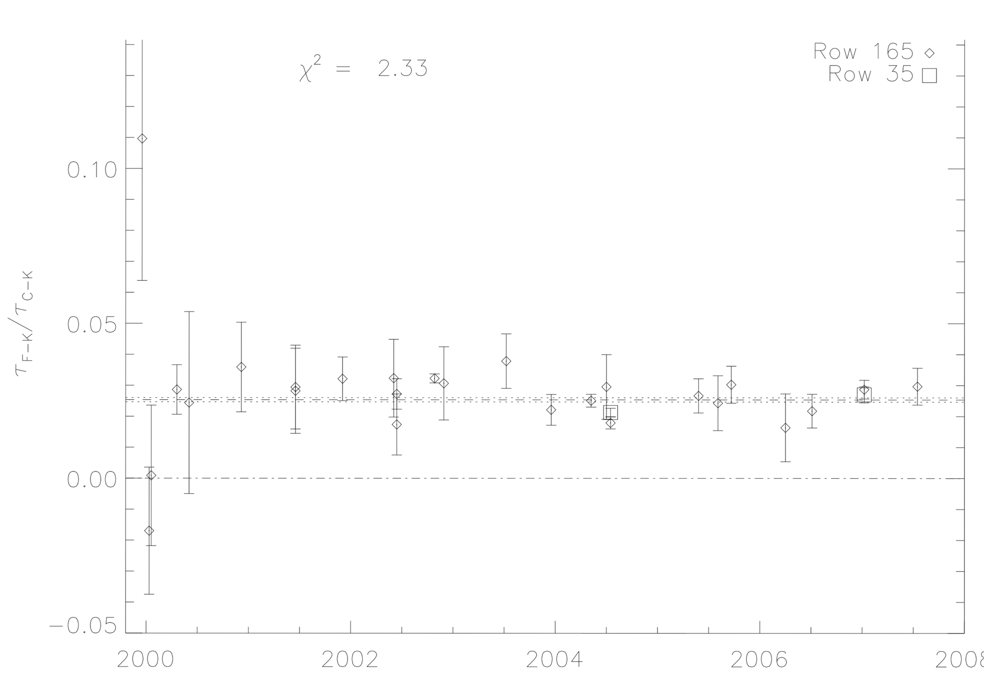


Fig. 9. Fitted optical depth of the F-K edge, relative to that at C-K. The data are well fitted by a constant. The χ_ν^2 for a fit to a constant in time is over 4. The open square represents data taken close to the readout frame where the contaminant is thicker.

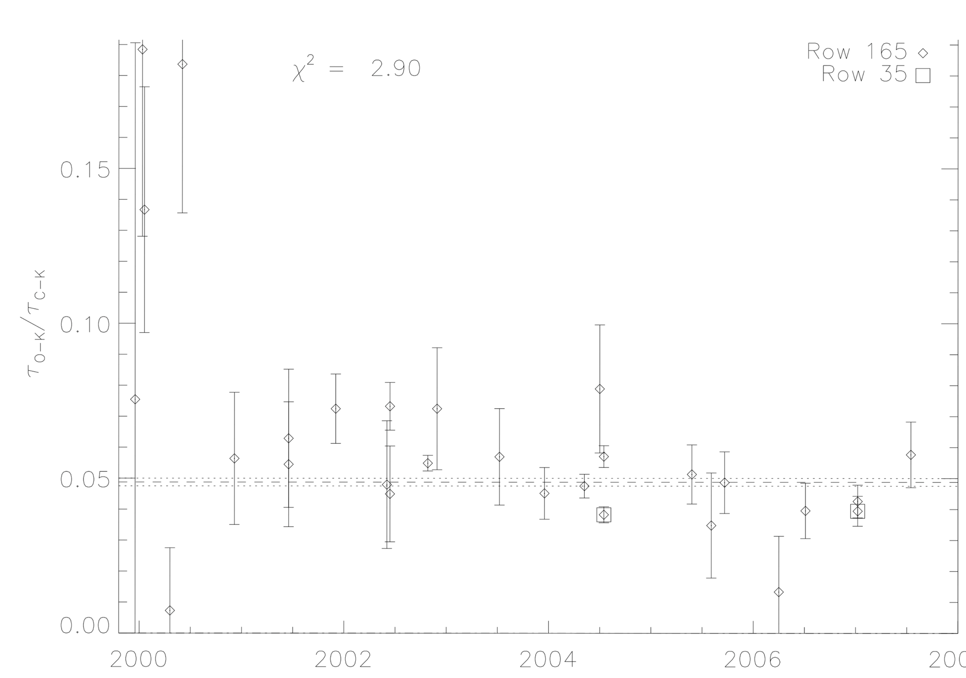


Fig. 9. Fitted optical depth of the O-K edge, relative to that at C-K. The data are well fitted by a constant. The χ_ν^2 for a fit to a constant in time is about 3.8.

Figs. 9-12: Optical depths of other features in the spectrum of the contaminant are measured as a function of time. Mos are related to the contaminant, so the data are fitted to a model where the feature is a fixed fraction of the C-K optical depth. The exception is the O-K resonance feature, which seems to be constant in absolute optical depth, regardless of the contaminant's optical depth. We conclude that this feature is due to a systematic error in the instrumental effective area or relates to the ISM. The other features indicate that the elemental component's abundance is invariant.

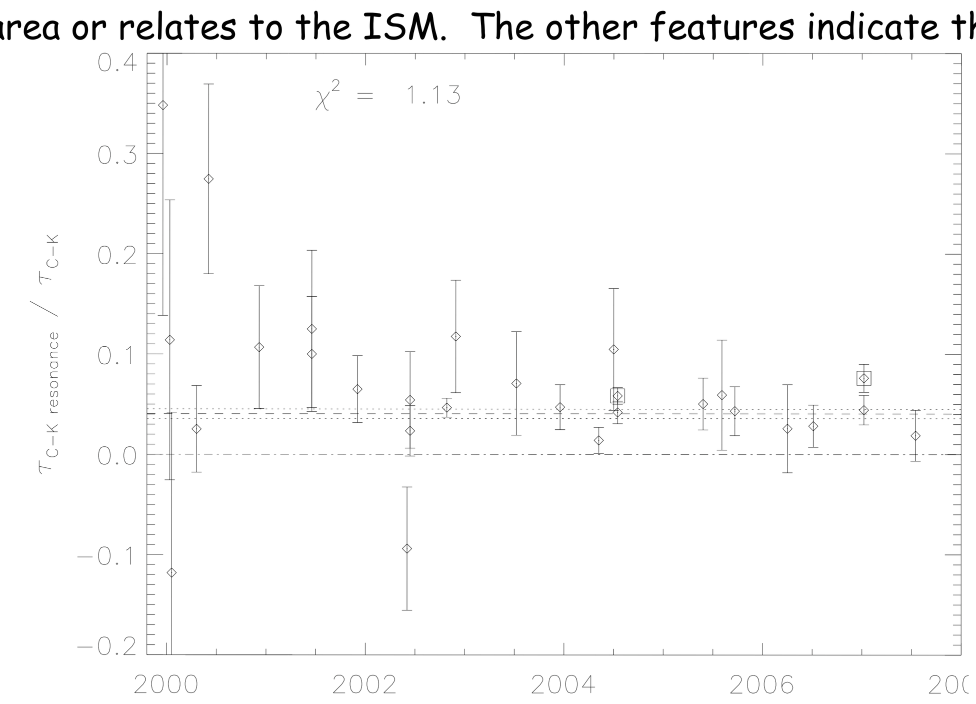


Fig. 9. Fitted optical depth of the C-K resonance feature, relative to that at C-K. The data are well fitted by a constar and the ratio to C-K is similar for rows 165 and 35.

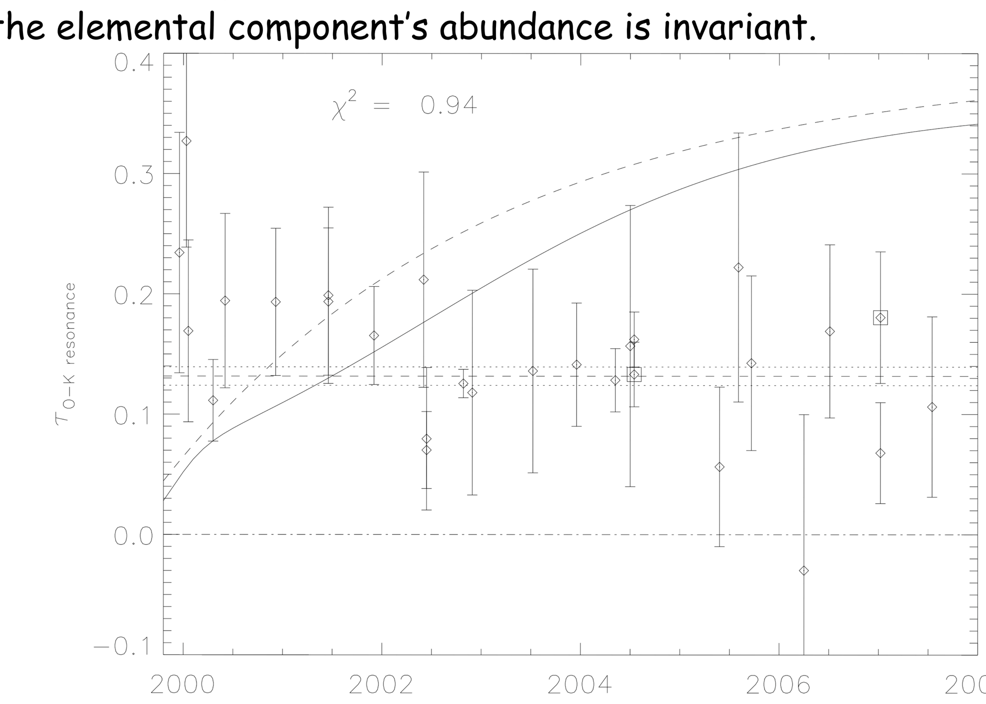


Fig. 9. Fitted optical depth of the O-K edge, relative to that at C-K. The data are well fitted by a constant. The χ_ν^2 for a fit to a constant fraction of C-K is just under 2.7.

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