# NOVAs
# a Numerical Observatory of Violent Accreting systems

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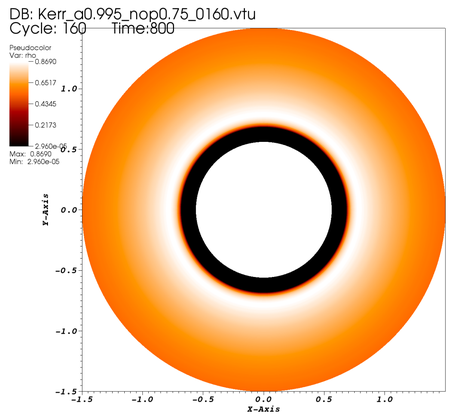
## Abstract:

Here we are presenting NOVAs, a Numerical Observatory of Violent Accreting systems, which couples a GR AMR MPI (GRAMRVAC) code able to follow accretion around a Kerr Black-hole with the ray-tracing code GYOTO. Together, they allow us to test different models by running the simulation and obtaining spectral energy distributions and power-density spectrums from which we can extract the same observables as for 'real' observations, hence making it a Numerical Observatory.

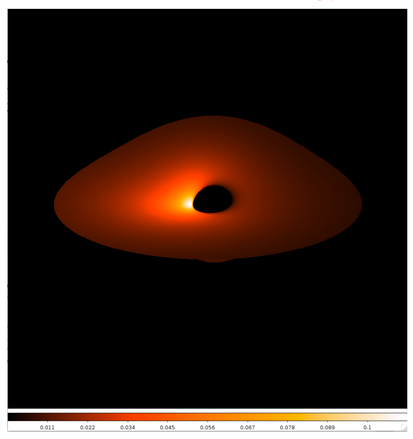
## How does NOVAs works

- The `NOVAs` chain starts from a physical model, say matter orbiting around a Kerr black hole of spin a, mass M.

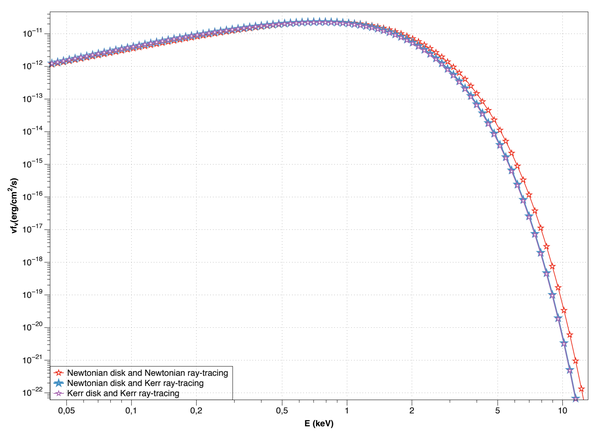
→ Using `GRAMRVAC` we evolve the system to obtain a self consistent disk, especially the inner edge




→ Using `gyoto` we ray-trace back to the observer the emitted flux as a function of energy

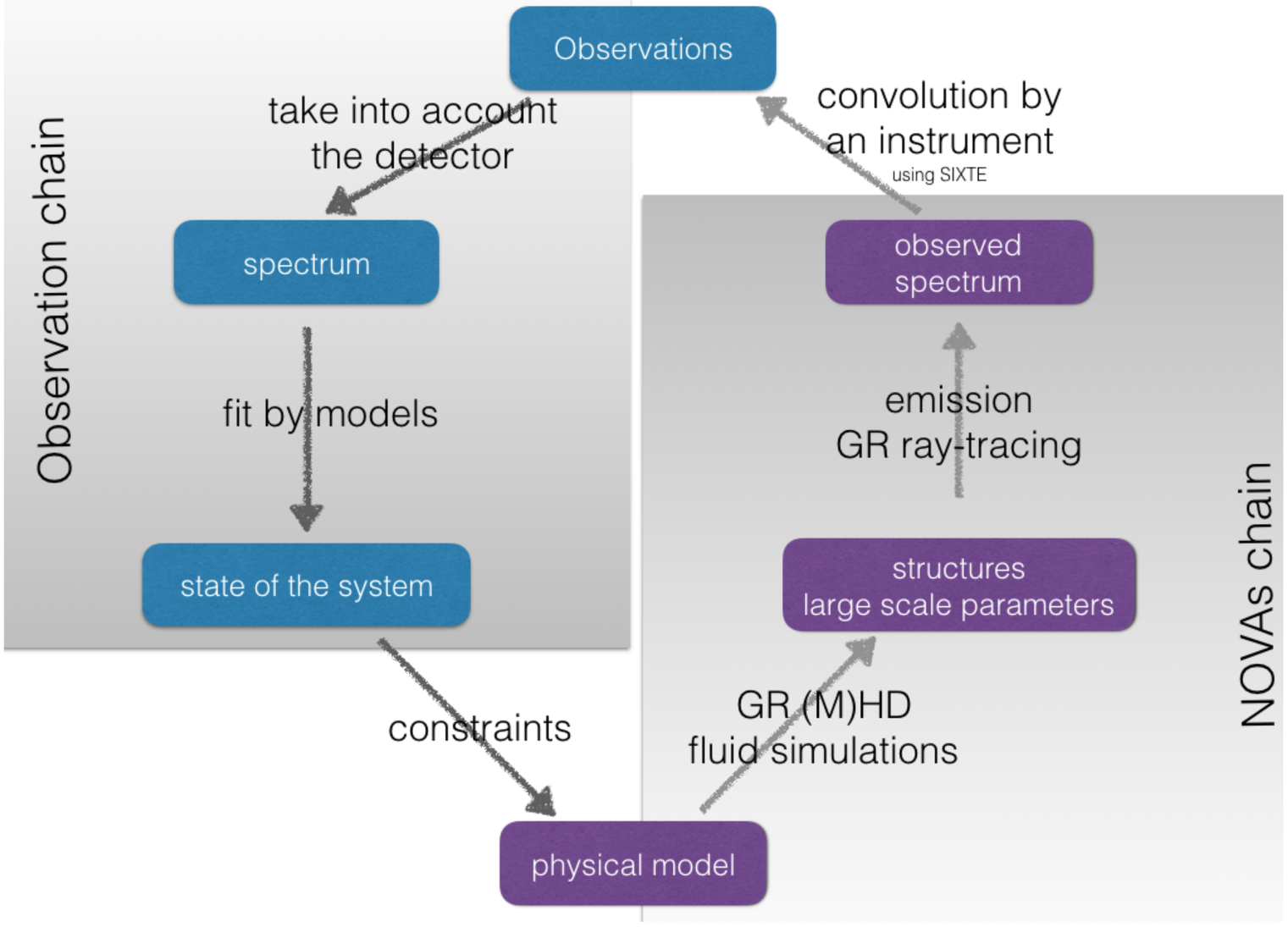


→ Which in turn can be translated into an energy spectrum




- This could be used to predict observations, test detectability with new instruments if we convolve the resulting spectrum by the response matrix of the desired instrument. This step is done using `SIXTE` and is in the testing phase.

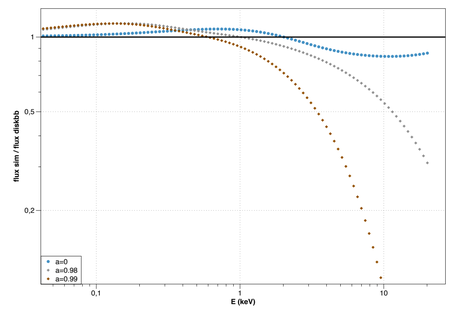
## NOVAs versus Observations



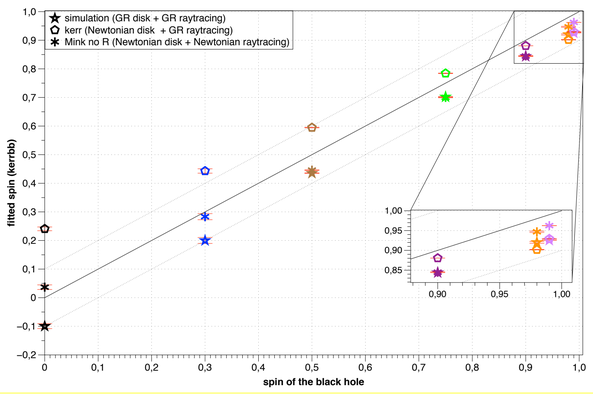

## Applications

This tool can have a lot of use, such as preparing observations, thanks to being easily coupled to `SIXTE`, but also trying to understand the origin of some observed features.

- For example, comparing the shape of the simulated disk spectrum with the standard `diskbb` from `xspec` we see that it will be harder to have good $\chi^2$ fits for high spin than it is for low spin.




- If we are interested in the spin value, using the `kerrbb` model and the exact value of inclination, mass and distance of the NOVAs *observation* we obtained:




## Conclusions:

⋆ By combining smoothly two GR codes, one providing a full hydrodynamical solution and one providing the ray-tracing of the emission, we now have a fully functional numerical observatory which allows us to obtain spectrums and lightcurves of theoretical models with limited hypotheses.

⋆ Further linking the output of NOVAs with SIXTE allows us to also test the capacity of new instruments to distinguish between models.

⋆ Among the numerous applications we first looked at the difference in shape of the spectrum as the spin increases. Indeed, this can explain the difficulty to get good $\chi^2$ for high spin sources.

⋆ We also explore how well the `kerrbb` model does constrain the spin. For our range of spin and accretion rates the `kerrbb` model was able to get the spin within 0.1 of its actual value.

References:

Casse, F., Varniere, P. & Meliani, Z., 2017, MNRAS 464, 3704.

Vincent, F. H., Paumard, T., Gourgoulhon, E., Perrin, G. 2011, Classical and Quantum Gravity, 28, 225011.