Quantifying the Activity of **Supermassive Black Holes** in **Cosmic Voids**

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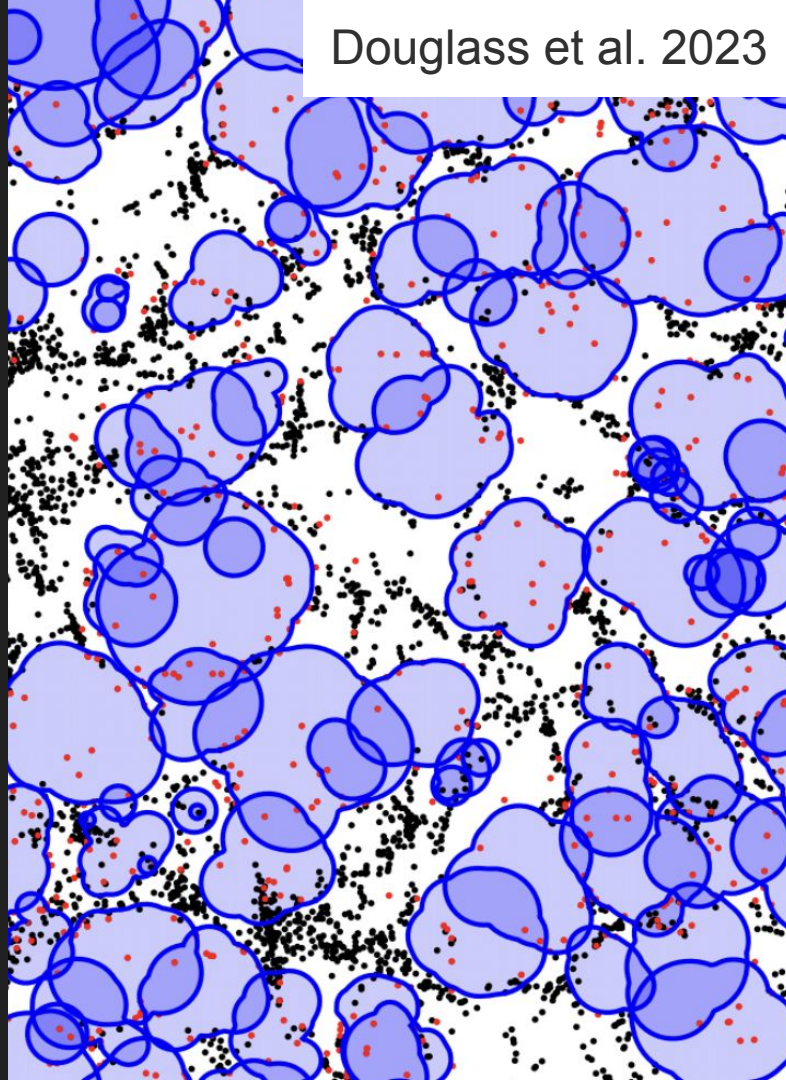
What are voids?

- Large 3D regions
- 50% of volume
- < 20% of galaxies

Why are we interested in them?

- Mergers → “hungry” monster black holes (BHs)?
- Harder to find active BHs

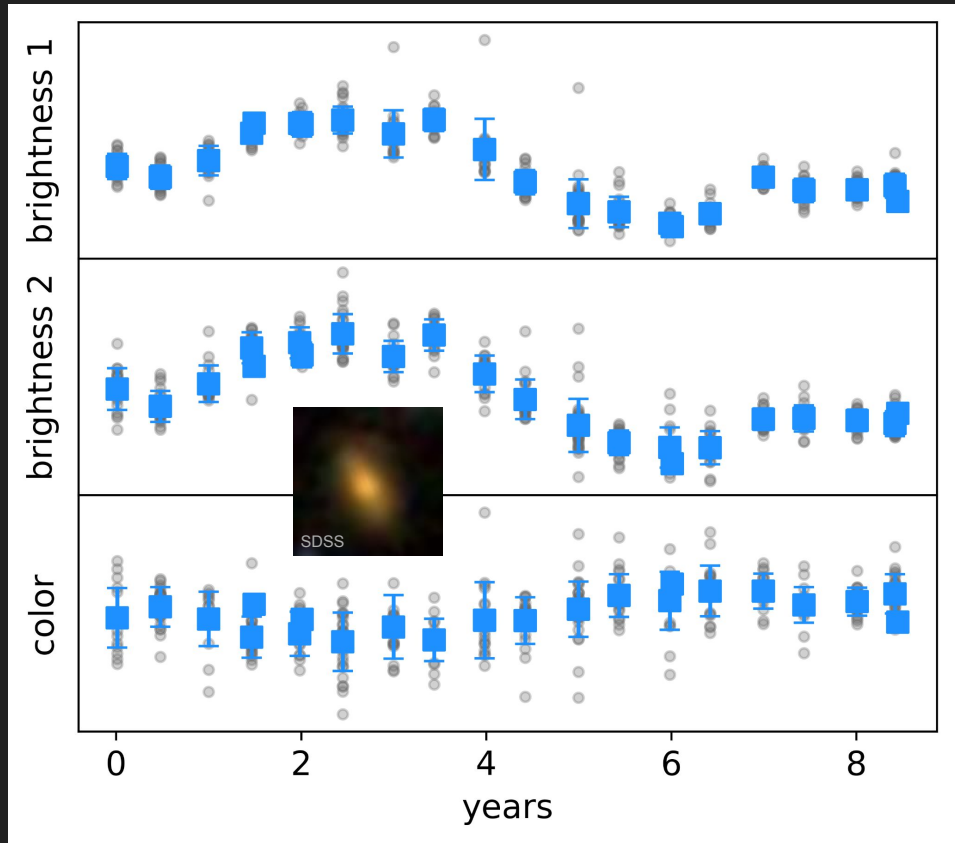


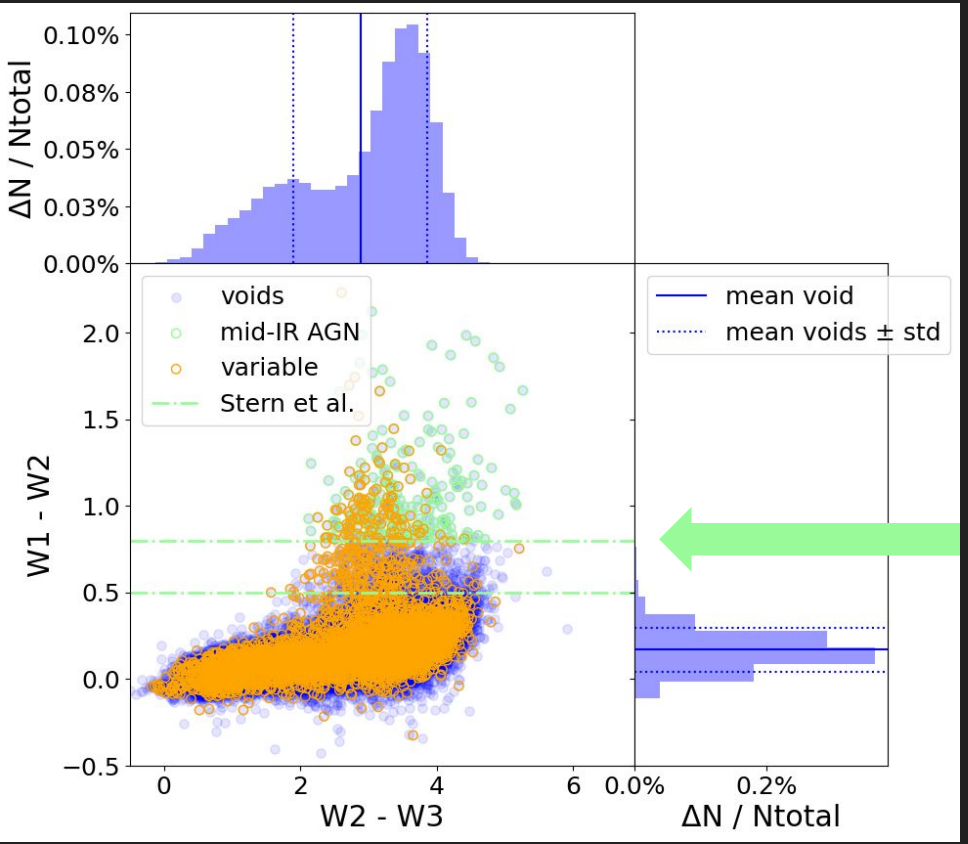
Douglass et al. 2023

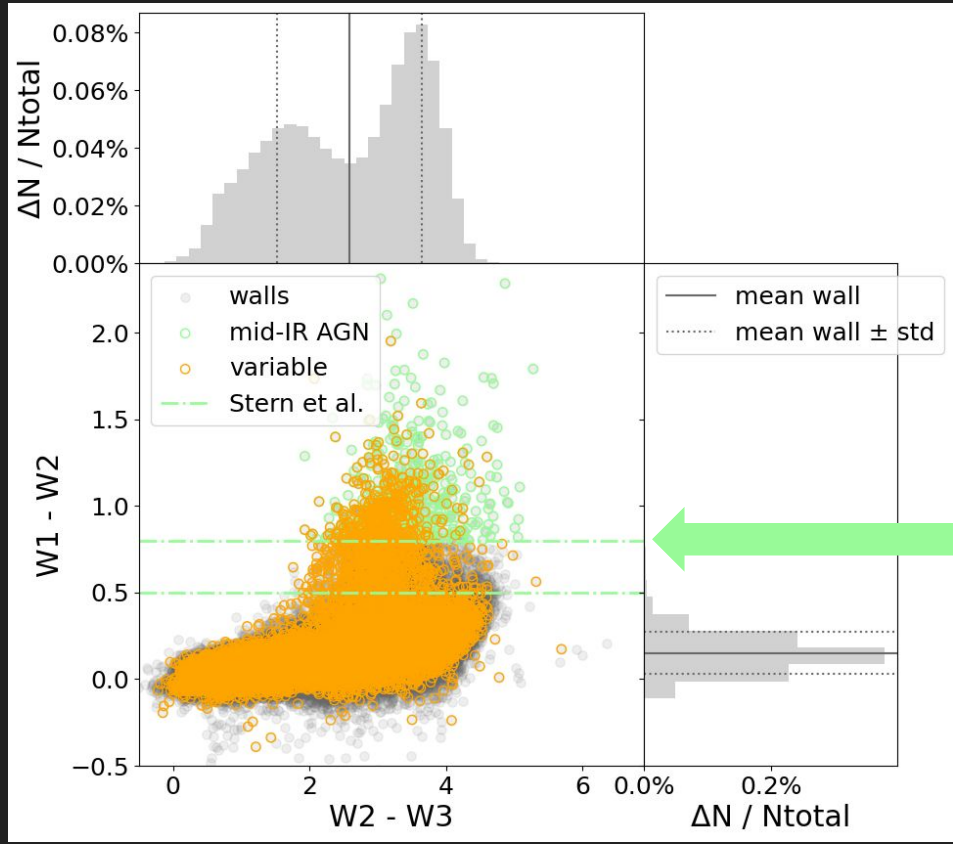
Variability uncovers hidden hunger

Mid-infrared (mid-IR) data (AllWISE/NEOWISE)

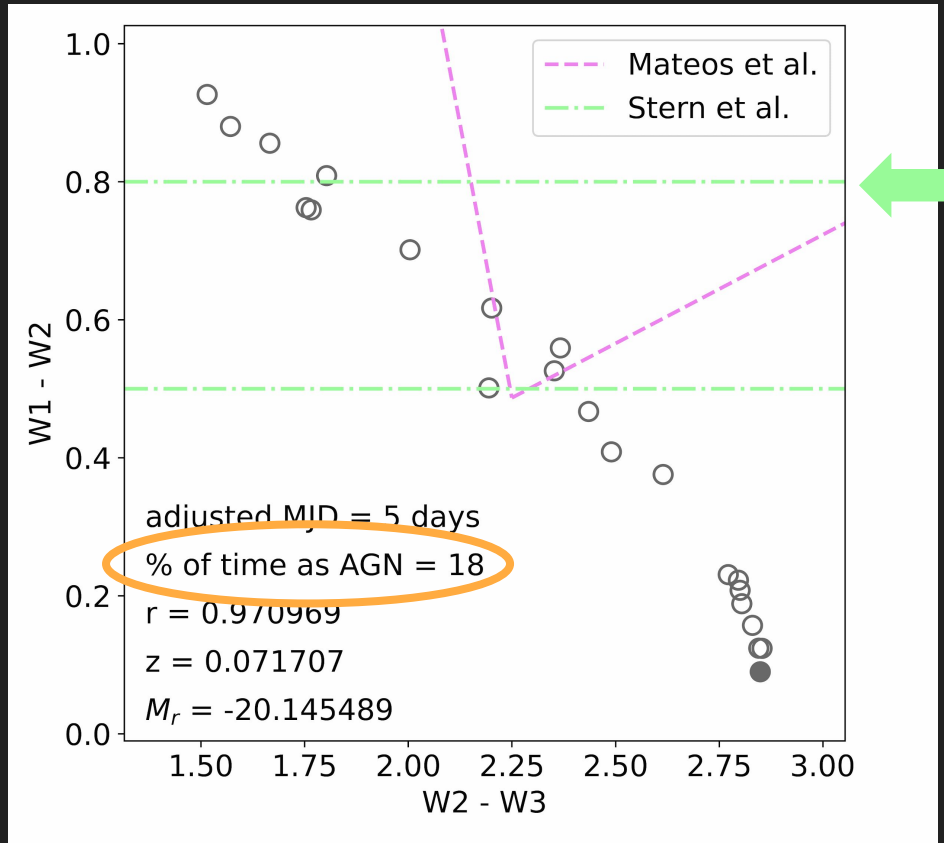
> 20,000 “hungry” monster BHs in overlooked **“blue”** galaxies (**~ 7%**)




ΔN / Ntotal
0.10%
0.08%
0.05%
0.03%
0.00%
voids
mid-IR AGN
variable
Stern et al.
mean void
mean voids ± std
W1 - W2
2.0
1.5
1.0
0.5
0.0
−0.5
0
2
4
6
W2 - W3
0.0%
0.2%
ΔN / Ntotal


ΔN / Ntotal
0.08%
0.06%
0.04%
0.02%
0.00%
walls
mid-IR AGN
variable
Stern et al.
mean wall
mean wall ± std
W1 - W2
2.0
1.5
1.0
0.5
0.0
−0.5
0
2
4
6
W2 - W3
0.0%
0.2%
ΔN / Ntotal

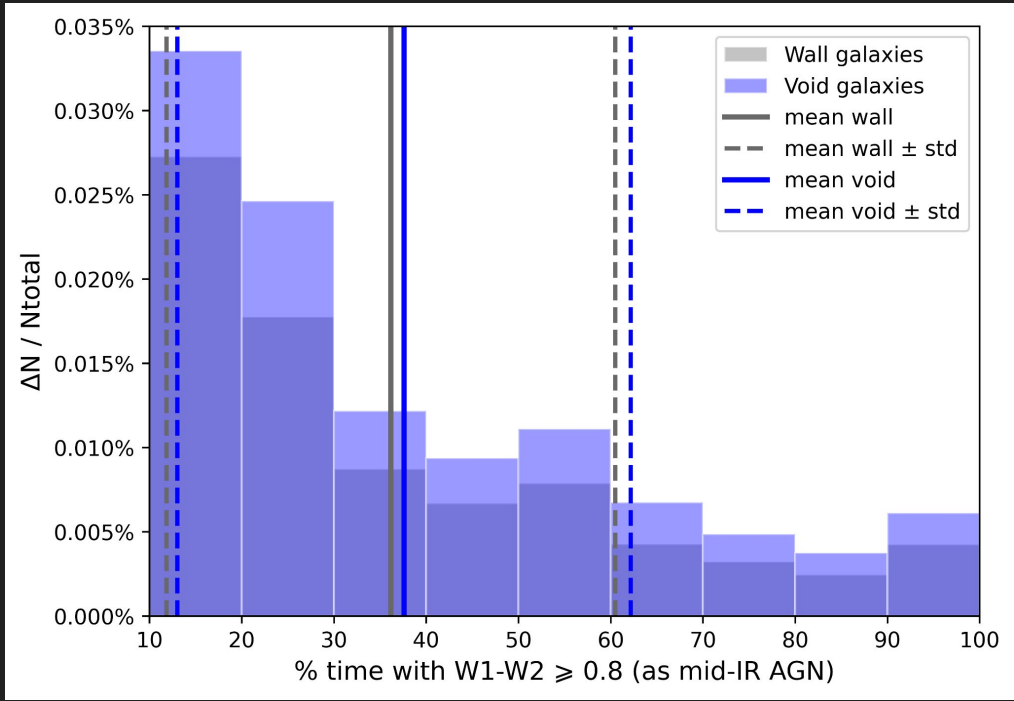
Changing BHs evade traditional methods



Lonely BHs may also be the hungriest

Hungry BHs are **more common in voids** among midsize/dwarf galaxies

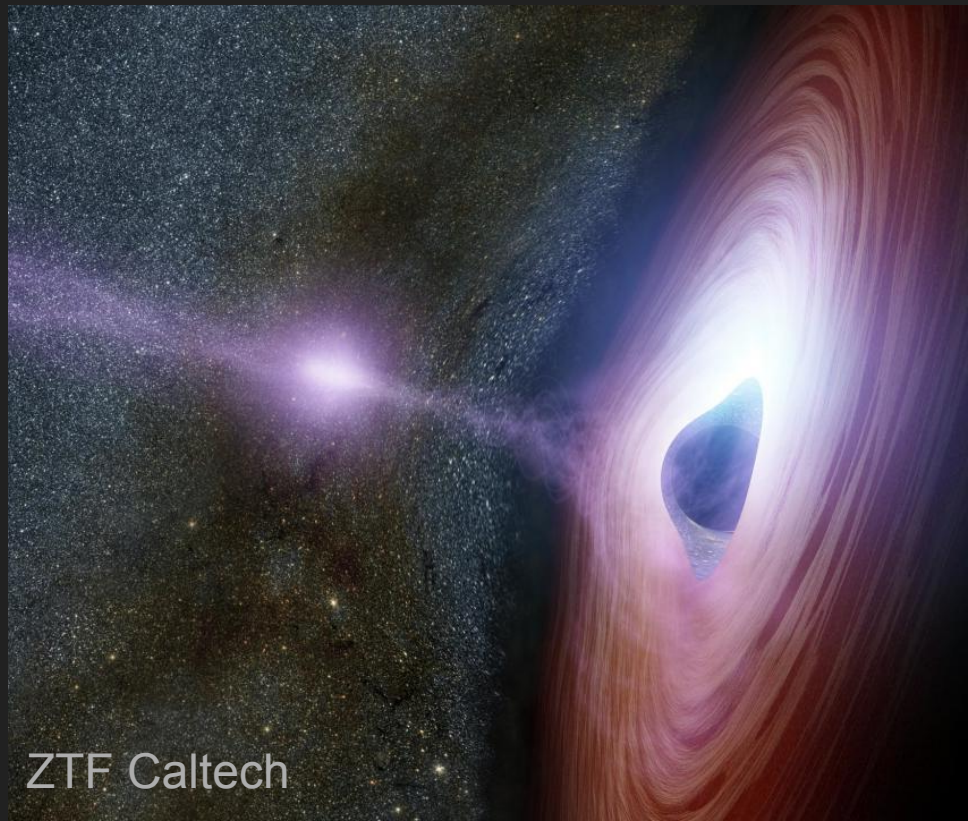
Reverse trend when comparing **all** galaxies



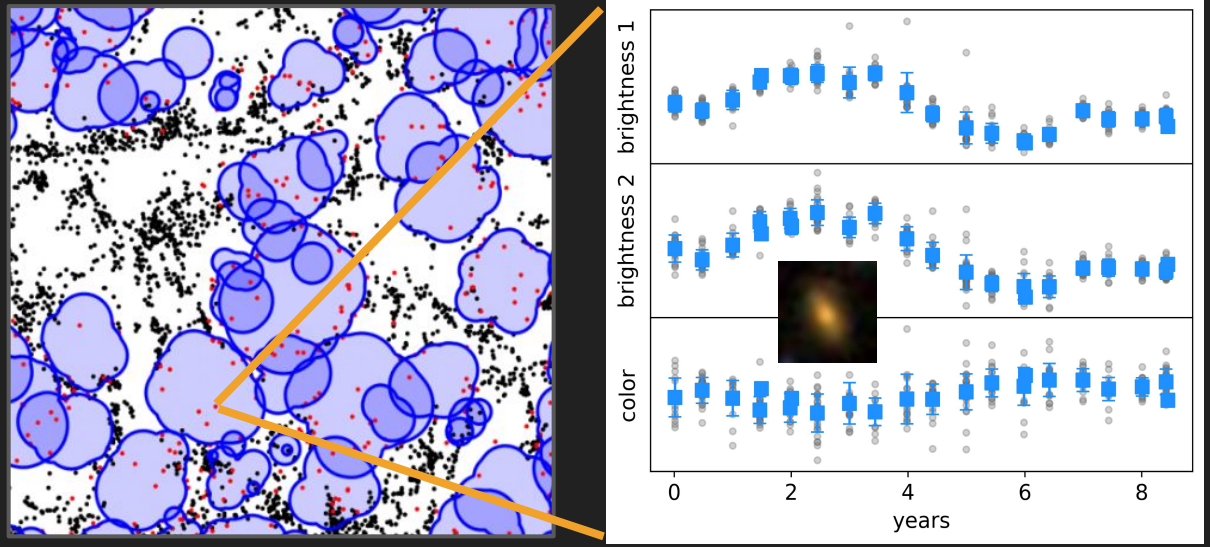
Shedding light on galaxy evolution

Interactions **encourage** “snacking” only among more **luminous** galaxies

Monster BH life cycle is **delayed/slowed** in voids



Summary



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