# The relxill model [version 1.2.0]

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## Abstract

This document describes the current state of the relxill mode, version 1.2.0, focusing on the changes from the previous version 1.0.x. The major change is a fixed bug in the normalization of the reflected component of the relxill model. The major effect of this change for model fits is that relxilllp will overall yield a lower reflection fraction. The spectral shape itself is not affected by this changed, unless fixReflFrac=1 was set.

Note that a major change in the emissivty implemented in version 1.1.0 has been reverted, as it was not correct. The correct description of the emissivity profile is given in Dauser et al. (2013) and remains unchanged when updating from 1.0.x to 1.2.0.

## 1 The relline model family

All models of the relline family (Dauser et al., 2010, 2013) are available as "Line Models" and "Convolution Models". Line models produce the relativistically smeared profile of a delta function line at the given energy. The convolution models are capable in applying the relativistic smearing to a complete spectrum. Generally, line models have the word "line" in their names, while the name of convolution type models contains "conv". Moreover there is a third class of models, called relxill (García et al., 2014), which directly combines the relativistics with an intrinsic reflection spectrum. This reflection is calculated by the xillver code (García & Kallman, 2010; García et al., 2011, 2013). The code of all the models can be downloaded at http://www.sternwarte.uni-erlangen.de/research/relxill/. The meaning of the different model parameters can also be found there.

A completely revised setup the of relxill modelling package has been released with version 1.0.0. It is uses a FFT convolution kernel, for a very fast computation of a complete relativstically smeared reflection spectrum. Moreover the memory management has been highly optimized by only loading parts of the large xillver tables in memory.

## 2 Changes in version 1.2.0

A mismatch between the normaliztion of the xillver reflection tables and the relxill relativistic smearing kernel lead to a wrong prediction of the overall flux at the order of cos(incl). This problem has been fixed in version 1.2.0.

The effect of the wrong normalization of the xillver spectra in combination with the reflection kernel lead to a too low normalization of the reflection spectrum in comparison to the primary spectrum at the order of cos(incl). Therefore mainly fits with an inclination larger than $\theta > 30^\circ$ are affected, with larger differences starting at $\theta > 60^\circ$. However, for a low source height ($h < 10\,r_g$) the relativistic blurring also strongly affects the emission angle (see Fig. 5 in García et al., 2014) and therefore averages out this effect,

meaning that even for large inclinations still a significant part of the flux is seen under a small emission angle with respect to the normal to the accretion disk. Therefore large differences are only expected for a combination of large inclination angle and large source height.

Importantly, this change does only affect the normalization of the reflection spectrum and therefore only the determination of the parameter `refl_frac`. Only in the case where the primary and reflected normalization are fixed to the prediction of the lamp post geometry (setting `fixReflFrac=1`), the spectral shape was not correctly predicted.

The `xillver` model itself and its normalization is not at all affected by this change.

## 3 How does the update to 1.2.0 affect previous model fits?

How the update to 1.2.0 affects your model fits depends on which models you used, and also on the actual paremter combination. For all combinations explained below.

1. If you did not use the lamp post version of the `relxill` model, or you used `relxilllp` and `relxilllpCp` model, but the normalization of the reflected spectrum was not fixed to the primary spectrum (i.e., fixReflFrac=0 was set): only the model parameter `refl_frac` might have been overestimated. The **spectral shape did not change** and therefore all **model fits** with `relxill` under the above conditions **remain unchanged**.

2. If you used `relxilllp` and `relxilllpCp` and did set `fixReflFrac=1`, the update will result in differences. Generally, the strength of the reflection in the observed spectrum was predicted too low. For low inclinations ($\theta < 30°$) those difference will be small, whereas for larger inclinations and large primary source height, they might be more significant. The way the parameters are influenced can not be easily predicted in a general way and strongly depends on the parameter combination.

In order to update your fit to work with `relxill` 1.2.0, we recommend freezing all parameters execpt for the reflection fraction, and the overall normalization of the `relxill` model and re-fit. In case of (3), it might be advisable to re-fit the height parameter as well. Afterwards, all variable parameteres should be re-fitted.

## 4 Summary

The update to `relxill` 1.2.0 fixes the normalization of the relativistic reflection- Its effect is largest for large inclination angles. While the shape of the spectrum is not affected by the latter problem (unless `fixReflFrac=1` was used), the obtained reflection fractions are affected by this change.

We appreciate any feedback on these changes and the current performance of the `relxill` model and are happy to answer any questions regarding this update or the `relxill` model in general.

## References


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