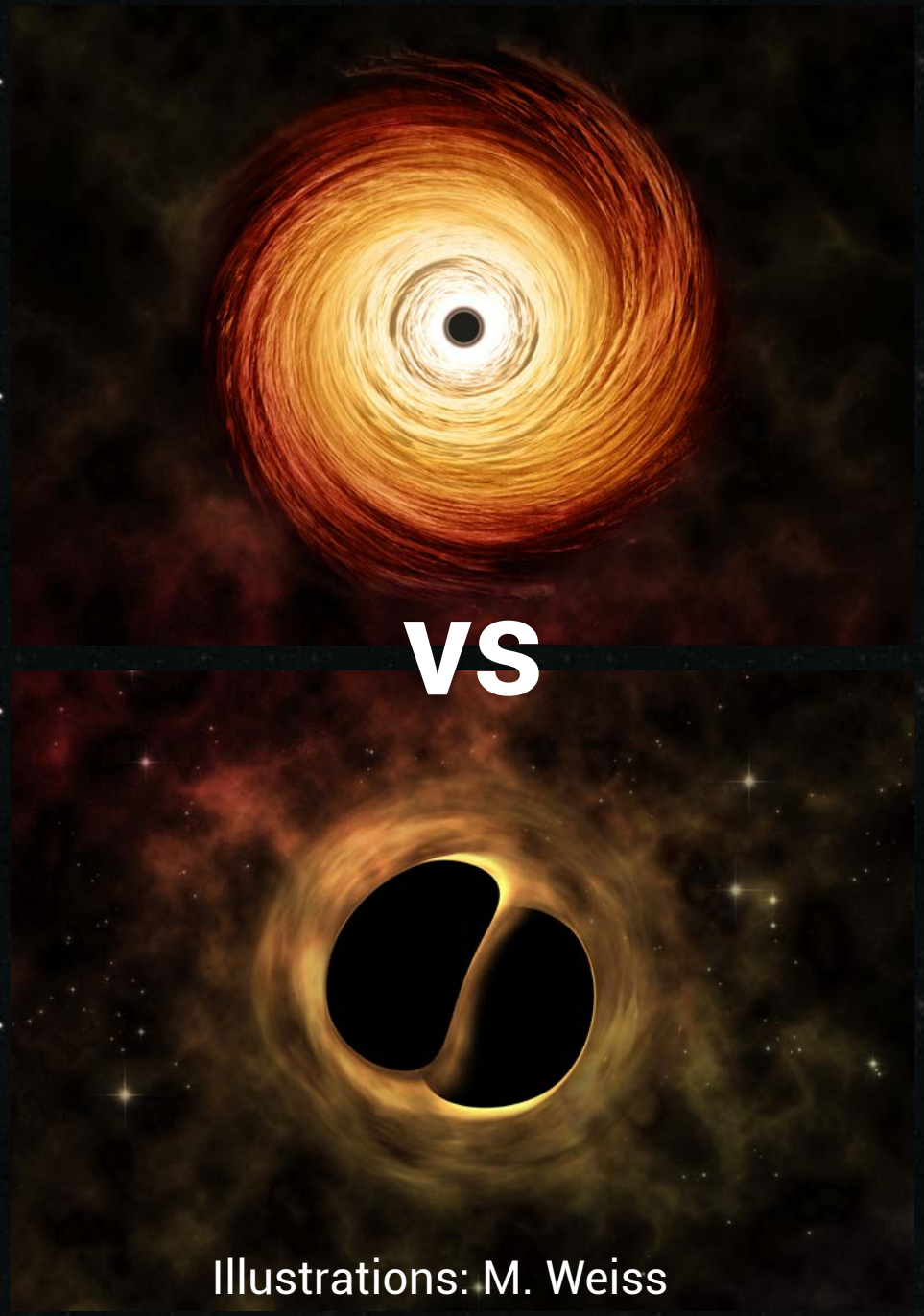

Illustrations: M. Weiss

How Black Holes Grow Across Cosmic Time

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CENTER FOR ASTROPHYSICS
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GORDON AND BETTY MOORE FOUNDATION

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AAS 236th Meeting Press Conference

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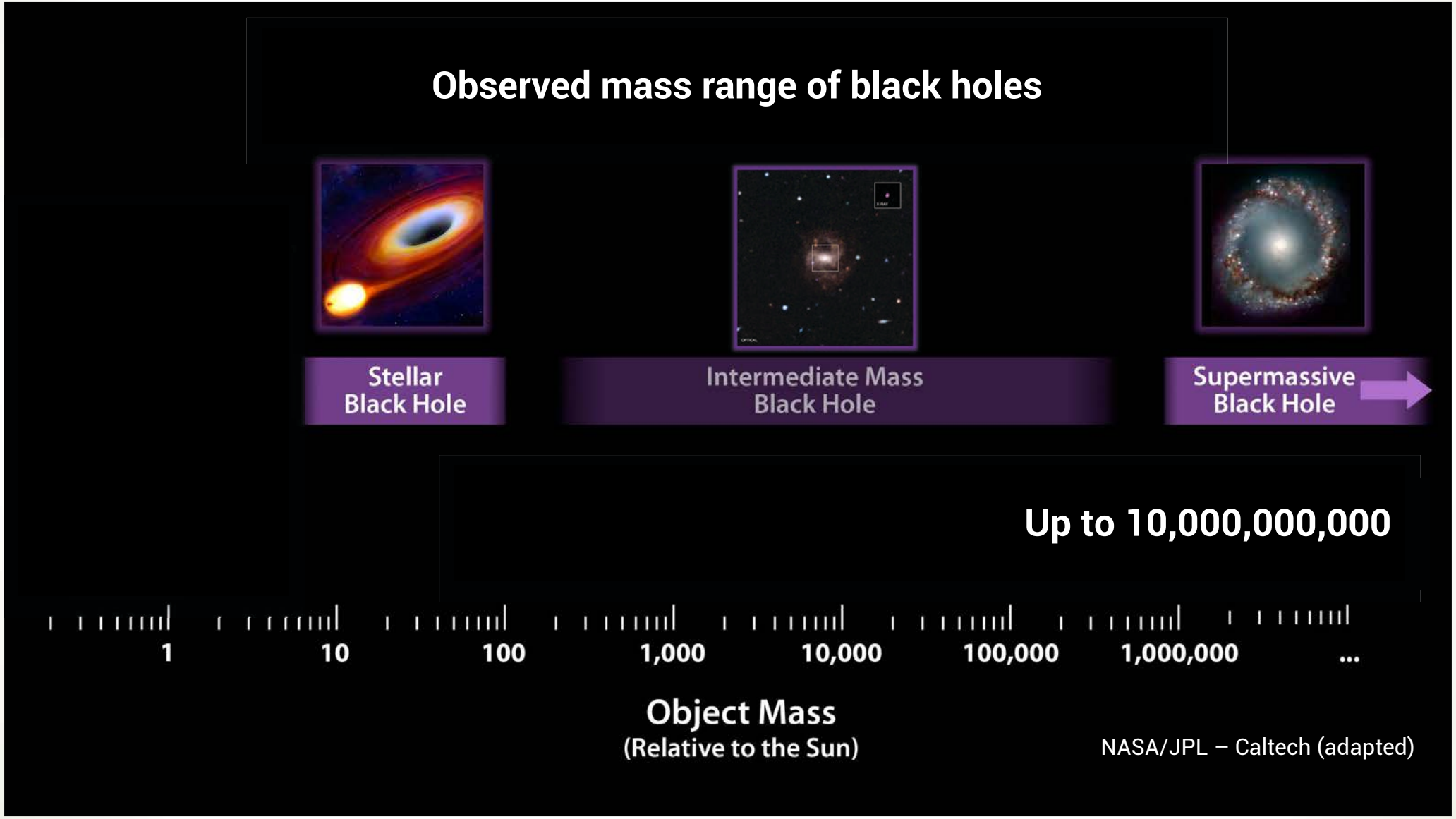
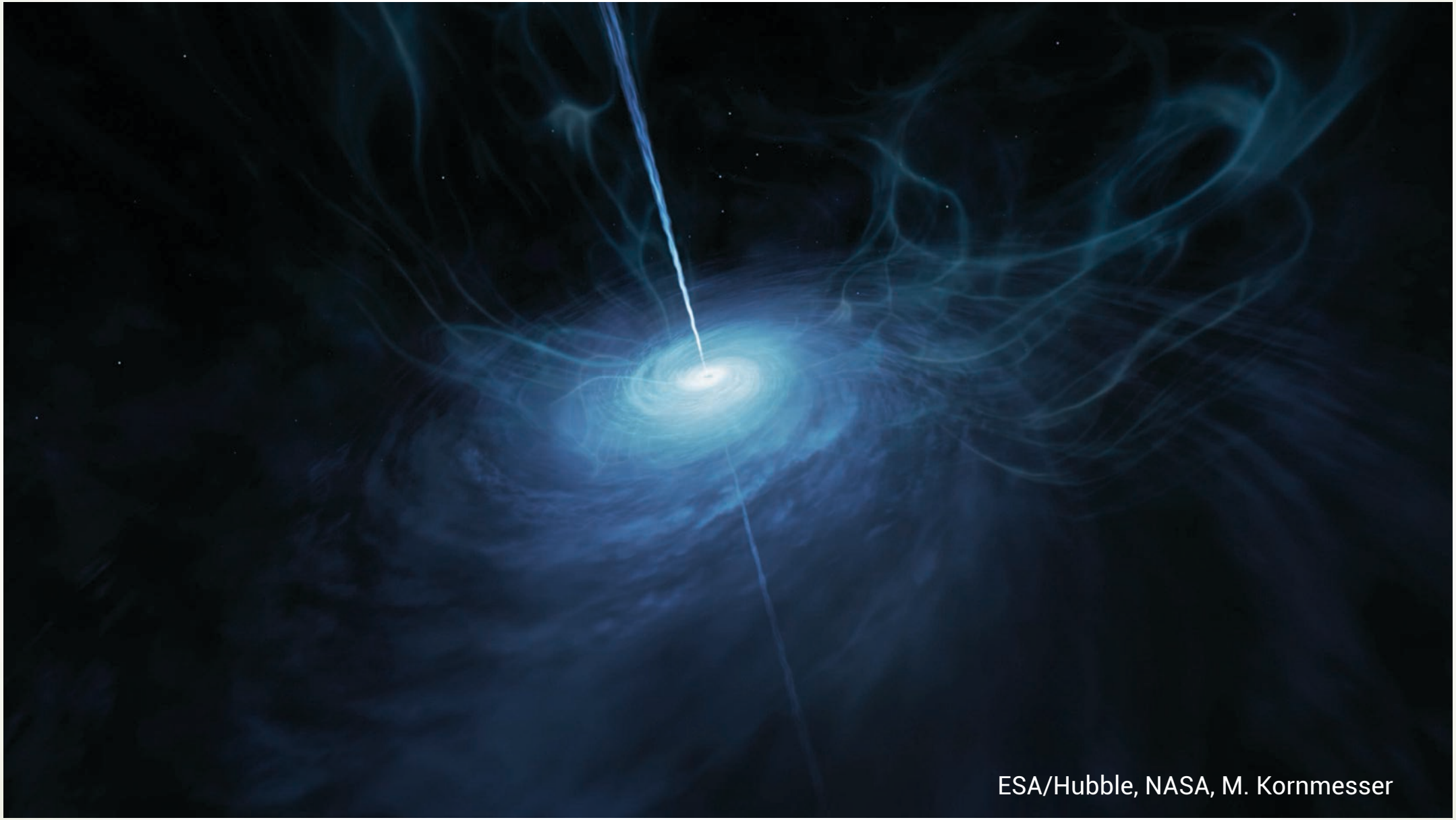
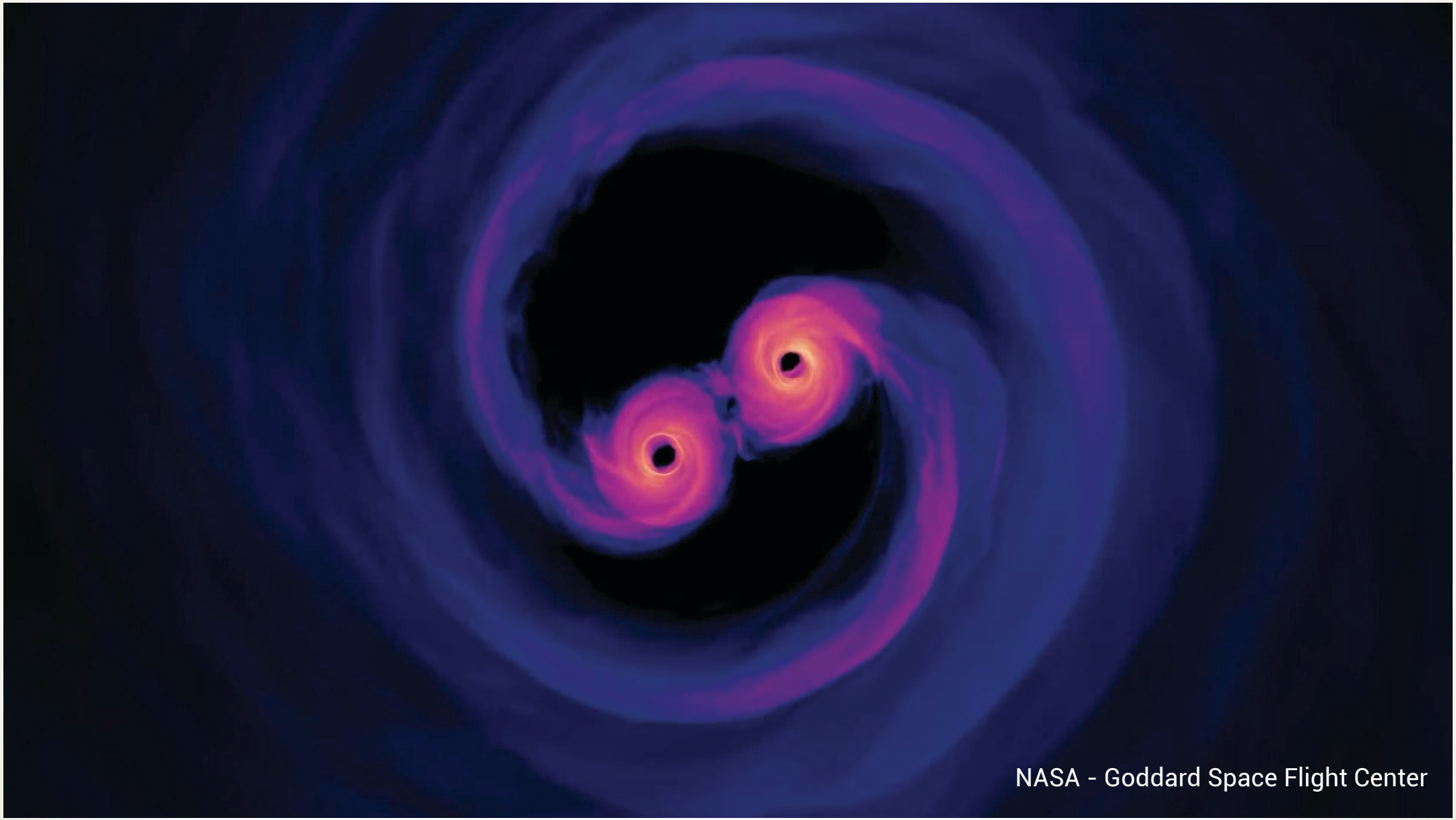
Black Holes Come of All Sizes



Growth by Accretion



Growth by Mergers



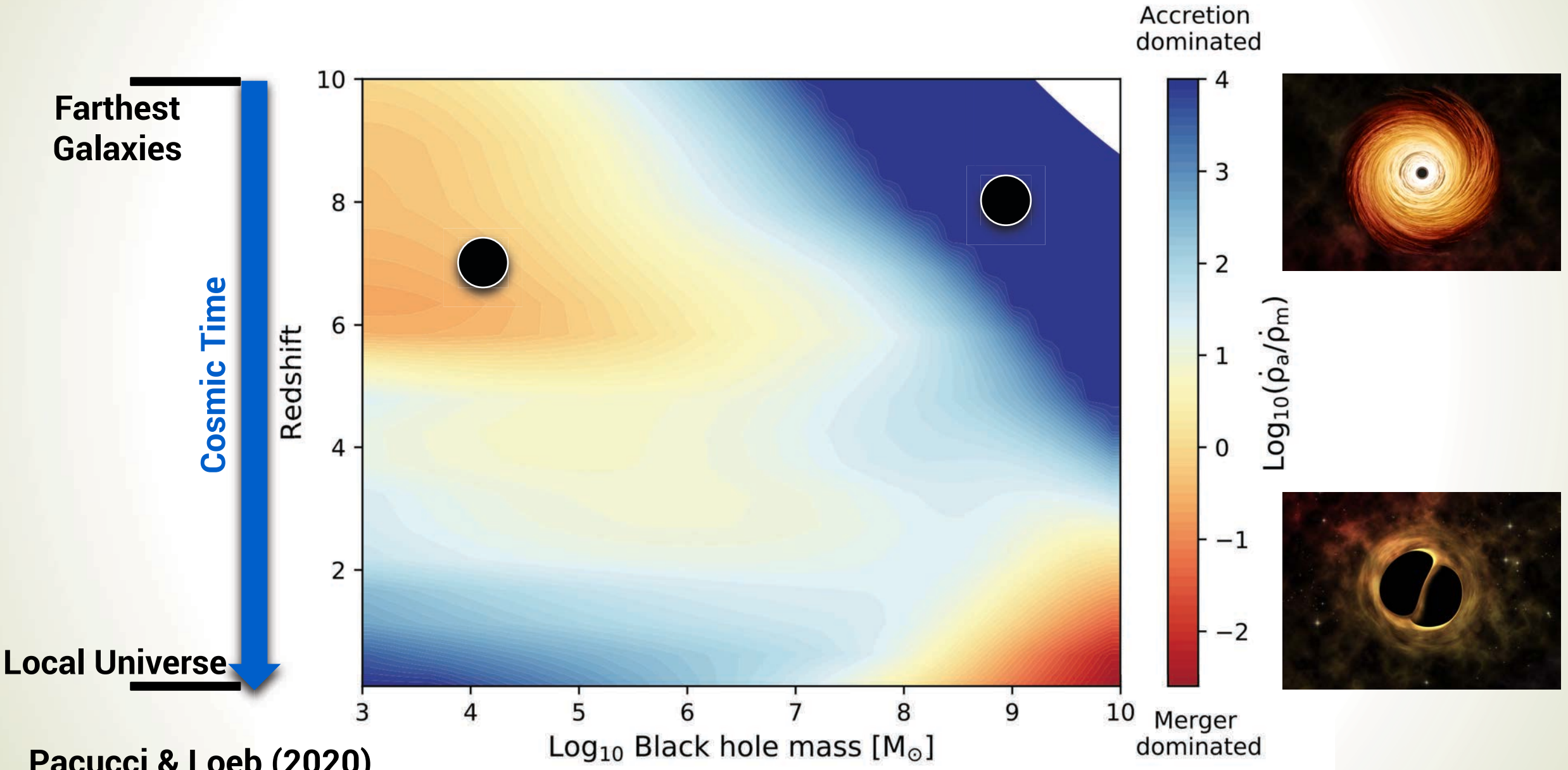
Accretion vs. Mergers Across Cosmic Time

FINAL GOAL

Determine the main growth channel as a function of:

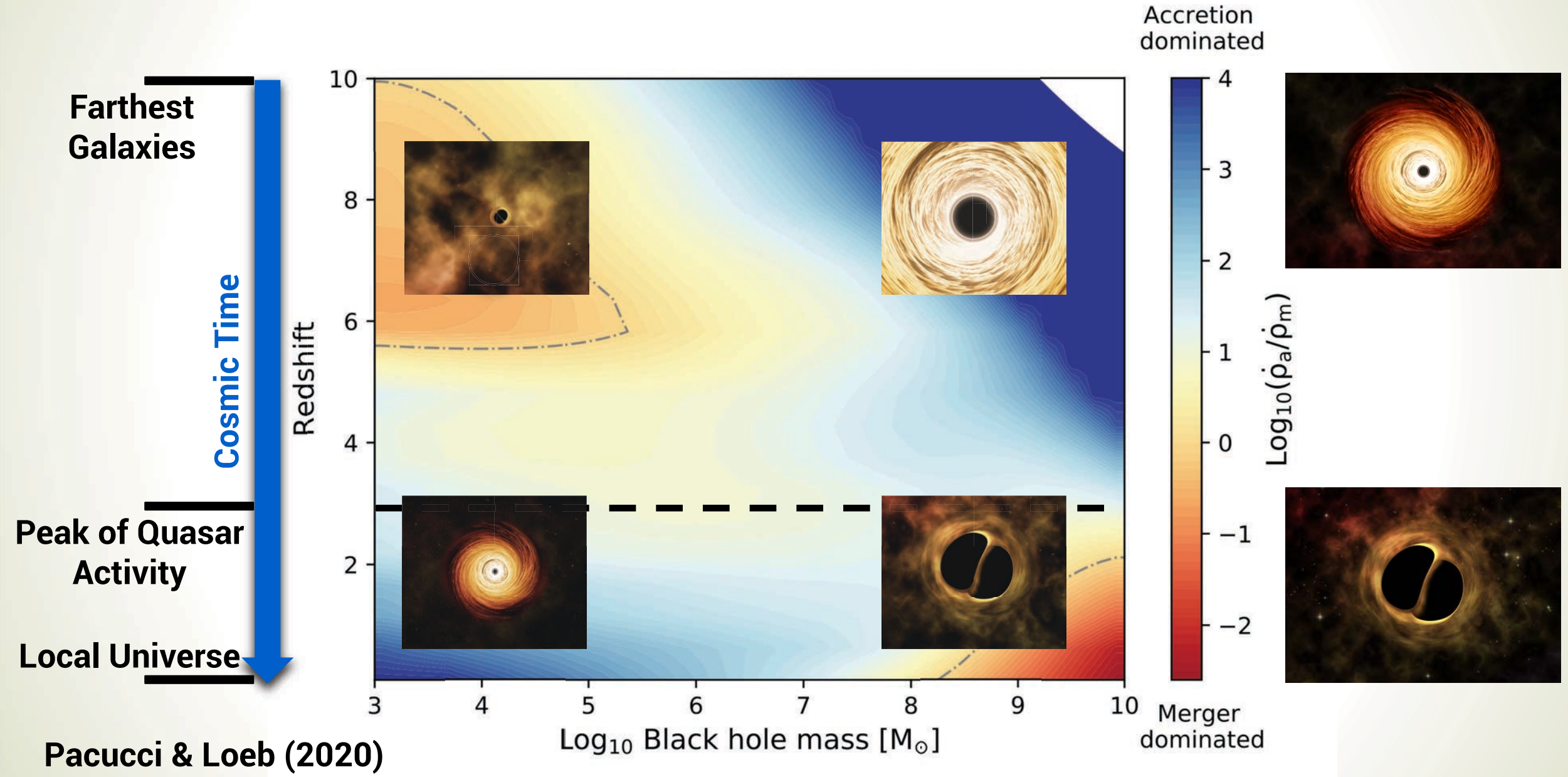
- **BLACK HOLE MASS**
- **REDSHIFT**

Accretion vs. Mergers Across Cosmic Time



Pacucci & Loeb (2020)

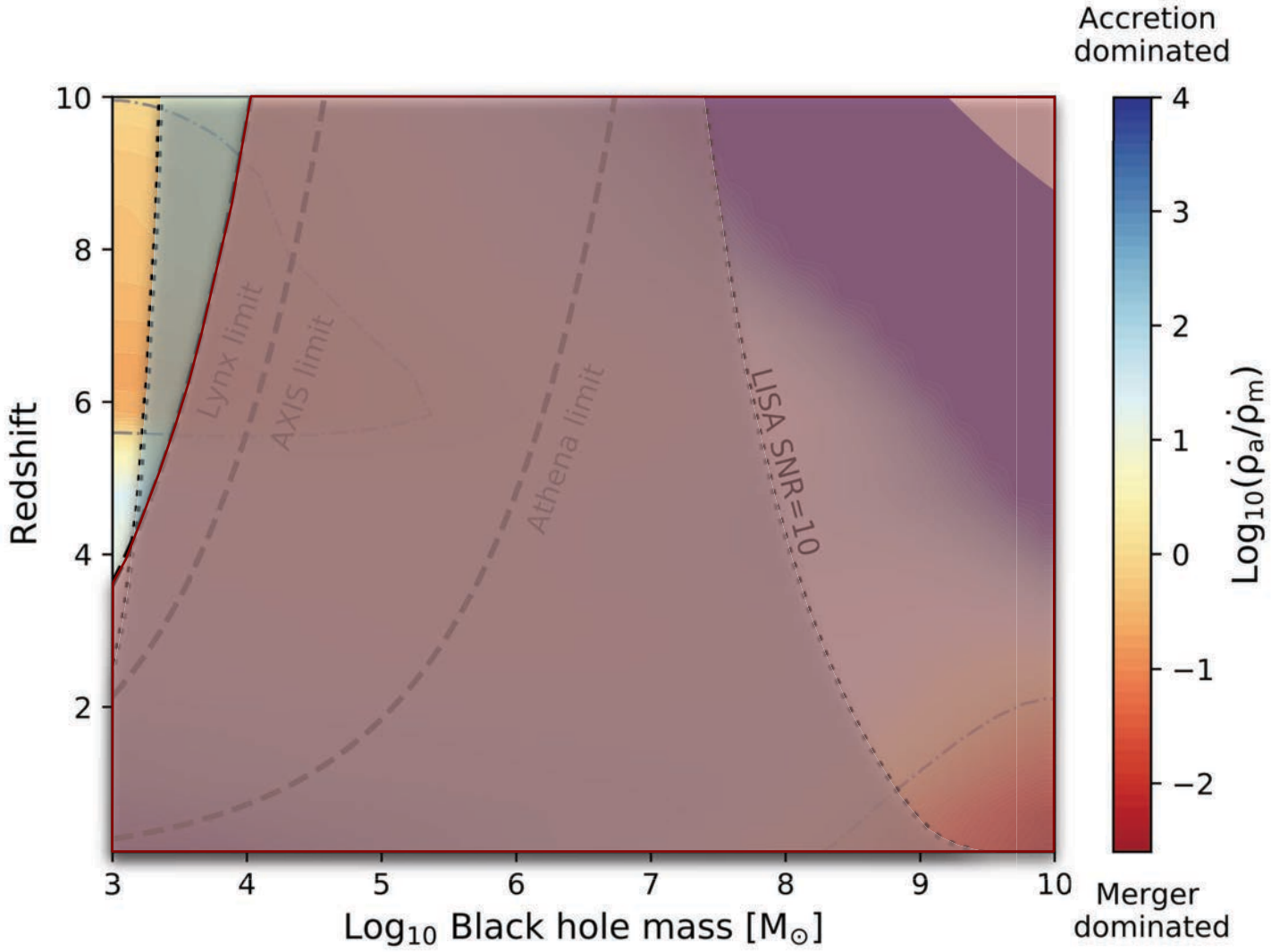
Accretion vs. Mergers Across Cosmic Time



Pacucci & Loeb (2020)

IMPLICATION #1

Growth Channel → Observation



Pacucci & Loeb (2020)

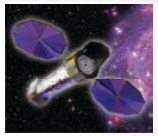
Future Space Observatories

GRAVITATIONAL WAVES to probe MERGERS

- **LISA**

X-RAYs to probe ACCRETION

- **Lynx**



- **AXIS**

- **Athena**

IMPLICATION #2

Accretion vs Mergers & Spin

GROWTH MOSTLY BY ACCRETION
Black hole is:

1) **Rapidly spinning:**

2) **More efficient in emitting radiation**

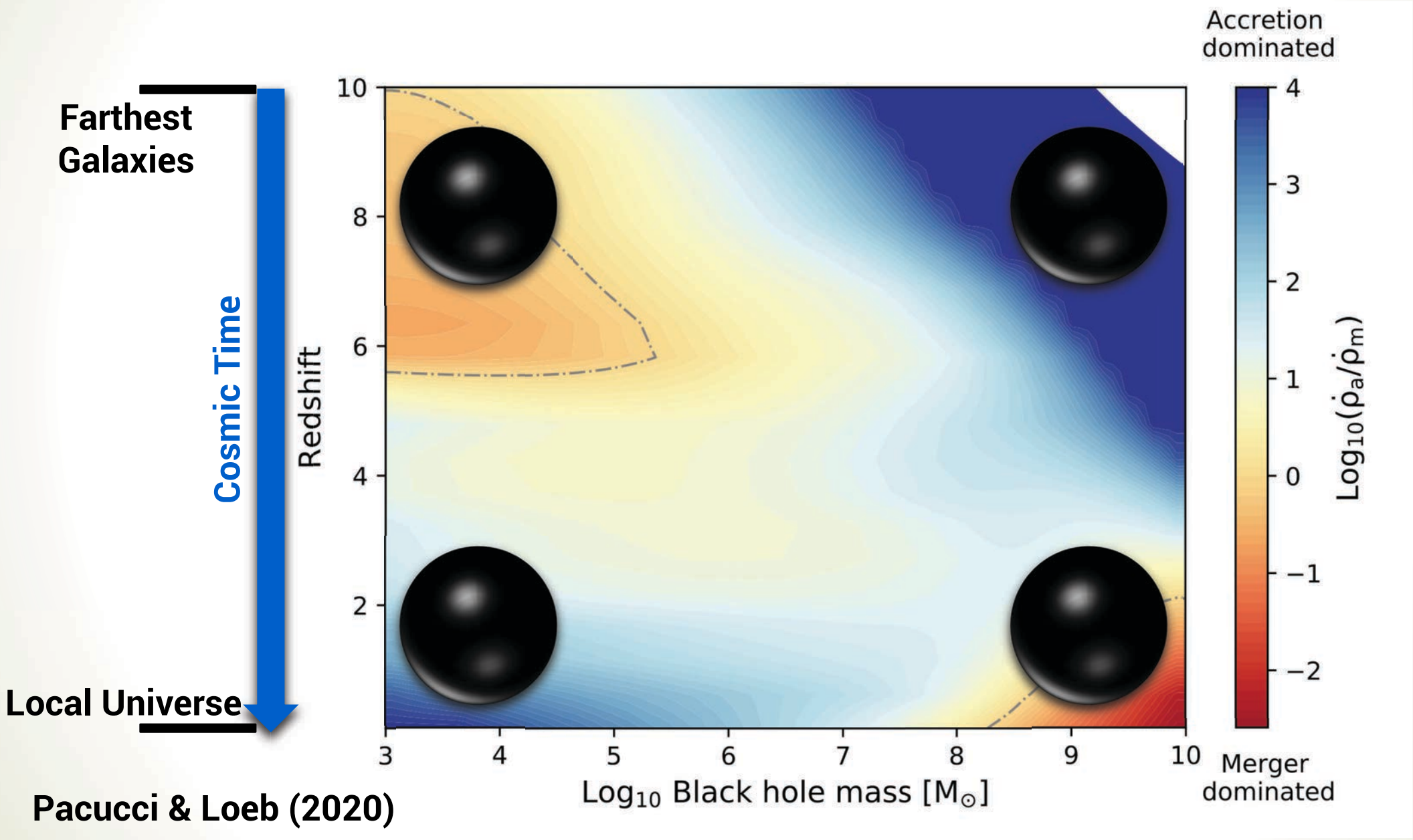
GROWTH MOSTLY BY MERGERS
Black hole is:

1) **Slowly spinning:**

2) **Less efficient in emitting radiation**

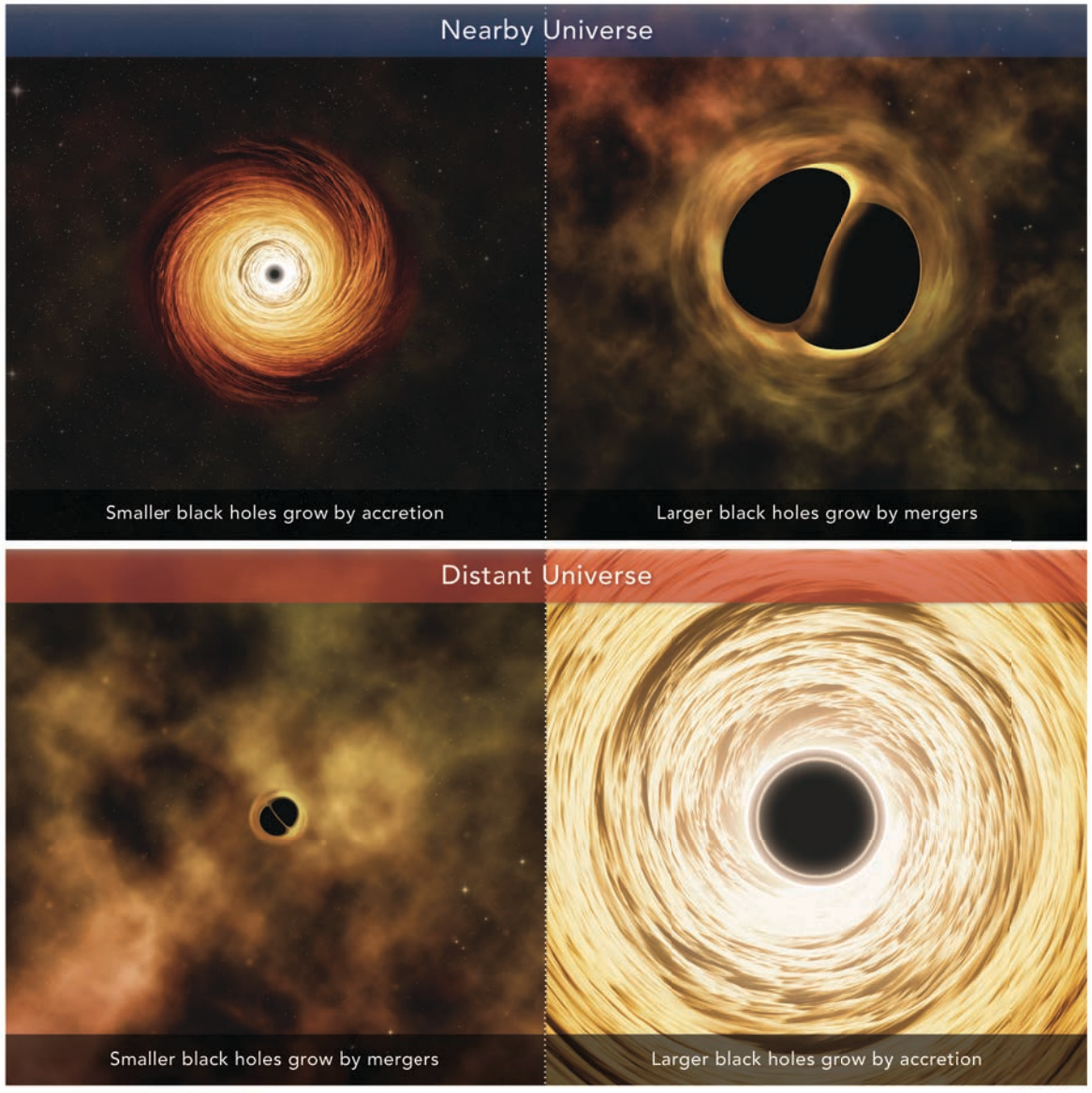
IMPLICATION #2

Accretion vs Mergers & Spin



Pacucci & Loeb (2020)

Takeaway Message



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