We present a physical X-ray reverberation model (so called REVB model) to investigate the spectrum and time lags during the high flux state of Mrk 335 observed by XMM-Newton in 2006. The model consists of an isotropic-point source stationary on the symmetry axis of a black hole. A ray-tracing simulation is performed in parallel using GPUs to follow the photons between the source, the disc and an observer. We calculate the ionization state of each disc-annulus and employ XILLVER model (e.g., Garcia+2013) to obtain the ionized back-scattered X-ray spectrum.

Since the back-scattered photons take a longer time to reach the observer compared to the direct photons. The energy bands dominated by the reflection component will lag behind those bands dominated by the direct component. These lags referred to as reverberation lags are associated with the light-travel time between the source and the disc allowing us to probe the location and geometry of the X-ray source(s).

Grid of REVB parameters and fitting procedure

To fit the data of Mrk 335, we produce the grid of REVB model as shown in table 1. The fitting procedure is performed in ISIS. The time lags were produced in a standard way, following the data reduction of Kara+2013.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>spin (a)</td>
<td>0.998</td>
</tr>
<tr>
<td>disc r</td>
<td>400</td>
</tr>
</tbody>
</table>

In ISIS, the XMM-Newton spectrum, background and responses are loaded as the first data set. We define a second data set which represents the time lag vs. frequency. The REVB model produces the time-averaged spectrum which is fit to the first data set and the time lag spectrum that is, simultaneously, fit to the second data set.

Spectral model requires 2 additional narrow Gaussians at ~6.4 and 7 keV interpreted as the distant reflection from molecular torus and the hot gas filling that torus, respectively.

Timing model requires additional power-law to produce the low-frequency positive lags that may be attributed to the propagation of fluctuations in the disc.

We begin simultaneous fitting the 2-10 keV spectrum and time lags between 2.5-4 and 4-6.5 keV bands (figure 4). The best fitting parameters are listed in table 2.

Finally, we fitted the combined 0.3-10 keV spectrum and 0.3-0.5 vs. 1.4 keV lags (figure 5). We add a blackbody component and replace two Gaussians with unblurred-XILLVER and VMEKAL models. Most of the REVB parameters are comparable to what previously obtained.