Comparison of relativistic iron line models I.
Fitting XMM-Newton data
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The analysis of the broad iron line profile in the X-ray spectra of active galactic nuclei and black hole X-ray binaries allows to constrain the spin parameter of the black hole. We compare the constraints on the spin value for two X-ray sources MCG-6-30-15 and GX 339-4 with a broad iron line using present relativistic line models in XSPEC — laor and kyrline. We investigate if the laor model still can be used for estimation of the spin with current data or if recently developed relativistic line models should be used instead.

Introduction
The galaxy MCG-6-30-15 has proven to be a very good source for testing different relativistic line models. The extremely skewed iron line has been revealed in X-ray spectra across all recent satellites. M XM-Newton observed MCG-6-30-15 for as long as 350ks during the summer 2003 (the revolutions 301, 302, 303) [3, 9]. The black hole binary GX 339-4 exhibited strong broadened line in 76ks observation in 2002 and also in two 130ks-observations in the spring 2004 [5, 6, 7, 8]. Unfortunately, the data from the long 2004 observations suffer significantly from pile-up. Hence, we used the previous observation, which avoided the problems with pile-up caused by using the burst mode. The following analysis is done on pn data for both objects. In cases of MCG-6-30-15 the spectra of all three data sets were joined into one spectrum.

Data analysis
We reduced the data using SAS v.7.1.2 and followed the instructions of the previous analyses until grouping of the data bins. Instead of using ewpyne with 'group min' command we used phabs script by M. Guainazzi which takes into account the energy resolution of the instrument. Next to the minimum number of counts per bin, we demand to oversample the instrumental resolution by a factor of 3. This different approach leads to a significant decrease of the total number of bins and to better statistics – more independent on the instrument properties. Consequently, the previous fits of GX 339-4 spectrum were not satisfying any more. We found a different fit, in which the line strength becomes much weaker. However, the spin value as α ≈ 0.7 enabled us to compare the laor model [4] with the kyrline model [2] for an intermediate value of the spin.

Results
The main difference between laor and more recent relativistic line models like kyrline is in the determination of the spin value. The spin value is not fitted directly by the laor model. However, it can be estimated from the value of the inner radius of the disc, if we assume that the disc extends down to the marginally stable orbit (see Fig. 4). The tables 1. and 2. show that in the studied cases the laor model slightly overestimates the spin value. The value of the spin is bound to other parameters of the line (see continuum spin vs. inclination angle) and also to the continuum parameters (see contours spin vs. powerlaw index). With the fitted continuum and with all other parameters of the line related we get αlaor = 0.98 – 1.0 and αkyrline = 0.94 – 0.98 for MCG-6-30-15, and αkyrline = 0.96– 0.98 and αkyrline = 0.96 – 0.98 for GX 339-4.

We also tested how fast each model finished a stepping command on the spin value in the range (0.90, 0.98). We find that the laor model was 10 times faster than the kyrline model. We also tried to compare the results with the kyrline model [1] which gives the same shape of the line as the kyrline model. However, we were not able to do it because the stepping command did not finish after 4 hours.

Conclusions
The kyrline model leads to a more well-defined minimum of χ² for the best fit value. The confidence contour plots for αk/M versus other model parameters are much more regularly shaped. This indicates that the kyrline model has a smoother adjustment between the different points in the parameter space allowing for more reliable constraints on αk/M. The laor model has a less accurate grid and is strictly limited to the extreme Kerr metric. It leads to the predictions of slightly higher values for the spin. However, the discrepancies between the kyrline and laor results are within the general uncertainties of the spin determination using the skewed line profile.

References