PIMMS version 3.9j Users' Guide

K. Mukai

1 Introduction

PIMMS (Portable, Interactive, Multi-Mission Simulator) is intended as a versatile simulation tool for X-ray astronomers.

PIMMS uses one command `GO` for actual execution, while other commands are mostly used for setting up various parameters. This approach allows users to repeat similar calculations using a slightly different parameter.

PIMMS uses the following terms:

- Model: spectral model to be used. PIMMS contains a small set of simple spectral models, and others can be imported.
  - However, spectral simulation is not a strength of PIMMS — it does not output spectra as such, and it is unlikely that PIMMS can keep up with the multitude of models that are used for various types of objects. We recommend the use of XSPEC for a full spectral simulation.
- Instrument: in addition to the instrument for which simulation is to be done, you can also specify the **input** instrument for count rate calculations. This is used for calculating normalization of the model; rather than starting from the source flux in cgs unit, PIMMS can start from e.g., Einstein IPC count rate.

2 New in v3.9/3.9a/3.9b/3.9c/3.9d/3.9e/3.9f/3.9g/3.9h/3.9i/3.9j

This is PIMMS version 3.9j.

Version 3.9j incorporates a new set of effective area curves for Chandra, suitable for use in writing Cycle 11 proposals.

Version 3.9i correctly treats the statistical errors in the Suzaku HXD background files provided to the users. Previous versions would have underestimated the necessary exposure times somewhat. It also corrects bugs for Swift XRT grade 0 count rates as well as ASCA count rates within the typical extraction regions, in cases when a limited energy range is spacified. Also updated is the message regarding the instrument-specific extra information (or the lack thereof) when a limited energy range is specified.

Version 3.9h includes minor updates to the effective area curves for Suzaku XIS and HXD instruments. In addition, PIMMS now outputs approximate time needed for 3-sigma and 5-sigma detection in standard HXD energy bands (1 for PIN and 2 for GSO), given the current level of systematic uncertainties in the background models.

Version 3.9g includes updated effective area curves for XMM-Newton EPIC MOS cameras, with an added warning from the team regarding MOS1 timing mode data. It also includes updated effective area curves for Swift XRT.

Version 3.9f includes updated effective area curves for Constellation-X instruments (under the revised mission name, "conx"), XEUS, INTEGRAL (ISGRI and JEM-X), and for Swift UVOT (except grisms).

Version 3.9e includes updated effective area curves for the Chandra instruments for Cycle 10 proposers.

Version 3.9d includes updated effective area curves for Suzaku XIS and HXD instruments for Cycle 3 proposers.

Version 3.9c includes updated effective area curves for XMM-Newton EPIC instruments for AO-7 proposers. The major change is that, starting with this version, the PN count rates are given for PATTERN=0 events only, to be conservative. This will reduce the predicted count rates by about a third, depending on the spectral shape. Pile-up calculation has been adjusted to still use the total count rates.

Version 3.9b includes a bug fix for energy flux calculations using redshifted table-based models (including Raymond-Smith). Effective area curves for Chandra instruments have been updated for Cycle 9 proposers in v3.9b.

Effective area curves for Suzaku XIS and HXD instruments have been updated for Cycle 2 proposers in v3.9a.

Effective area curves for XMM-Newton EPIC instruments have been updated for AO-6 proposers.

One bug, which caused crashes for the command-line version on Linux platforms, has been fixed in this version.

3 Previous Updates

3.1 New in v3.8/3.8a

The Swift/XRT effective area curves for Photon Counting and Windowed Timing data have been updated in v3.8a.

Previous versions used an old and incorrect deadtime fraction for burst mode for *XMM-Newton* EPIC-pn detector. This has been corrected.

With this version, PIMMS now calculates Swift/BAT count rates in 4 standard survey bands, and also includes the background count rates and hence the exposure time necessary to reach a signal-to-noise ratio of 5.0.

3.2 New in v3.7/v3.7a

Suzaku-specific information has been updated in v3.7a, with in-orbit calibration as of early November, 2005.

This version now provides assumptions regarding the input count rate (such as extraction region for imaging instruments) for various missions.

This version includes the AO-5 versions of *XMM-Newton* EPIC effective area curves, which differs slightly from the AO-4 versions. There are no updates for the RGS effective area.

This version also includes calibration updates of the *RXTE* PCA effective area curves. The count rate should increase by about 11to previous versions. This is deemed minor enough that no impact is expected in proposals and in observation planning.

PIMMS now uses the post-launch name, *Suzaku,* for the former *Astro-E2*.

This version also includes post-launch calibration of the Swift XRT, in three data modes (photon counting, photodiode, and windowed timing).

3.3 New in v3.6/v3.6a/v3.6b/v3.6c

This version has the new Swift BAT effective area curve for one detector, to match the default units used in BAT analysis software. In comparison, previous versions (v3.6b and earlier) used the effective area for 16384 detectors (the total number fully illuminated by an on-axis source).

V3.6b differs from v3.6a in that it incorporates the new set of Chandra effective area curves for Cycle 7 proposers.

V3.6a differs from v3.6 in that it includes a new set of effective area curves for *XMM-Newton* RGS.

This version includes updated *XMM-Newton* effective area curves appropriate for AO-4 proposals. Note that, starting this version, the EPIC effective area curves are given for a 15 arcsec radius extraction region, which is typical for a point source. On-axis observation is assumed.

It also corrects a bug in model parser, and now allows specification of N_H for file-based models used as second (etc.) component.

3.3.1 New in v3.5

This version includes *Astro-E2* effective areas, based on best available calibration data as of 2004 July, and a routine to estimate XRS grade fractions for bright sources.

3.3.2 New in v3.4/v3.4a

V3.4a differs from v3.4 only in having an updated set of Chandra effective area curves for AO-6 proposers.

Swift effective area curves are newly included; to enable UVOT count rate predictions, a new UV/optical extinction function has been added to the code.

3.3.3 New in v3.3/v3.3a

PIMMS now allows to convert to/from flux density; it can be in photons $\mathrm{cm}^{-2}\mathrm{s}^{-1}\mathrm{keV}^{-1}$, ergs $\mathrm{cm}^{-2}\mathrm{s}^{-1}\mathrm{keV}^{-1}$, photons $\mathrm{cm}^{-2}\mathrm{s}^{-1}\mathring{A}^{-1}$, or ergs $\mathrm{cm}^{-2}\mathrm{s}^{-1}\mathring{A}^{-1}$ depending on whether the energy/wavelength is specified as keV or in $\mathring{A}$.

V3.3 also incorporates *Chandra* updates for Cycle 5.

V3.3a incorporates *XMM-Newton* effective area curves for AO-3 propoers.

3.3.4 New in v3.2/3.2a/3.2b/3.2c/3.2d

Chandra effective area curves have been updated in V3.2d for Cycle 4 proposers. In addition, it corrects a minor bug in `pms_slmdl.f` (the bug caused PIMMS to run out of memory unnecessarily when repeatedly reading in file-based spectral models), and another in `pms_rarea.f` (this bug prevented PIMMS from reading effective area cure of the maximum specified size).

V3.2c corrects one bug introduced in 3.2a (3.2b was an attempt to correct this, but it was only partially successful); if 3.2a or 3.2b crashes, obtain either 3.2c or just one corrected file, `pms_docrt.f`. (The XTE HEXTE effective area curves have also been updated in 3.2c, but this should not have a major effect on the calculations.)

V3.2a incorporates cosmetic tweaks to eliminate unnecessary warning messages.

1. XMM-Newton AO-2 support: Effective area curves for EPIC-MOS, EPIC-PN, and RGS have been updated using in-orbit calibrationand.
2. Also includese a new formula to estimate pile-up for EPIC-MOS, based on in-orbit data.
3. WARNING: This version does not have an updated pile-up formula for EPIC-PN.

3.3.5 New and updated in v3.1a/3.1b/3.1c

1. Bug fix in 3.1c: Multiple component models with two or more Raymond-Smith models now work correctly.
2. Chandra AO-3 support, including clarification of first order count rates.
3. Minor clean-ups and bug fixes of v3.0.

3.3.6 New and updated in v3.0

1. Chandra AO-2 support.
2. Preliminary Integral support, including CGRO OSSE effective area curve.
3. Multi-component model capability.
4. Capability to read commands from a file using @<filename> syntax.

3.3.7 New and updated in v2.7

1. Latest (1999 June) effective area curves for the ASTRO-E instruments.
2. Now uses XTE PCA count rate per PCU (Proportional Counter Unit), not per 5 PCUs.
3. Changed all (except historical) references to 'AXAF' to 'Chandra'.
4. Enlarged the buffer size for storing external spectral models (supplied as an ASCII file) to 65536 lines.

3.3.8 New and updated in v2.6 through v2.6c

1. 1999 January versions of ASTRO-E XRS and XIS responses, including the XRS event grade calculations.
2. 1999 January versions of XMM EPIC responses, including the pile-up and dead-time calculations.
3. RXTE PCA calibrations appropriate for 'Epoch 4' gain setting.

3.4 New and updated in v2.5

1. β-release support for AXAF ACIS pile-up calculations.
2. Whenever energy range can be/must be specified, wavelength range (in $\AA$) can be specified instead.
3. Restrictions on power law index has been eliminated.
4. First preliminary effective area curves for ASTRO-E XRS is included.

3.5 New and updated in v2.4b

1. Updated calibrations of the SAX instruments.
2. Bug-fix for long path/file names

3.6 New and updated in v2.4

1. Updated calibrations of the XTE instruments for AO-3 proposals.
2. New ASCA SIS telemetry limit calculations based on the latest hot/flickering pixel rates.
3. Pimms now supported on Linux machines with g77, on a beta-test basis.
4. Model normalization can be used as input rate.

3.7 New and updated in v2.3

1. New (in-orbit) calibrations for XTE PCA and HEXTE instruments. Use of the new numbers is a requirement for XTE AO-2 proposals.
2. An optional set of extra Raymond-Smith models, suitable in particular for EUVE and ROSAT data.
3. The "Snowden R-band" effective area curve, courtesy Dr. Richard West of Leicester.
4. A new command "LOG": this allows users to capture PIMMS output in a log file.

4 Sample Sessions

Note that these sample sessions use PIMMS v2.3, to illustrate the general feel of PIMMS sessions. Note, in particular, that the changes with mission specific details for the XTE PCA.

Example 1. Estimating ASCA SIS count rates

```
*** PIMMS version 3.0 ***
    2000 April 28 release
    (this version does not simulate images)
    Reading mission directory, please wait
* Current model is BREMSSTRAHLUNG, kT=  10.0000 keV; NH =  1.000E+21
   <--- Use 'MODEL' command to change
* By default, input rate is taken to be
 Flux (    2.000-   10.000 keV) in ergs/cm/cm/s
   <--- Use 'FROM' command to change the default
* Simulation product will be
 Count rate in ASCA SIS
   <--- Use 'INSTRUMENT' command to switch to another instrument
PIMMS > go 1 einstein ipc
* For thermal Bremsstrahlung model with kT= 10.0000 keV; NH =  1.000E+21
  and  1.000E+00 cps in EINSTEIN IPC
  (Model normalization =  5.882E-03)
* PIMMS predicts  1.516E+00 cps with ASCA SIS
    [Count rate per single SIS, not per pair, over an entire chip assuming
    a point source at the 1-CCD mode position; within the maximum circular
    extraction region that fits on the default chip, usable rates are
          1.3 (3.2 arcmin radius, SIS-0) and       1.0 (2.5 arcmin, SIS-1)]

* An exposure of      17.42s is required for a 5-sigma detection using optimal
  extraction radius of 5.67 arcmin ( 1.49E+00 src and  6.10E-02 bgd cps)

* Extrapolated to 1998 Dec for S1C3 in 1-CCD mode at 2 SIS temperatures:

  Telemetry is 85.6% full, 10.7% full, 21.4% full, and  2.7% full (nominal)
  Telemetry is  saturated, 12.8% full, 25.7% full, and  3.2% full (warm)
         in    Faint  (M), Faint  (H), Bright (M), and Bright (H) modes
    (S0C1 has lower flickering pixel rate; decide modes based on S1C3)
PIMMS > quit
```

In this example, the default spectral model is used to estimate the ASCA SIS count rate (which happens to be the default). The only place where user did not use the default set-up was to specify conversion from Einstein IPC count rate. PIMMS not only reports the total SIS count rate but also count rates in the typical extraction regions for SIS-0 and SIS-1, and information on telemetry saturation and recommendations on suitable data modes.

Example 2. Estimating XTE count rates I

```
*** PIMMS version 3.0 ***
    2000 April 28 release
    (this version does not simulate images)
    Reading mission directory, please wait
* Current model is BREMSSTRAHLUNG, kT=  10.0000 keV; NH =  1.000E+21
   <--- Use 'MODEL' command to change
* By default, input rate is taken to be
 Flux (    2.000-   10.000 keV) in ergs/cm/cm/s
   <--- Use 'FROM' command to change the default
* Simulation product will be
 Count rate in ASCA SIS
   <--- Use 'INSTRUMENT' command to switch to another instrument
PIMMS > from exosat me
PIMMS > inst xte pca
PIMMS > mo rs 1 5e19
WARNING - this version of PIMMS has a grid of  59 Raymond-Smith plasma models
      from log T of  5.60; kT =  0.034
        to log T of  8.50; kT = 27.250
          choosing the nearest one, hope that's okay
         New temperature is  0.967 keV (log T is  7.05)
PIMMS > go 1
* For Raymond Smith model with kT= 0.9669 keV (logT= 7.05); NH =  5.000E+19
  and  1.000E+00 cps in EXOSAT ME
  (Model normalization =  2.196E-02)
* PIMMS predicts  2.100E-01 cps with XTE PCA
ERROR:: non-overlapping energy ranges of model and calibration
ERROR:: non-overlapping energy ranges of model and calibration
   (Count rate is per PCU)

%%%        With 3 PCUs operational:
           (Use these numbers in RPS)

PIMMS predicts     0.630 cps from the source plus    91.380 background cps
5-sigma detection will be achieved in 5.80E+03s
(but undetectable with 1% systematic uncertainties in bgd)

Results in the 6 canonical XTE PCA bands are:

Channels  Nominal    Source   BGD   5-sigma    (+1%)
          E (keV)    (cps)    (cps) detection (s)
  0- 13  0.00- 6.14     0.612 10.56  746.858 ( 2934.732)
```

```
 14- 17  6.14- 7.90     0.018  3.46 2.80E+05 (*********)
 18- 23  7.90- 10.5  7.81E-04  4.56 1.87E+08 (*********)
 24- 35  10.5- 15.8  5.09E-10  7.87 7.60E+20 (*********)
 36- 49  15.8- 22.1  0.00E+00  8.90 ******** (*********)
 50-249  22.1-116.0  0.00E+00 56.05 ******** (*********)

%%% ...and with 2 PCUs operational:

PIMMS predicts     0.420 cps from the source plus    60.920 background cps
5-sigma detection will be achieved in 8.70E+03s
(but undetectable with 1% systematic uncertainties in bgd)

Results in the 6 canonical XTE PCA bands are:

Channels  Nominal    Source   BGD   5-sigma    (+1%)
          E (keV)    (cps)    (cps) detection (s)
  0- 13  0.00- 6.14     0.408  7.04 1120.287 ( 4402.101)
 14- 17  6.14- 7.90     0.012  2.31 4.20E+05 (*********)
 18- 23  7.90- 10.5  5.21E-04  3.04 2.80E+08 (*********)
 24- 35  10.5- 15.8  3.39E-10  5.24 1.14E+21 (*********)
 36- 49  15.8- 22.1  0.00E+00  5.93 ******** (*********)
 50-249  22.1-116.0  0.00E+00 37.37 ******** (*********)
PIMMS > model rs 1 1e20
WARNING - this version of PIMMS has a grid of  59 Raymond-Smith plasma models
      from log T of  5.60; kT =  0.034
        to log T of  8.50; kT = 27.250
          choosing the nearest one, hope that's okay
         New temperature is  0.967 keV (log T is  7.05)
PIMMS > go 1
* For Raymond Smith model with kT= 0.9669 keV (logT= 7.05); NH =  1.000E+20
  and  1.000E+00 cps in EXOSAT ME
  (Model normalization =  2.201E-02)
* PIMMS predicts  2.104E-01 cps with XTE PCA
ERROR:: non-overlapping energy ranges of model and calibration
ERROR:: non-overlapping energy ranges of model and calibration
   (Count rate is per PCU)

%%%        With 3 PCUs operational:
           (Use these numbers in RPS)

PIMMS predicts     0.631 cps from the source plus    91.380 background cps
5-sigma detection will be achieved in 5.78E+03s
(but undetectable with 1% systematic uncertainties in bgd)

Results in the 6 canonical XTE PCA bands are:

Channels  Nominal    Source   BGD   5-sigma    (+1%)
```

```
         E (keV)    (cps)    (cps) detection (s)
  0- 13  0.00- 6.14     0.613 10.56  744.286 ( 2894.601)
 14- 17  6.14- 7.90     0.018  3.46 2.78E+05 (*********)
 18- 23  7.90- 10.5  7.83E-04  4.56 1.86E+08 (*********)
 24- 35  10.5- 15.8  5.10E-10  7.87 7.57E+20 (*********)
 36- 49  15.8- 22.1  0.00E+00  8.90 ******** (*********)
 50-249  22.1-116.0  0.00E+00 56.05 ******** (*********)

%%% ...and with 2 PCUs operational:

PIMMS predicts     0.421 cps from the source plus    60.920 background cps
5-sigma detection will be achieved in 8.66E+03s
(but undetectable with 1% systematic uncertainties in bgd)

Results in the 6 canonical XTE PCA bands are:

Channels  Nominal    Source   BGD   5-sigma    (+1%)
         E (keV)    (cps)    (cps) detection (s)
  0- 13  0.00- 6.14     0.408  7.04 1116.429 ( 4341.900)
 14- 17  6.14- 7.90     0.012  2.31 4.18E+05 (*********)
 18- 23  7.90- 10.5  5.22E-04  3.04 2.79E+08 (*********)
 24- 35  10.5- 15.8  3.40E-10  5.24 1.14E+21 (*********)
 36- 49  15.8- 22.1  0.00E+00  5.93 ******** (*********)
 50-249  22.1-116.0  0.00E+00 37.37 ******** (*********)
PIMMS > quit
```

In this example, the user specified conversion from EXOSAT ME count rate to XTE PCA and used Raymond-Smith models with two different columns. Since PIMMS has a limited grid of Raymond-Smith models, the temperature of the actual model used does not exactly match the request. In addition, Raymond-Smith models are not calculated up to very high energies (where the flux tends to be low) so error messages are displayed to that effect. As with ASCA, PIMMS provides instrument-specific information for the XTE PCA (source and background count rates, and 5σ detection times in the entire passband and in the 6 canonical PCA bands with 2 or 3 PCUs operational).

Example 3. Estimating XTE count rates II

```
*** PIMMS version 3.0 ***
    2000 April 28 release
    (this version does not simulate images)
    Reading mission directory, please wait
* Current model is BREMSSTRAHLUNG, kT=  10.0000 keV; NH =  1.000E+21
   <--- Use 'MODEL' command to change
* By default, input rate is taken to be
 Flux (    2.000-   10.000 keV) in ergs/cm/cm/s
```

```
   <--- Use 'FROM' command to change the default
* Simulation product will be
 Count rate in ASCA SIS
   <--- Use 'INSTRUMENT' command to switch to another instrument
PIMMS > from ginga lac both
PIMMS > mo pl 1.5 15 30 1e22
Value of Nh is rather small ---
Assuming that log10(Nh) was given
Warning:: Ignoring extra numerical parameter(s)
PIMMS > inst xte pca
PIMMS > go 500
* For power law model with photon index = 1.5000; NH =  1.000E+15
  and  5.000E+02 cps in GINGA LAC BOTH
  (Model normalization =  1.805E-01)
* PIMMS predicts  1.226E+02 cps with XTE PCA
   (Count rate is per PCU)

%%%        With 3 PCUs operational:
           (Use these numbers in RPS)

PIMMS predicts   367.907 cps from the source plus    91.380 background cps
5-sigma detection will be achieved in    0.085s
(or in    0.085s with 1% systematic uncertainties in bgd)

Results in the 6 canonical XTE PCA bands are:

Channels  Nominal    Source   BGD   5-sigma    (+1%)
          E (keV)    (cps)    (cps) detection (s)
  0- 13  0.00- 6.14   144.709 10.56    0.185 (    0.185)
 14- 17  6.14- 7.90    50.814  3.46    0.526 (    0.526)
 18- 23  7.90- 10.5    58.519  4.56    0.461 (    0.461)
 24- 35  10.5- 15.8    64.826  7.87    0.432 (    0.432)
 36- 49  15.8- 22.1    28.216  8.90    1.165 (    1.166)
 50-249  22.1-116.0    20.823 56.05    4.432 (    4.514)

%%% ...and with 2 PCUs operational:

PIMMS predicts   245.271 cps from the source plus    60.920 background cps
5-sigma detection will be achieved in    0.127s
(or in    0.127s with 1% systematic uncertainties in bgd)

Results in the 6 canonical XTE PCA bands are:

Channels  Nominal    Source   BGD   5-sigma    (+1%)
          E (keV)    (cps)    (cps) detection (s)
  0- 13  0.00- 6.14    96.473  7.04    0.278 (    0.278)
 14- 17  6.14- 7.90    33.876  2.31    0.788 (    0.788)
```

```
 18- 23  7.90- 10.5    39.012  3.04    0.691 (    0.691)
 24- 35  10.5- 15.8    43.217  5.24    0.649 (    0.649)
 36- 49  15.8- 22.1    18.810  5.93    1.748 (    1.749)
 50-249  22.1-116.0    13.882 37.37    6.649 (    6.771)
PIMMS > inst xte hexte def
PIMMS > go 500
* For power law model with photon index = 1.5000; NH =  1.000E+15
  and  5.000E+02 cps in GINGA LAC BOTH
  (Model normalization =  1.805E-01)
* PIMMS predicts  3.038E+01 cps with XTE HEXTE DEFAULT
   (Source-only count rate in 1 cluster; BGD rate is 73.1 per cluster)
5-sigma detection will be achieved in      5.4s

Results in the 4 canonical XTE HEXTE bands are:
             (per HEXTE cluster)

  Channels Nominal   Source   BGD  5-sigma
           E (keV)   (cps)    (cps) detection (s)
    5- 29   12-  30    15.2   11.86      4.7
   30- 61   30-  62     8.2   17.93     18.5
   62-125   62- 126     5.6   21.94     45.2
  126-250  126- 250     1.4   21.35    650.8
 (The default 16-s rocking cycle is assumed for detection time)
PIMMS > quit
```

In this case, a special version of the power law model (with high energy cut-off) is used, by specifying index, cut-off energy and e-folding energy, as well as Nh, on the command line. User then calculated PCA and HEXTE count rates for a 500 cps Ginga LAC source.

Example 4. Estimating ROSAT PSPC count rates

```
*** PIMMS version 3.0 ***
    2000 April 28 release
    (this version does not simulate images)
    Reading mission directory, please wait
* Current model is BREMSSTRAHLUNG, kT=  10.0000 keV; NH =  1.000E+21
   <--- Use 'MODEL' command to change
* By default, input rate is taken to be
 Flux (    2.000-   10.000 keV) in ergs/cm/cm/s
   <--- Use 'FROM' command to change the default
* Simulation product will be
 Count rate in ASCA SIS
   <--- Use 'INSTRUMENT' command to switch to another instrument
PIMMS > from flux ergs 0.1-4
PIMMS > mo rs06_665 3e19
```

```
PIMMS > inst rosat pspc open
PIMMS > go 5e-12
* For model rs06_665; NH =  3.000E+19
   and a flux (  0.100-  4.000keV) of  5.000E-12 ergs/cm/cm/s
  (Model normalization =  1.893E-03)
* PIMMS predicts  6.594E-01 cps with ROSAT PSPC OPEN
PIMMS > inst rosat pspc r6r7
PIMMS > go 5e-12
* For model rs06_665; NH =  3.000E+19
   and a flux (  0.100-  4.000keV) of  5.000E-12 ergs/cm/cm/s
  (Model normalization =  1.893E-03)
* PIMMS predicts  1.330E-01 cps with ROSAT PSPC R6R7
PIMMS > quit
```

In this example, 0.6 Solar abundance, log$T$=6.65 Raymond-Smith model with an absorption of $3{\times}10^{19}$ cm^{-2} is used to estimate ROSAT PSPC count rates (total and in 3 combinations of the Snowden R bands) for a $5{\times}10^{-12}$ ergs cm^{-2}s^{-1} source.

5 Using multi-component models

The ability to add up to 8 component models together, including Gaussian lines, have been added to PIMMS starting v3.0. Since this is a new feature, and the command syntax can become complex, this new section contains 3 examples. These, and the 4 example from the previous section, are avialable as *.xco files, in the new 'sample' subdirectory of PIMMS.

```
*** PIMMS version 3.0 ***
    2000 April 28 release
    (this version does not simulate images)
    Reading mission directory, please wait
* Current model is BREMSSTRAHLUNG, kT=  10.0000 keV; NH =  1.000E+21
   <--- Use 'MODEL' command to change
* By default, input rate is taken to be
 Flux (    2.000-   10.000 keV) in ergs/cm/cm/s
   <--- Use 'FROM' command to change the default
* Simulation product will be
 Count rate in ASCA SIS
   <--- Use 'INSTRUMENT' command to switch to another instrument
PIMMS > mo rs logt 6.6 3e19 rs logt 7.2 3e19 0.5 1.0
PIMMS > output rs2t 0.1 4.0 0.002
PIMMS > inst rosat pspc open
PIMMS > from flux ergs 0.1-2.0 u
PIMMS > go 3e-11
* For Raymond Smith model with kT= 0.3431 keV (logT= 6.60); NH =  3.000E+19
```

```
    + Raymond Smith model with kT= 1.3657 keV (logT= 7.20); NH =  3.000E+19
             (  0.5000 times component 1 at     1.0000 keV)
   and an unabsorbed flux (    0.100-    2.000keV) of  3.000E-11 ergs/cm/cm/s
  (Model normalization =  6.958E-03)
* PIMMS predicts  3.639E+00 cps with ROSAT PSPC OPEN
```

This first example illustrates the use of two-temperature Raymond-Smith model. The absorption columns (to be specified explicitly for each component) are the same in this example. The second component has a flux at 1 keV which is 50% of the first component. Note, however, this is a tricky proposition for the line-rich Raymond-Smith models, and the composite model may differ significantly depending on whether the low (default) or the high (extra) resolution version is used. It is best to check this via the output command, which allows the users to check the actual model spectrum.

```
*** PIMMS version 3.0 ***
    2000 April 28 release
    (this version does not simulate images)
    Reading mission directory, please wait
* Current model is BREMSSTRAHLUNG, kT=  10.0000 keV; NH =  1.000E+21
   <--- Use 'MODEL' command to change
* By default, input rate is taken to be
 Flux (    2.000-   10.000 keV) in ergs/cm/cm/s
   <--- Use 'FROM' command to change the default
* Simulation product will be
 Count rate in ASCA SIS
   <--- Use 'INSTRUMENT' command to switch to another instrument
PIMMS > mo brems 15 3e23 brems 15 1e20 0.1 10 ga 6.5 0.1 250
PIMMS > output partial 0.1 10.0 0.005
PIMMS > inst xmm pn thin
PIMMS > go 0.5 asca sis
* For thermal Bremsstrahlung model with kT= 15.0000 keV; NH =  3.000E+23
    + thermal Bremsstrahlung model with kT= 15.0000 keV; NH =  1.000E+20
             (  0.1000 times component 1 at    10.0000 keV)
    + Gaussian model with E=  6.5000 keV; sigma= 0.1000 keV; NH =  3.000E+23
                          (Eq.W=250.0000 eV)
  and  5.000E-01 cps in ASCA SIS
  (Model normalization =  1.122E-02)
* PIMMS predicts  8.409E+00 cps with XMM PN THIN
  before dead time correction

% Pile-up and dead-time corrected count rates in 4 energy bands
  using various window options are:

 Window    Pileup  Dead                Corrected Good Count Rates
   Option   frac.   Time    0.1-0.4   0.4-1.0   1.0-2.5  2.5-10.0     Total
```

```
 Full      1.092%   7.0%     0.8676    1.4627    1.4825    3.4925       7.7348
 FullExtd  5.090%   2.0%     0.8773    1.4790    1.4991    3.5315       7.8212
 Large     0.633%   9.0%     0.8529    1.4379    1.4574    3.4332       7.6036
 Small     0.021%  29.0%     0.6696    1.1288    1.1441    2.6952       5.9690
 Timing   -------   1.5%     0.9291    1.5663    1.5876    3.7399       8.2826
 Burst    -------  99.8%   1.89E-03  3.18E-03  3.22E-03  7.59E-03      0.0168

% Any pile-up predictions over 10% are highly uncertain
```

This example shows how to set up a spectrum suffering from partial covering absorption. In addition, a Gaussian is added which has a different syntax: the three parameters are the line energy (keV), the physical width (keV), and the equivalent width (eV). Absorbing column is assumed to be the same as the first component (it can be specified explicitly, as the third parameter before the equivalent width).

```
*** PIMMS version 3.0 ***
    2000 April 28 release
    (this version does not simulate images)
    Reading mission directory, please wait
* Current model is BREMSSTRAHLUNG, kT=  10.0000 keV; NH =  1.000E+21
   <--- Use 'MODEL' command to change
* By default, input rate is taken to be
 Flux (     2.000-   10.000 keV) in ergs/cm/cm/s
   <--- Use 'FROM' command to change the default
* Simulation product will be
 Count rate in ASCA SIS
   <--- Use 'INSTRUMENT' command to switch to another instrument
PIMMS > mo pl 1.7 3e23 ga 6.4 0.2 150 rs 1.2 0.0 1.0 2.5 z 0.01 8e19
WARNING - this version of PIMMS has a grid of  59 Raymond-Smith plasma models
      from log T of  5.60; kT =  0.034
        to log T of  8.50; kT = 27.250
          choosing the nearest one, hope that's okay
         New temperature is  1.217 keV (log T is  7.15)
PIMMS > output agn_sb 0.1 10.0 0.01
PIMMS > inst chandra acis-s
PIMMS > go 1e-11
Warning:: integration to energies > model table
* For power law model with photon index = 1.7000; NH =  3.000E+23
    + Gaussian model with E=  6.4000 keV; sigma= 0.2000 keV; NH =  3.000E+23
                          (Eq.W=150.0000 eV)
    + Raymond Smith model with kT=  1.2172 keV (logT=7.2); NH =  0.000E+00
            (  1.0000 times component 1 at     2.5000 keV)
 ...redshifted with z=  0.0100 and a Galactic Nh= 8.000E+19
   and a flux (  2.000- 10.000keV) of  1.000E-11 ergs/cm/cm/s
  (Model normalization =  7.429E-03)
* PIMMS predicts  1.642E-01 cps with CHANDRA ACIS-S-BI
```

```
% Pileup estimate for ACIS:
  Pile-up is tolerable (10.0 %) at a frame-time of  1.612 s
```

In this example, the entire composite model is to be redshifted with z=0.01. Absorption specified with each component is taken to be intrinsic (i.e., also redshifted). Additionally, a Galactic (unredshifted) absorption is specified. For 'unabsorbed' flux, both intrinsic and Galactic absorption will temporarily be set to 0.

6 Comments on extended sources

PIMMS is written primarily for point sources. To simulate the count rate for an extended source, estimate the total counts/flux within the field of view of the target instrument and use that as the input to the "GO" command.

7 Missions

PIMMS reads the list of missions from a file called "pms_mssn.lst" in the data directory. It then looks, for each mission (i.e., satellite), detector and "filter" combination, the appropriate calibration files for the effective area etc. Since this is a run-time process, the following items may not exactly correspond to what you see. For a listing of what is currently available, use the DIRECTORY command.

For active and near-future missions, we provide the latest effective area curves with PIMMS for proposal preparation purposes. If the effective area changes in-orbit, count rate to flux conversion factor for actual observations is time-dependent, which PIMMS is currently not well equipped to handle.

7.1 ASCA

The Japanese X-ray satellite *ASCA* had 4 co-aligned telescopes, each having an effective area of $\sim$250 cm^2 at 1 keV; there were two GIS (imaging gas scintillation proportional counters) and two SIS (Solid-state Imaging Spectrometer, X-ray CCDs) detectors. Count rates are given for a single GIS or a single SIS, as appropriate.

7.2 BBXRT

BBXRT is flown on the Shuttle with the ASTRO payload in December 1990. The effective area curve is that for pixel A0.

7.3 CGRO

The Compton Gamma Ray Observatory OSSE instrument is now available as in PIMMS, primarily as an aid in Integral observation planning.

7.4 Chandra

The Chandra X-ray Observatory was formerly known as AXAF; starting with v2.7, PIMMS has switched to Chandra.

This version includes the Chandra instrument effective area curves appropriate for Cycle 10 proposals as provided by the Chandra X-ray Observatory Center (http://chandra.harvard.edu/), where the details of the instruments can be found. Older versions are available by request.

All effective areas assume an on-axis observation.

The 4 CCDs of the Chandra CCD Imaging Spectrometer Imaging array (ACIS-I) cover 17 by 17 arcmin of sky with 0.5 arcsec square pixels. PIMMS calculates the on-axis count rate uncorrected for pile-up.

Two of the 6 ACIS-S CCDs are back-illuminated (BI), to improve the low energy effective areas. For imaging with ACIS-S, the observer will thus have the choice of FI/BI. Since the FI chips have a performance identical to that of the ACIS-I chips, only the BI chip option is separately available in PIMMS.

High Resolution Camera covers a larger area of the sky with smaller pixels.

ACIS-S will be the normal readout instrument for HETG (High Energy Transmission Grating) spectra. The curves use the flight instrument chip layout of 4 FI and 2 BI chips. PIMMS will provide count rates for both grating subsets (MEG and HEG) separately, or for the combination. A single observation provides both spectra simultaneously in a cross-shaped orientation. Since the energy response and spectral resolution of the two grating assemblies differ, separation of the output may be important for some users. In all cases the output is for isolated first order. The energy resolution of the ACIS instrument will allow the user to separate this from the higher order light. See the Proposers' Observatory Guide for more information. Count rate in the zeroth order image can also be calculated.

HRC-S is the normal readout instrument for LETG (Low Energy Transmission Grating) spectra. PIMMS currently allows determination of the count rates in the 0th order image; 1st order spectrum; and the higher orders; through the "normal" part of the UV/Ion shield. NOTE in practice, due to the lack of energy resolution of the HRC, isolation of the first order signal will require a combination of "normal" and "low-energy reject" mode observations which are likely to take roughly twice as long as the estimate provided by PIMMS. An alternative is to use the High Energy Suppression Filter (HESF) which effectively isolates first order from 0.05-0.44 keV.

LETG data can also be read out with the ACIS-S detectors; 0th and 1st order count rates for this combination can also be estimated with PIMMS.

Observations of bright sources with ACIS are limited by photon pileups (see Proposers' Observatory Guide). This version of PIMMS includes a pileup estimate (based on the separate 'pileup' tool written at CXC). This feature will provide you with an estimate of the degree of pile-up for ACIS imaging mode observations (ACIS-I, ACIS-S, LETG-ACIS-I ORDER0, LETG-ACIS-S ORDER0, HETG-ACIS-I ORDER0, and HETG-ACIS-S ORDER0).

Note that this is valid only for point source observations on-axis.

Pile-up effect can be mitigated by placing the source off-axis — the inferior PSF will spread the photons over many pixels. Quantitative analysis of this is not yet available in PIMMS. The other principal method of altering the frame time can be evaluated by PIMMS. For this purpose, the 'go' command of PIMMS for ACIS-I and ACIS-S-BI allows an optional numerical parameter. If given, it will be taken as the frame time (allowed range: 0.2–3.2 s), and gives the pile-up fraction accordingly. If absent, PIMMS will attempt to estimate the frame time at which the pile-up fraction is 10% (which is the rule-of-thumb number above which you will have a severe problem). For the 0th order images, the default frame time of 3.2 s is assumed.

7.5 Constellation-X ("conx")

The Constellation X-ray Mission is NASA's next generation X-ray Observatory dedicated to high resolution spectroscopy. PIMMS 3.9f contains effective area curves derived from the simulation-grade resonse matrices released in 2008 February. See http://constellation.gsfc.nasa.gov/ for more details.

7.6 EINSTEIN

Currently PIMMS only have IPC and MPC effective area curves.

7.7 EUVE

PIMMS currently has the effective area curves for the three channels of the spectrometer, which is used by GOs for pointed observations. Detectors are SW (70–190Å), MW (140–480Å) and LW (280–750Å)

7.8 EXOSAT

For the Low Energy telescopes, only the LE1/CMA effective area data are kept within PIMMS. Specify filter OPEN, LX3, LX4, ALP, or BRN. The ME effective area is for a half-array; GSPC area is also available.

7.9 Ginga

Ginga is the 3rd Japanese X-ray astronomy satellite, which carried the LAC (Large Area Counter) array with an effective area of $\sim$4000 cm^2. Count rate can be calculated for TOP layer of the detector only or BOTH.

7.10 HEAO-1

Currently, only the A4 LED is supported.

The PIMMS set-up for this instrument is meant to make it straightforward to use the Levine et al (1984, ApJS 54, 281) catalog for XTE proposals. As an input, use the A+B+C combined count rate; as an output, A+B+C rate as well as the individual rate in the four bands (A through D) are given. One suggested use is to specify "HEAO1 A4" as both input and output instrument: by an iterative process, the user can find a spectral model that reproduces the distribution of counts in different bands. Then switch to a different output instrument (in terms of energy range, LED matches the higher end of XTE PCA and the lower end of XTE HEXTE) keeping that model.

7.11 Integral

As of version 3.9f, PIMMS includes effegtive area curves for ISGRI and JEM-X instruments, based on calibration as of 2008 March. See http://obswww.unige.ch/isdc/ for details of the mission.

7.12 ROSAT

For the German XRT, effective area curve with PSPC (filter OPEN or BRN) and HRI are available. Also, beginning with v2.3, the Snowden R bands (see Snowden et al 1994, ApJ 424, 714) are available as software filters (R1, R1R2, R4, R4R5, R4TOR7, R5, R6, R6R7, and R7). For the British WFC, filters S1, S2, P1 and P2 effective area curves are available; these are appropriate for the time of launch. Note the S1 and S2 sensitivity dropped to $\sim$75% of initial value by the end of the survey, followed by a steeper decline to 15–20% of the original value after The Tumble. Non-survey (P1 and P2) filters have suffered much smaller degradation.

7.13 SAX

Although the official name for this Italian-Dutch satellite is now BeppoSAX, the mission name within PIMMS remains "SAX". It was launched in Apr 1996 by an Atlas G-Centaur directly into a 600 km orbit at 3 degrees inclination. SAX carries 4 narrow field instruments (1 LECS, 2 MECS, 1 HPGSPC, 1 PDS), covering the energy band from 0.1 to 200 keV, and two Wide Field Cameras (WFC, 2-30 keV) which view the sky through a coded mask perpendicularly to the axis of the narrow field instruments. The LECS (0.1-10 keV) is an imaging gas scintillation proportional counter similar to the MECS but extends the energy range down to 0.1 keV. The MECS (1-10 keV) is an imaging gas scintillation proportional counter similar to the LECS. There are 2 working MECS on board SAX (a third unit developed a fault in May 1997). The count rate estimate is for the 2 MECS, starting with version 2.4b (previous versions estimated for 3 MECS). The HPGSPC is an high pressure gas scintillation proportional counter sensitive in the energy range 3-120 keV with a FOV of 1 deg. The PSD, phoswich detector system, consists in four phoswich units. The observations are carried out with two halves of the experiment alternatively pointing source and background region, providing a continuous monitoring of the background. The PSD is sensitive in the 15-300 keV energy bandwidth and has a FOV of 1.5 deg. The Wide field Cameras is position sensitive proportional counter sensitive in the 2-30 keV band. There are 2 WFC on board SAX. The FOV per unit is 20 deg X 20 deg with an angular resolution of a few arcmin.

7.14 Suzaku

Suzaku (formerly *Astro-E2*) is a Japanese-US X-ray astronomy satellite, launched in July 2005. The current PIMMS implimentation is based on information from the instrument teams as of 2007 October, as collected by the *Suzaku* Guest Observer Facility (http://suzaku.gsfc.nasa.gov/).

The Hard-Xray Detector (HXD) is a non-imaging instrument with an effective area of $\sim$300 cm^2 featuring a compound-eye configuration and an extremely low background. It consists of two types of sensors, silicon PIN diodes and GSO crystal scintillators.

Starting with v3.9h, PIMMS also outputs approximate time needed for 3-sigma and 5-sigma detections in standard energy bands (1 for PIN and 2 for GSO), taking into account the current level of systematic uncertainties in the background models.

There are four units of the X-ray Imaging Spectrometer (XIS) on-board *Suzaku,* three with frontside-illuminated (FI) CCDs and one with a backside-illuminated (BI) CCD. Each XIS detector is located at the focus of a conical foil X-Ray Telescope (XRT) with a 4.75m focal length. The CCD pixels of XIS vastly oversamples the XRT PSF, thereby allowing high S/N spectroscopy with a relatively benign amount of photon pile-up.

PIMMS currently returns count rate per one unit of XIS, with no further instrument specific information.

The X-Ray Spectrometer (XRS) lost its liquid helium cryogen and is no longer operational. A pre-launch estimate of the XRS effective area is included for reference.

7.15 Swift

Swift (see `http://heasarc.gsfc.nasa.gov/docs/swift/swiftsc.html`) is a multiwavlength gamma-ray burst observatory launched on 2004 November 20. Swift carries a wide-field (2 sr), coded-aperture Burst Alert Telescope (BAT, 15-150 keV); an X-Ray Telescope (XRT, 0.2-10 keV); and a UV/Optical Telescope (UVOT, 170-650 nm). The effective area curves for XRT now reflects the 2008 July CALDB release, for photon counting and window timing modes. The photodiode mode (no longer operative) is also included using an older calibration. Of the UVOT (9 filters, including "white" for unfiltered and 2 grisms) effective areas, those for the 2 grisms are pre-launch estimates, and others (in PIMMS 3.9f) are derived from the 2007 May CALDB release. The BAT response in PIMMS v3.6c and later yields the counts per fully illuminated detector, which matches the BAT analysis software default units. One detector has a geometric area of 0.16 cm^2. An on-axis source illuminates 16384 detectors; PIMMS v3.6b and earlier calculated the total on-axis count rates (i.e., per 16384 detectors).

Note that PIMMS is primarily an X-ray tool, and extrapolation to the UV regime introduces additional uncertainties. In particular, PIMMS assumes $\mathrm{E_{B-V}} = \mathrm{N_H}$ / $4.8 times 10^{21}$ and an average Milkyway extinction law.

7.16 SXG

Spectrum-X-Gamma (SXG, see `http://hea-www.harvard.edu/SXG/sxg.html`) is a Russian-led international mission. This version of PIMMS supports the SODART X-ray telescope with LEPC and HEPC (both are Microstrip Proportional Counters) and with SIXA (Silicon Spectrometer).

7.17 XEUS

XEUS (X-ray Evolving Universe Spectroscopy) mission is a potential follow-on to ESA's XMM-Newton mission. PIMMS 3.9f and later includes effective area curves derived from simulation-grade response matrices released in 2007. See `http://www.rssd.esa.int/index.php?project=XEUS` for details.

7.18 XMM

XMM-Newton (implemented using the pre-launch name, XMM, in PIMMS) was launched successfully in 1999 December. It consists of three coaligned high-throughput 7.5m focal length telescopes with six arc second (FWHM) angular resolution. The European Photon Imaging Camera (EPIC), which consists of two MOS and one PN CCD arrays, provide moderate spectral resolution over a30 arc minute field of view. High-resolution spectral information (E/dE$\sim$300) is provided by the Reflection Grating Spectrometer (RGS) that deflects half of the beam on two of the X-ray telescopes (those with the MOS arrays). The observatory also has a coaligned 30cm optical/UV telescope called the Optical Monitor (OM). See http://astro.estec.esa.nl/XMM/xmm.html for further details.

The count rates for the EPIC MOS are given for one instrument each (we have averaged the effective area curves for MOS1 and MOS2), not for pairs of instruments. Note that, starting with V3.6, PIMMS now uses EPIC effective area curves for 15 arcsec radius extraction regions that are typically used for point sources observed on-axis.

Starting with Version 3.9c, PN rates are for PATTERN=0 events only.

For the RGS, count rates in RGS1 and RGS2 in two orders can be calculated separately (i.e., a total of 4 possible combinations). Even though the term "filter" is used (because that's what the most common use of the third level of instrument specification in PIMMS), these do not represent physical filters. Data are taken in all three orders simultaneously, to be extracted into separate spectra using software filters.

Current version of PIMMS contains effective area curves appropriate for AO-6 proposals.

7.19 XTE

XTE, which was launched in Dec 1995, carries the All-Sky Monitor (ASM), large area proportional counter array (PCA) and the high energy X-ray Timing Experiment (HEXTE).

PCA is a mechanically-collimated array of five xenon proportional counter units (PCUs) with a total effective area of $\sim$7000 cm^2; however, different observations are taken with difeerent numbers of PCUs on. Therefore, starting with PIMMS v2.7, user must supply the count rate *per PCU* when this is used as the input mission ('from xte pca'). When used as the output mission ('inst xte pca'), the first output is count rate per PCU summed over all energies and over all 3 xenon layers. Additional outputs (the rates in the 6 canonical PCA channels required on the proposal form and used in RECOMMD) are given for 3 and 2 PCU combinations, which are becoming more frequent (and the proposal form requires numbers for 3 PCUs). The effective area curves, channel boundaries and the extimated background rates are all appropriate for 'Epoch 4' gain setting.

HEXTE consists of two clusters of detectors, with 4 scintillation detectors in each cluster. Count rates are given per cluster. Values are given for the total count rate, and the count rates in the 4 canonical HEXTE channels required on the proposal form and used in HEXTEmporize.

The quoted detection times assume two-cluster 16-s source/background beamswitching, i.e., one cluster measures background while the other is on-source. In this case, the "detection time" applies to the combined HEXTE instrument. For those bright source observations (source rate >> background rate) where a HEXTE cluster is selected to be in STARE mode, this detection time can also be interpreted as appropriate for a single HEXTE cluster. For the combined HEXTE detection time, divide by $\sqrt{2}$.

7.20 Flux

PIMMS can also calculate conversion to/from flux values not folded through any instrument responses can also be used. To use flux, the unit must be specified: "ERGS" for ergs $\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$ or "PHOTONS" for photons $\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$. Also necessary is the energy range of interest, to be specified in the form "2.5–10" (for 2.5 to 10 keV; PIMMS now accepts "2.0-20 A" to mean 2 to 20A range in wavelength). Optional keyword "UNABSORBED" following the range will make PIMMS calculate flux with Nh set to 0.0; this is useful in relating the flux to the total bolometric luminosity of the X-ray source before interstellar absorption.

7.21 (Flux) Density

New in PIMMS v3.3: it can now convert to/from flux density at a specific energy, rather than integrated flux over a range of energies ("flux"). To use density, the unit must be specified: "ERGS" for ergs $\mathrm{cm}^{-2}\mathrm{s}^{-1}\mathrm{kev}^{-1}$ or "PHOTONS" for photons $\mathrm{cm}^{-2}\mathrm{s}^{-1}\mathrm{kev}^{-1}$. Also necessary is the energy of interest (in keV). Alternatively, this can be specified as the wavelength in Angstroms, with the optional argument "Angstrom," in which case flux density is in (photons or ergs) $\mathrm{cm}^{-2}\mathrm{s}^{-1}\mathring{A}^{-1}$. Flux density can be "unabsorbed" as is flux.

7.22 Normalization

PIMMS also supports the use of 'model normalization'. This is most useful for modelx imported from xspec, in which case a normalization of 1.0 is the flux level as simulated within xspec. The use of normalization is not recommended for models bulit-in to PIMMS, as they do not necessarily relate to any physical quantities.

8 User interface

8.1 Command interpreter

Commands can be abbreviated (as long as it is unique), numerical and character string parameters can be passed onto the commands. Parameters are interpreted according to their positions within the command line (first string is input file name, second file name is output file name etc., although this does not happen in PIMMS). Some parameters are compulsory — PIMMS will prompt you for them if they are not given on the command line; others are optional (default values will be used unless the user specifies them on the command line). Commands can be stringed together by using a semicolon.

PIMMS can switch command input to a file, using <filname> convention. PIMMS will assume .xco extension, if none is given. Nested indirections are not allowed.

8.2 On-line help

PIMMS contains a VMS-style help facility, within which information is stored in a hierarchical structure. On the top level, there are two types of topics. Those listed in ALL CAPITAL LETTERS are PIMMS command names, containing the usage of these commands. Others are of more general nature, not linked with specific commands. HELP items are arranged in many levels, so that you start with a general introduction and pick up as many specific details as you like by going down several levels.

This help is case-insensitive (i.e., it accepts both lower-case and capital letters). If you type n characters, it will be matched against the first n characters of the topic names at that level. No wild card is allowed in specifying item names.

If the topic name string supplied by the user can be matched to (parts of) two more more topic names, then information on all the matching topics will be displayed.

Type "?" to repeat the current level.

Type <RETURN> as the topic name to go up one level.

To exit HELP, type the EOF character ($\hat{Z}$ on VAX/VMS, $\hat{D}$ on UNIX machines).

8.3 Spawn

Enter a dollar sign "$" followed by a command to be spawned. Note that some operating system may not pass aliases, environment variables, logicals etc.

Appendix A. PIMMS commands

MODEL

Command syntax: MODEL <name> <par> <nh> [<name> <par> <nh> <ratio> <refe>...]
or MODEL PL <par1> <par2> <par3> <nh>
or MODEL <filename> [<nh>]
or MODEL ?
Minimum abbreviation: M
Examples: "MO PL 1.7 3e21" "MO mymodel.dat"

Model specifies the spectral shape to be folded with the effective area curve of the instrument. Starting with version 3.0, up to 8 model components can be added together to represent multi-temperature plasma, power law plus Gaussian emission line, partial-covering absorber etc. Only a limited combinations of models have been rigorously tested; users of complicated models are urged to check the composite model by using the OUTPUT command.

As components, PIMMS recognizes BLACKBODY, POWERLAW, BREMSSTRAHLUNG, GAUSSIAN and RAYMONDSMITH. If the model name string does not match these, PIMMS will try to interpret the string as a file name containing a precalculated model containing energy, photon flux pairs (see EXTERNAL_MODELS; MODELS_DIRECTORY). Nh, the equivalent neutral hydrogen column density (using Morrison & McCammon model) is expected for each component, except for GAUSSIAN and external files. Nh should be specified in full with an appropriate exponent (e.g., 2.5e21), or as a small non-zero number less than 30.0, to be intepreted as log10(Nh).

Model normalization for the built-in models do not necessarily correspond to physical quantities. Instead, PIMMS is designed to allow users to compare 2 observable quantities (count rates through specific instruments, or fluxes in specific energy bands) without having to know the model normalization.

Optionally, all components may be redshifted using a common z (in which case, all component Nh are interpreted as intrinsic absorber, with the same z) with an optional Galactic NH.

Syntax

The Model commands takes 1–8 blocks of component specification, and a final optional block of redshift specification. Each block starts with a valid name of a component (including a valid file name), followed by a set of numerical parameters. As a special case, the Raymond-Smith model takes an optional string ('logt' or 'kev', the latter being the default) specifying the unit of temperature. For 2nd through 8th component blocks, additional parameter(s) specifying the ratio of that component to component 1, and the reference energy at which this is to be evaluated, must also be given (NB the reference energy for Gaussian is always its central energy).

MODEL — ?

MODEL command with a question mark (or no parameters) will return a short listing of available models.

MODEL — Blackbody

Can be abbreviated to "BL.." or "BB". Parameter is temperature in keV.

MODEL — Bremsstrahlung

Can be abbreviated to "BR.." or "TB" (short for Thermal Bremsstrahlung); the model include the Gaunt factor. Parameter is temperature in keV.

MODEL — Power Law

Can be abbreviated to "P.." or "PL". Parameter is photon index (flux in photons $cm^{-2}\,s^{-1}$ is $E^{-(index)}$. You can now enter a negative number as the index, and PIMMS will calculate a power law that increases with increasing energy in photon space.

A power law with high energy cutoff $E^{-index}\exp[(E_{cut}-E)/E_{efold}]$ can be specified by typing "model pl 1.5 13.5 20.0 1e22" for example — this will result in an index of 1.5, cut-off energy of 13.5 and e-folding energy of 20 keV, with an N_H of 1E22.

MODEL — Raymond & Smith

Can be abbreviated to "R.." or "RS". At the moment, PIMMS cannot compute an arbitrary RS model but uses one of pre-calculated model files. The standard installation has a set of 12 coarse models. An additional tar file can be used to extend the temperature range and grid density (see MODELS_DIRECTORY) Plasma temperature can be specified in log T (type "model rs logt 6.8 3e21" for example) or in keV (type "model rs 0.5 5e19" for example). Abundances are assumed to be Solar, as defined by Allen.

See also "Models directory" below.

MODEL — Gaussian

Can be abbreviated to "G". This model takes the central energy and physical width (in keV) as parameters, and optionally also Nh. A physical width of 0 is allowed, which is interpreted as a delta function (integrations of delta function is treated appropriately, although it may look incorrect in the differential form, which is what is saved by the OUTPUT command).

Gaussian is primarily intended as second (etc.) component in addition to a continuum model, with the same Nh as the primary component. In such cases, specify the equivalent width in eV rather than the 'relative strength'.

MODEL — External Models

Other, perhaps more complex, models can be imported in the form of an Ascii file containing energy (keV) vs. flux (photons $\mathrm{cm}^{-2}\,\mathrm{s}^{-1}\,\mathrm{keV}^{-1}$ pairs. N_H correction is optional (i.e., interstellar absorption can be included when producing the file or done within PIMMS). If the full directory/file name is not specified, user's current default directory is assumed first, and if not the models directory is searched.

MODEL — Models directory

Some external models (see help item under that name) may be kept under the MODELS subdirectory. If the file names and a short description is also included in the MODEL.IDX file, then PIMMS users will be able to see what is available. Currently, a series of 0.25 Solar abundance Raymond-Smith models are available from MODELS directory by default.

A set of 295 additional Raymond-Smith model files (8000 lines each) are available in a separate tar file (extra_v3.tar.Z). These files are called RSxx_yyy.mdl, where abundances are x.x solar (02, 04, 06, 08 or 10) and log T is y.yy (5.60 - 8.50 in 0.05 increment).

MODEL — Importing from XSPEC

To import a model from XSPEC, start XSPEC and read, e.g., a template ASCA SIS pha file (which specifies the SIS response matrix which specifies the PHA channel boundary etc.). Create your model. Then use IPLOT MODEL command to plot the model, then from within plot use the WD <filename> command to output the model into an Ascii file. The program XSING within the MODELS directory should be used to convert the XSPEC output into a form readable by PIMMS.

FROM

Command syntax: FROM <mission> [<det> [<filt>]] [<lo>-<hi>]
FROM FLUX <unit> <lo>-<hi> [UNABSORBED] [ANGSTROMS]
FROM NORMALIZATION
Minimum abbreviation: F
Examples: "FROM EINSTEIN IPC" "'FROM FLUX PHOTONS 0.5-10"

This command specifies the default "instrument" that the conversion is to take place from. This default will be used in GO (in count rate simulation mode) or POINT (in image simulation mode) command if not explicitly specified. See Missions for details of the available instruments, or try DIRECTORY. Initially the default is 2.0–10.0 flux in ergs $\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$.

INSTRUMENT

Command syntax: INSTRUMENT <mssn> [<det> [<filt>]] [<lo>-<hi>]
or INSTRUMENT FLUX <unit> <lo>-<hi> [UNABSORBED] [ANGSTROMS]
Minimum abbreviation: I
Examples: "INST EXOSAT LE LX3" "INST FLUX ERGS 1-10 U"

This command specifies the "instrument" that the conversion is to take place to. See Missions for details of the available instruments, or try DIRECTORY. Initially default is ASCA SIS.

GO

Minimum abbreviation: G
Command syntax: GO <input_rate> [<mission> [<det> [<filt>]]] [<lo>-<hi>]
or GO <input_rate> [FLUX <unit> <lo>-<hi> [UNABSORBED]]
Examples: "G 1.0" "GO 3.4 EINSTEIN IPC"

This command actually tells PIMMS to execute the simulation.

Given a source spectrum in the form specified with MODEL, which produces an input rate (count rate in the specified instruments or flux) of <input_rate> it GO predicts what the rate would be for the instrument specified with the INSTRUMENT command. Unit of input rate can be specified here, or else the default is used (see FROM).

OUTPUT

Command syntax: OUTPUT <filename> <loE> <hiE> <deltaE>
Example: "OUT compoite 0.1 10.0 0.005"

This command produces an Ascii file containing the current spectral model, and is intended primarily as a debugging tool for complicated multi-component models. Each row consists of energy, total model flux, and flux of each component if there are more than one. The energy grid should be specified using the minimum and maximum values and the increment.

PIMMS currently forces output file names to be all lowercase.

SHOW

Command syntax: SHOW
Minimum abbreviation: SH

Presents a summary of the current defaults on the screen.

DIRECTORY

Command syntax: DIRECTORY [<mission> [<detector>]]
Minimum abbreviation: D
Examples: "DIR" "DIRE EXOSAT"

This command prints, on your screen, the full listing of missions that PIMMS recognizes. For explanations and comments, see "Missions" in this help.

LOG

Command syntax: LOG <log-file-name> or LOG close
Minimum abbreviation: L
Example: "LOG crab"

When this command is issued, PIMMS opens a log file (default extension .log). Thereafter, screen outputs from PIMMS (except for questions/prompts) will be copied to the log file. LOG CLOSE will close the current log file; the purpose of this command would be to send further output to a separate log file. This command will indicate error if (1) a log file is already open; (2) (on UNIX systems) the specified file already exists; (3) (on VMS systems) when the specified "log file name" is also a DCL Logical; and (4) PIMMS failed to open the file for the usual reasons, including a lack of disk space and file system protection.

PIMMS currently forces output file names to be all lowercase.