# The Densities of Black Hole Accretion Discs and Their Implications in X-ray Data

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Ask me questions For paper 1

For paper 2

For paper 3

An important aspect of my research is to study the densities of the accretion discs around black holes (BHs), and their effects on resulting radiation. This key attribute has been long overlooked by previous work but promises to reveal key insights into the detailed disc structures, disc energy exchanges and the connection between supermassive and stellar-mass black holes.

Note that the high temperature and density of BH accretion discs within a strong-gravity environment make them beyond the studies in the laboratory or convincingly in computational simulations. Therefore, X-ray observations of BH accretion discs are unique and hold the key to our understanding of high-energy plasma with extreme properties.

### How?

Free-free absorption becomes important and the disc surface will have a higher temperature when its electron density is high.



Inferred disc density values by disc reflection spectroscopy compared to standard thin disc model prediction. The solid and dashed lines show standard thin disc model predictions assuming no coronal power and 40% of the disc energy dissipated in the corona. The points on the right show the measurement for AGN and the points on the left show the ones for BH XRBs.

![](_page_0_Figure_16.jpeg)

Left: Temperature profiles of an illuminated slab under hydrostatic equilibrium for different electron densities. Right: Relativistic disc reflection spectra for different densities corresponding to the left-hand panel.

#### Conclusions

A stellar-mass BH accretion disc has a much higher density than a supermassive BH accretion disc. Most objects require a density parameter significantly higher than the previous assumption of  $n_p=10^{15}$  cm<sup>-3</sup>.

There are also other indications by the high-density disc reflection models, e.g., systematic differences in inferred values of black hole spins and disc iron abundances. Check my papers for more details.

#### I am attending XRU 2023 online. So...

Catch Honghui Liu (presenting at 17:00, 14 Jun), Dom Walton, and Adam Ingram in the corridor for more questions.

- I also have two oral presentations on 13 Jun:
- 1. A Highly Accreting Low-Mass Black Hole Hidden in the Dust
- 2. The Awakening Beast in the Seyfert 1 Galaxy KUG 1141+371

Ehud Behar, Gitika Mall (14 Jun) and Julia Sisk-Reynes (15 Jun) will give relevant presentations at XRU 2023.