Investigating Maximal Magnetic Flux of Super Massive Black Hole Accretion Disks in the MAD Regime

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INTRODUCTION

The accumulation of magnetic flux near a supermassive black hole can become so strong that it arrests the inward flow of matter, episodically releasing material and energy. We call the state of the system the **Magnetically Arrested Disk (MAD)** state, and it corresponding to the most powerful black hole outflows. We ultimately want to know **how much magnetic flux** can the black hole and the accretion disk tolerate.

METHODOLOGY

We simulate the accretion process of a spherical cloud of gas around a black hole via the **HARM** (High-Accuracy Relativistic Magneto-hydrodynamics) scheme. The limits of magnetic flux on the black hole is understood, but little is known about the analogue of the accretion disk. We calculate the **wavelength of the MRI** (Magneto-Rotational Instability) or the minimum wavelength over which gas can bend magnetic field lines in one orbital period. I**ts ratio to scale height** of the accretion disk indicates when the magnetic field in the disk is at its upper limit.

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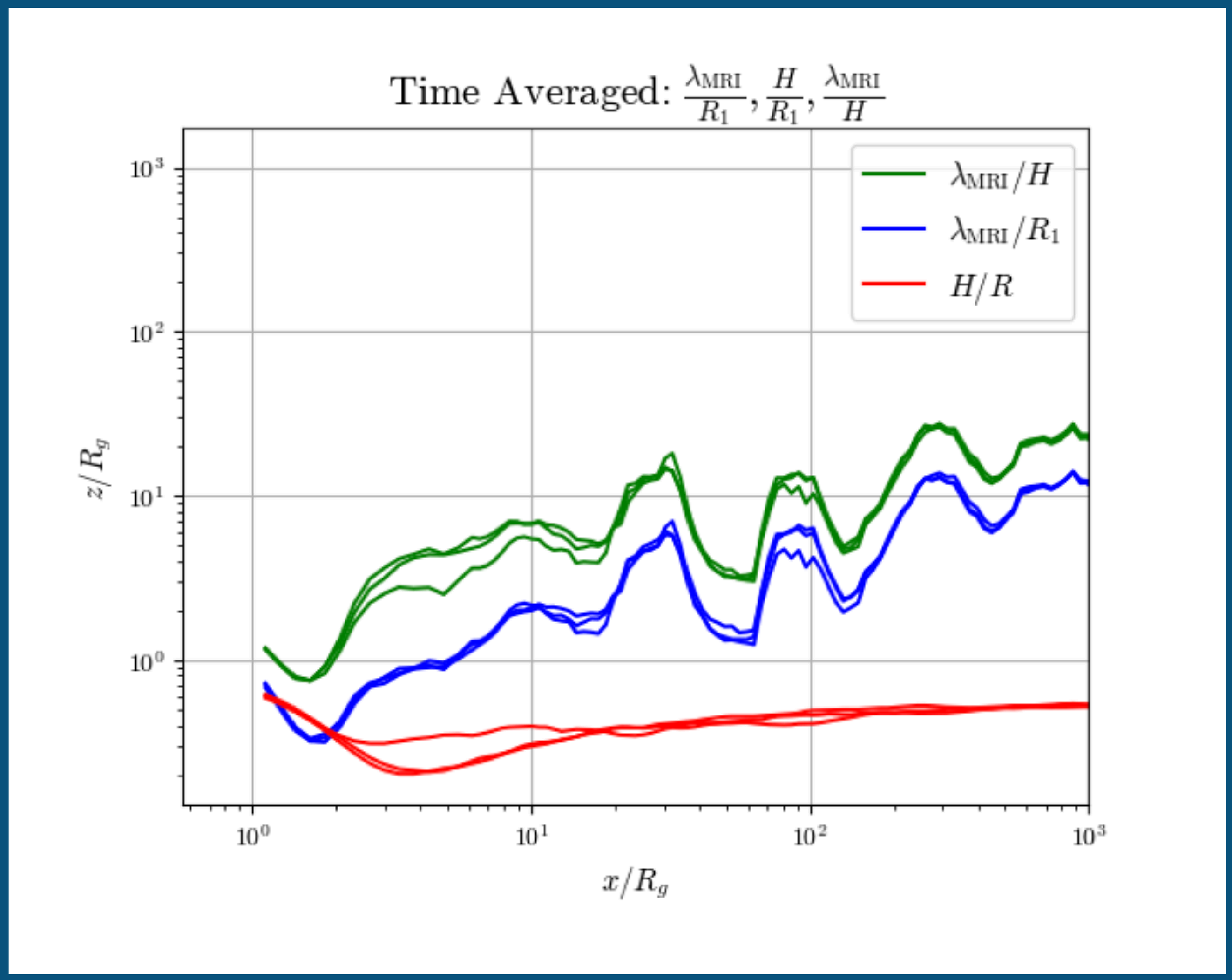
RESULTS



We expected the value of the ratio of wavelength to scale height to return **~2**, yet our time-averaged value is ~**10** suggesting that the magnetic field is **considerably past** the upper limit we expected.

We also calculated a thickness of **~.6** which **we expected**.

Lastly, our calculation of dimensionless wavelength of ~**3-4** is also as **we expected**.

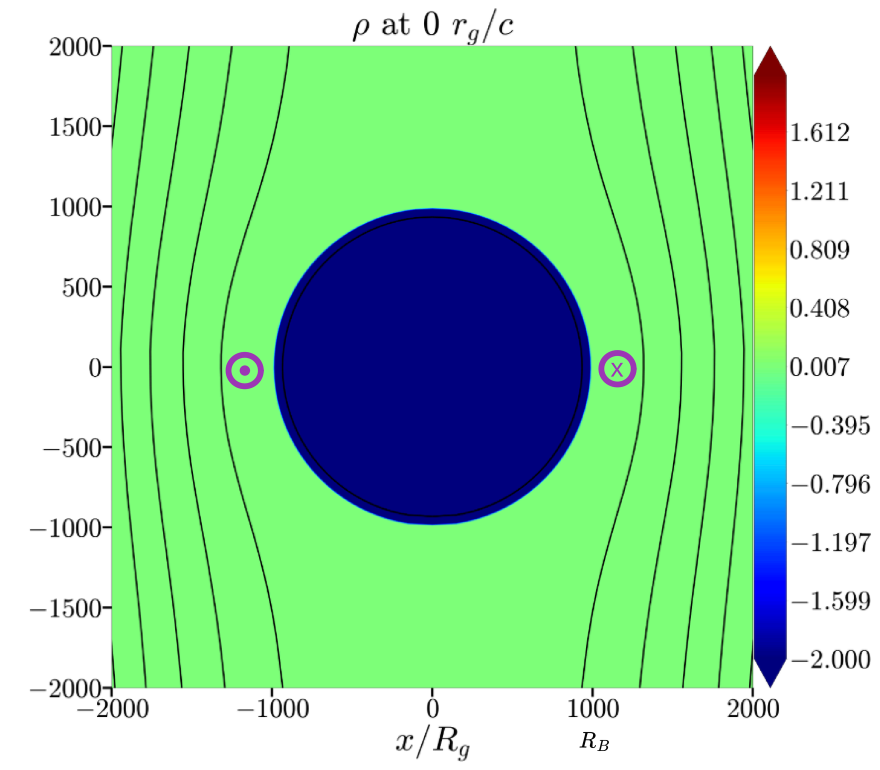


Figure 1: Vertical slice of gas density around the black hole at initial time. The purple circles indicate accretion flow direction. The black lines indicate magnetic field, and the blue circle contains the infalling gas and black hole.

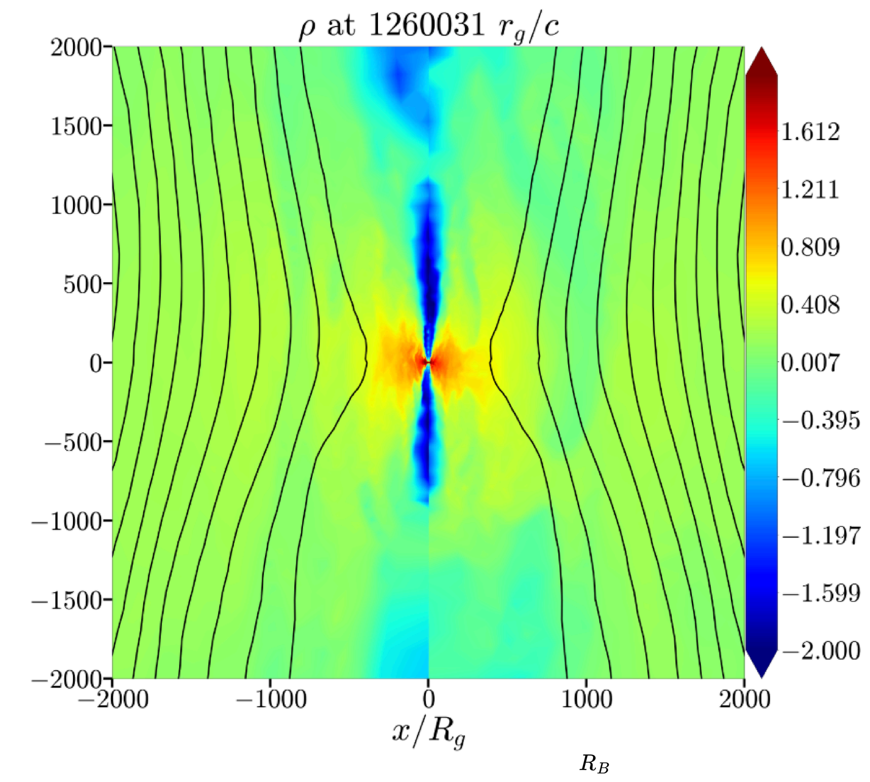


Figure 2: Vertical slice of gas density around the black hole at final time. The jets are indicated in blue, and the accretion disk accrues near the black hole in red.

FUTURE DIRECTIONS

The **polytopic index** of 5/3 controls disk thickness. In future work, we will run and compare identical simulations with smaller indices, and thus thinner disks. We will also investigate uncooled disk where viscously generated energy from flow is locked into the accretion disk instead of outwardly radiated.

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