

Massimiliano Matteuzzi, Corso di Astrofisica, 03/03/2023

Lo zoo degli AGN parte IV

Super-unificazione AGN

Cosa vedremo stasera sugli AGN

Modello Super-Unificato

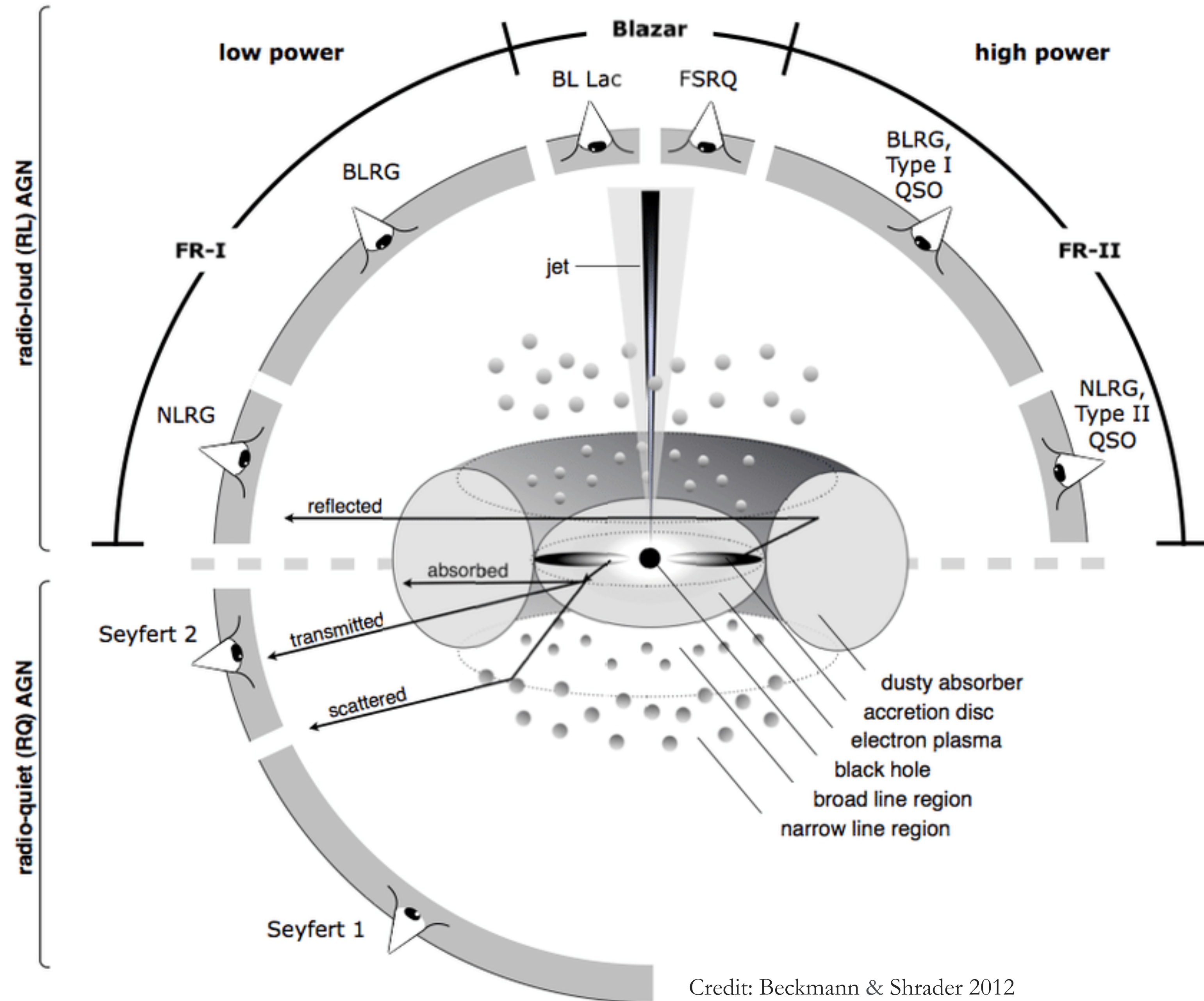


Formazione ed evoluzione



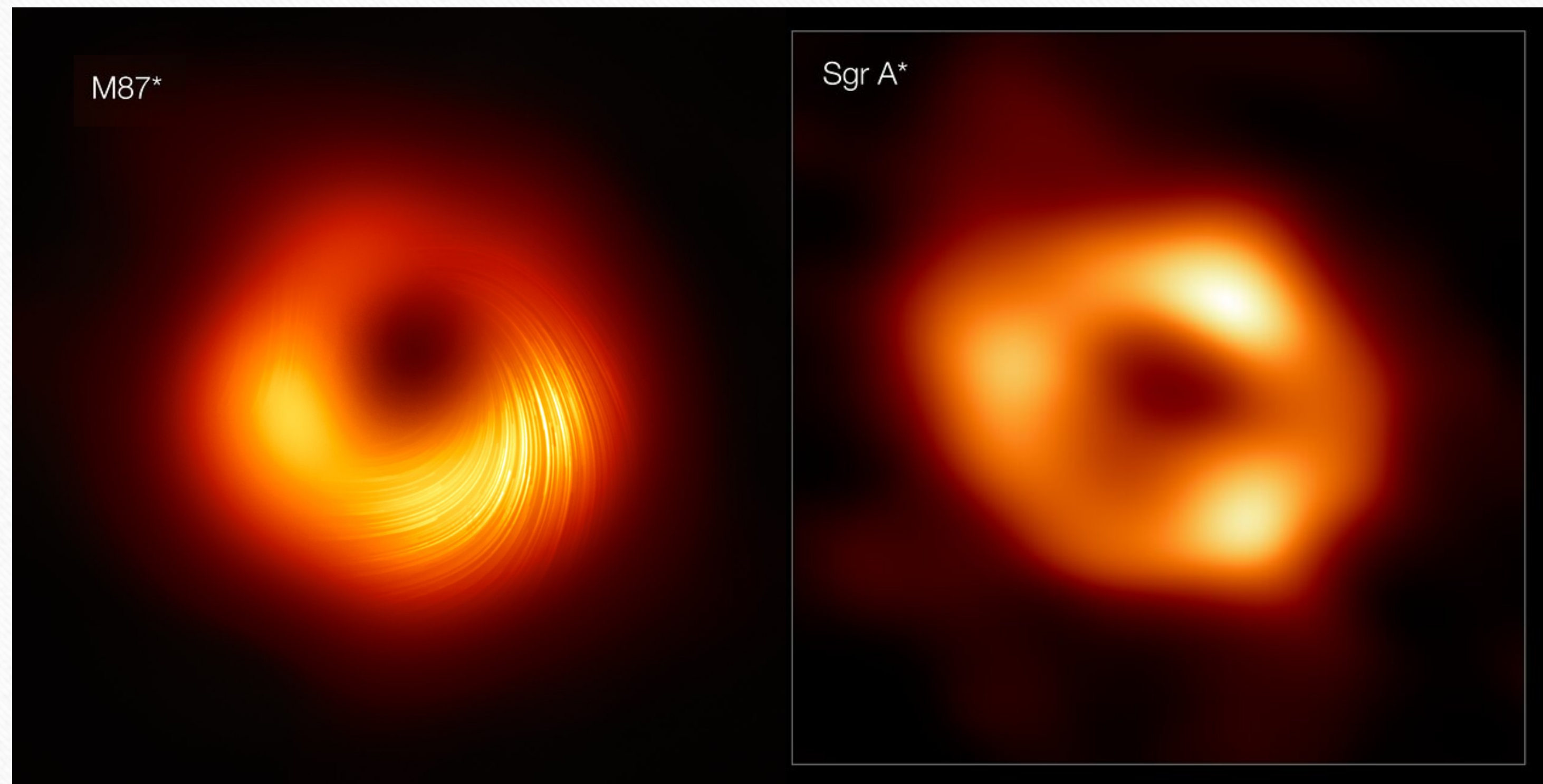
Impatto sull'ambiente circostante

Modello Unificato degli AGN



Credit: Beckmann & Shrader 2012

Buchi neri supermassicci!

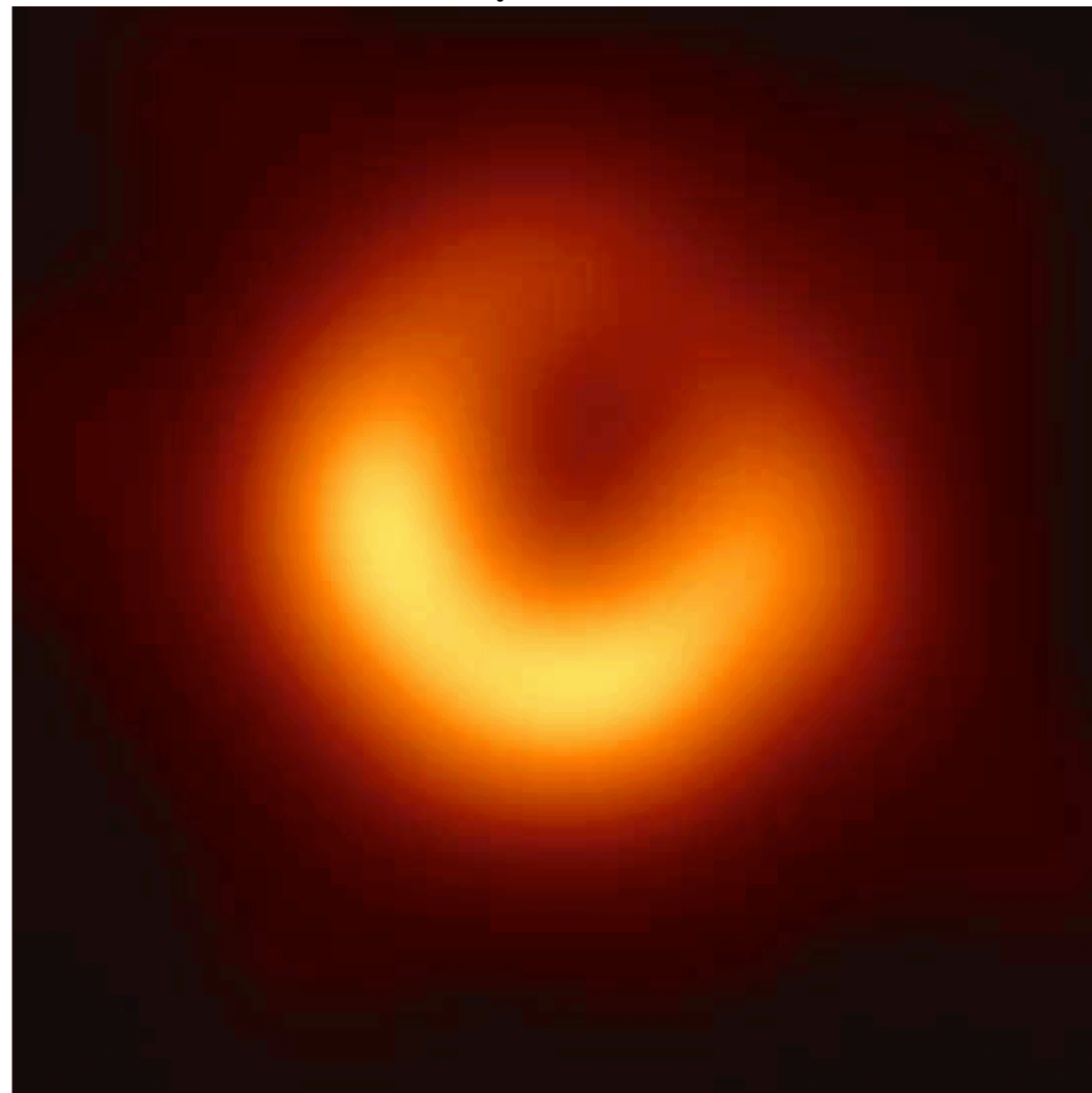


- Buco nero:
regione in cui $v_{\text{fuga}} > c$;
- Prime prove dirette di
SMBHs;
- Co-evoluzione
SMBH — galassia.

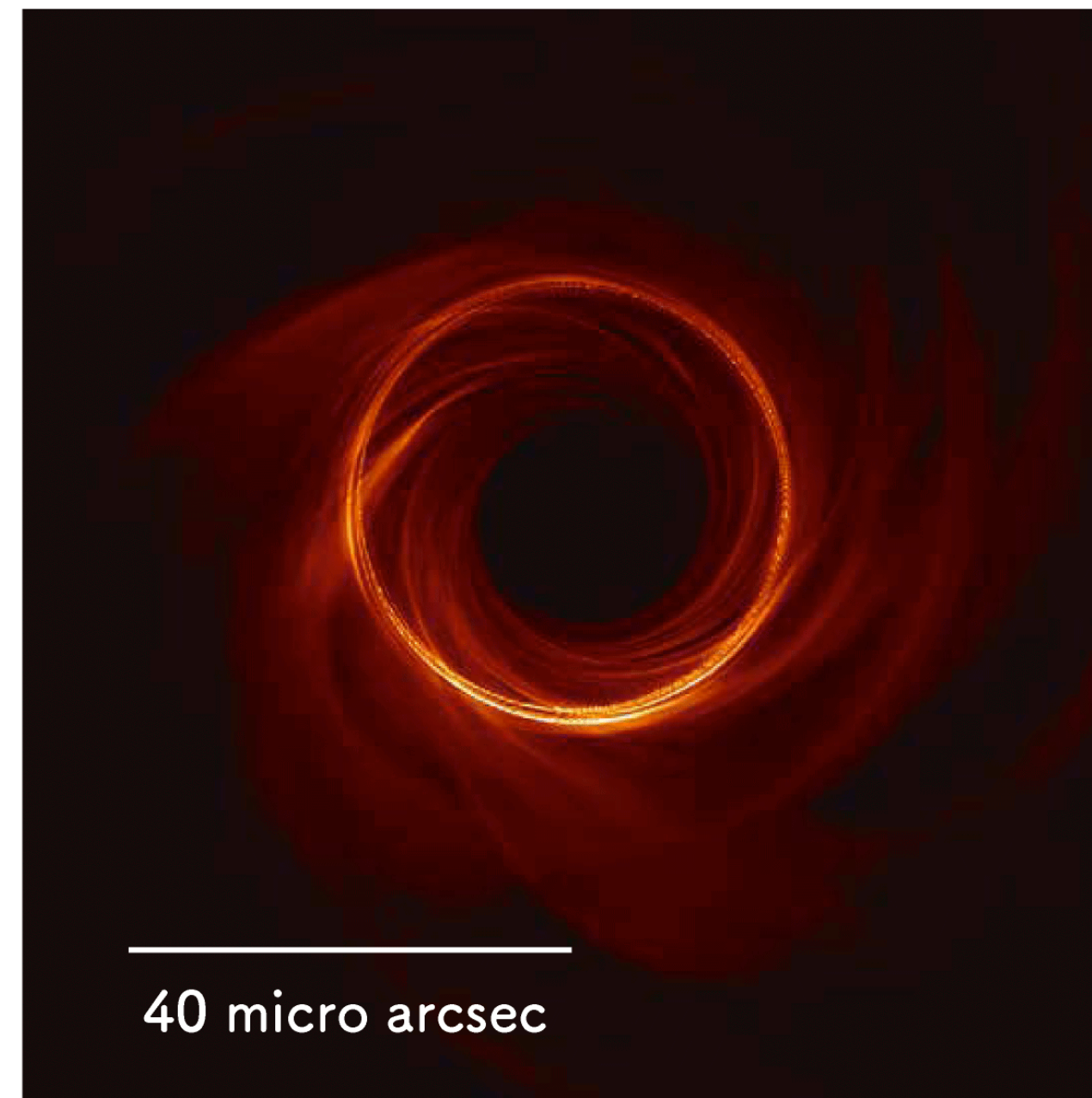
Credit: EHT Collaboration

Buchi neri supermassicci?

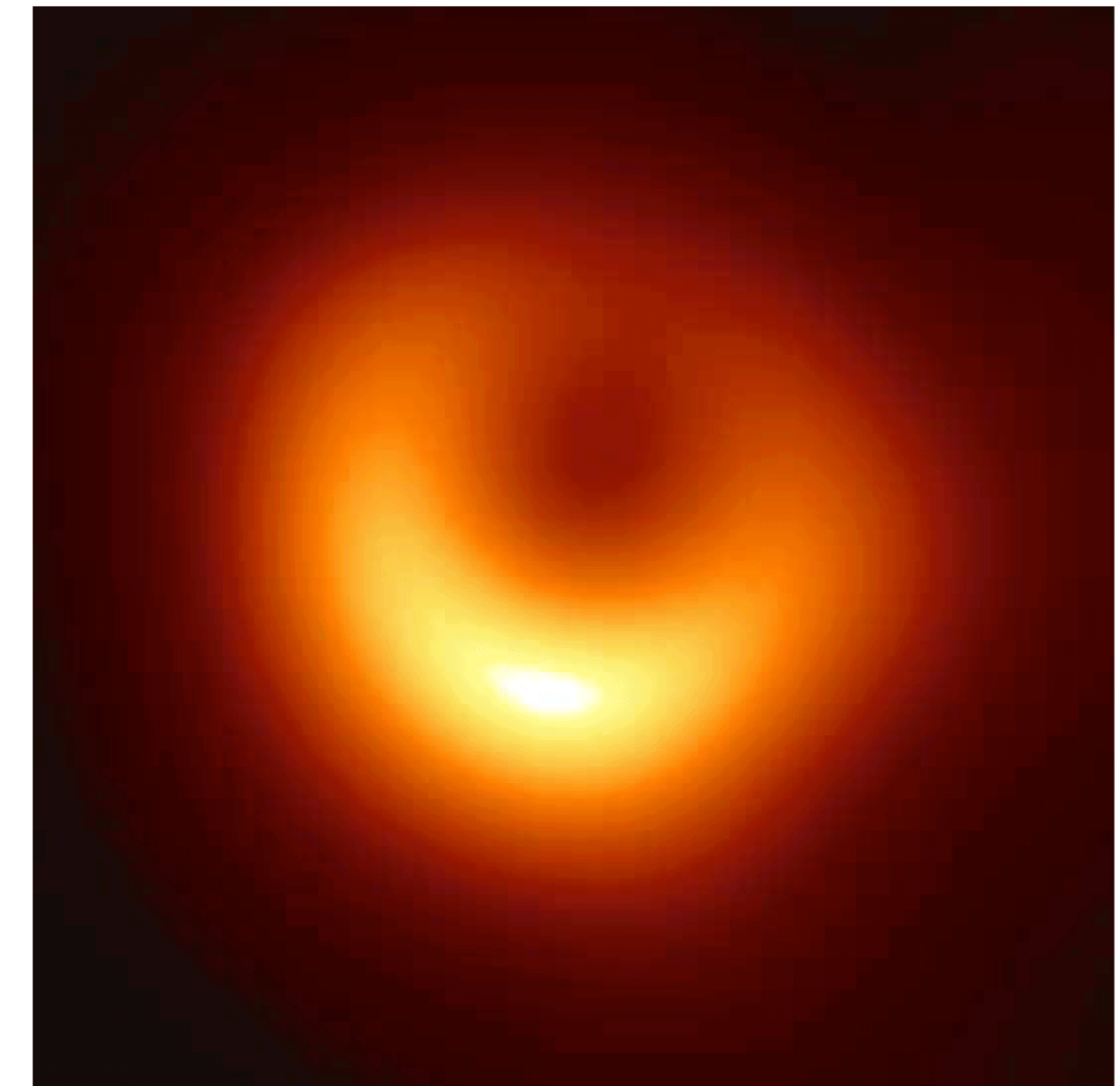
M87 (Apr 6. 2017)



Simulation

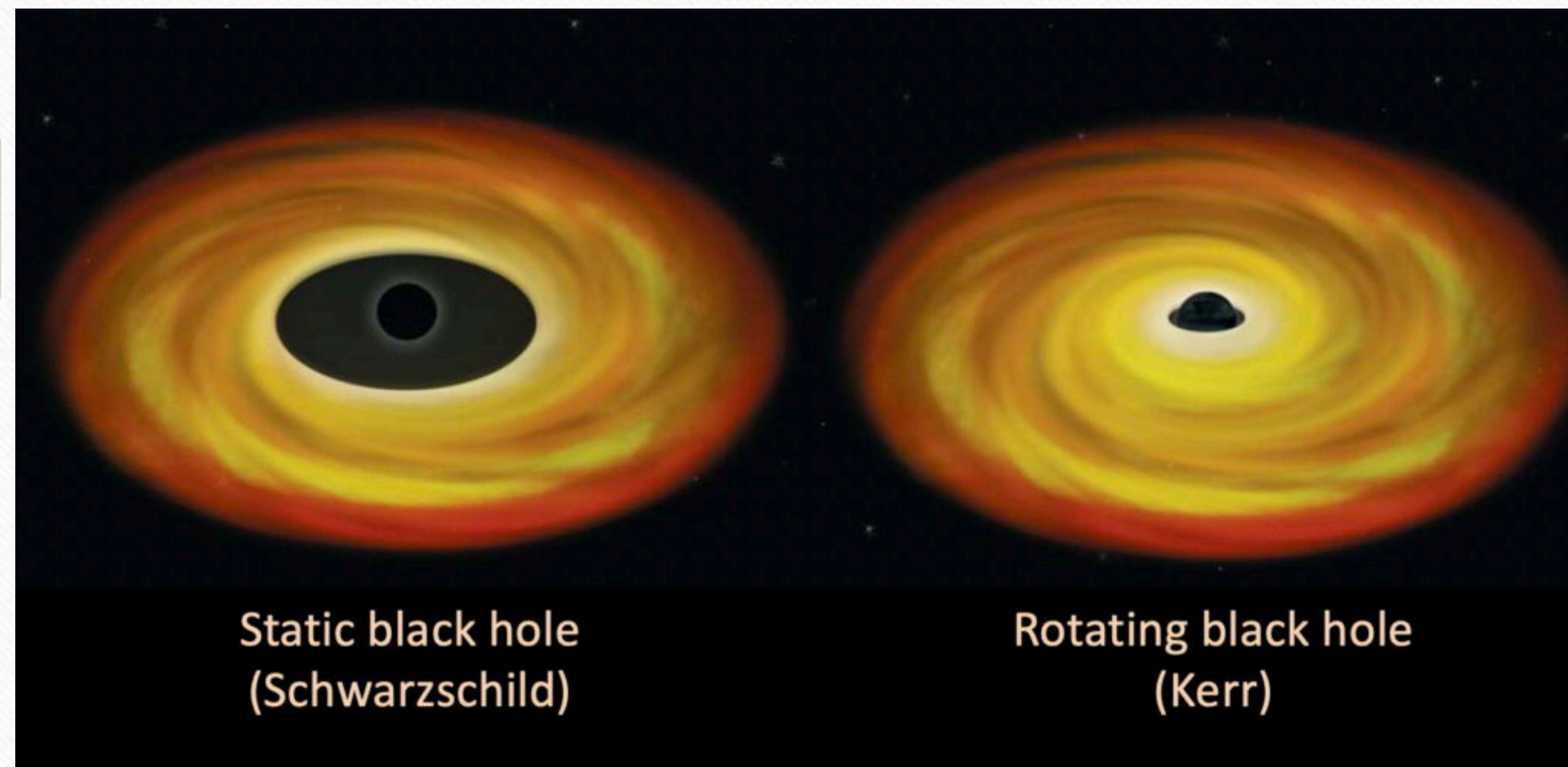


Blurred Simulation

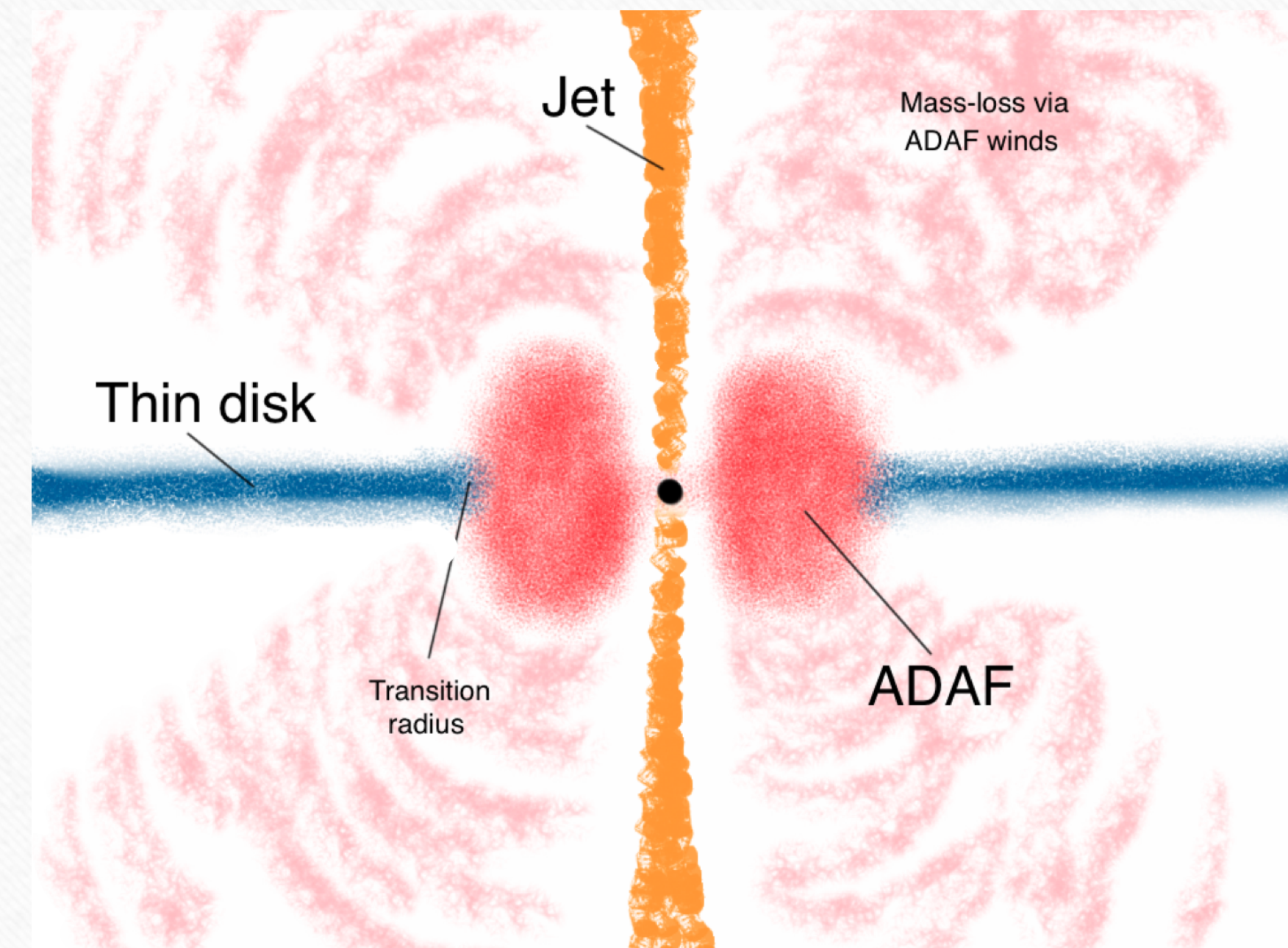


Credit: EHT Collaboration

Disco di accrescimento

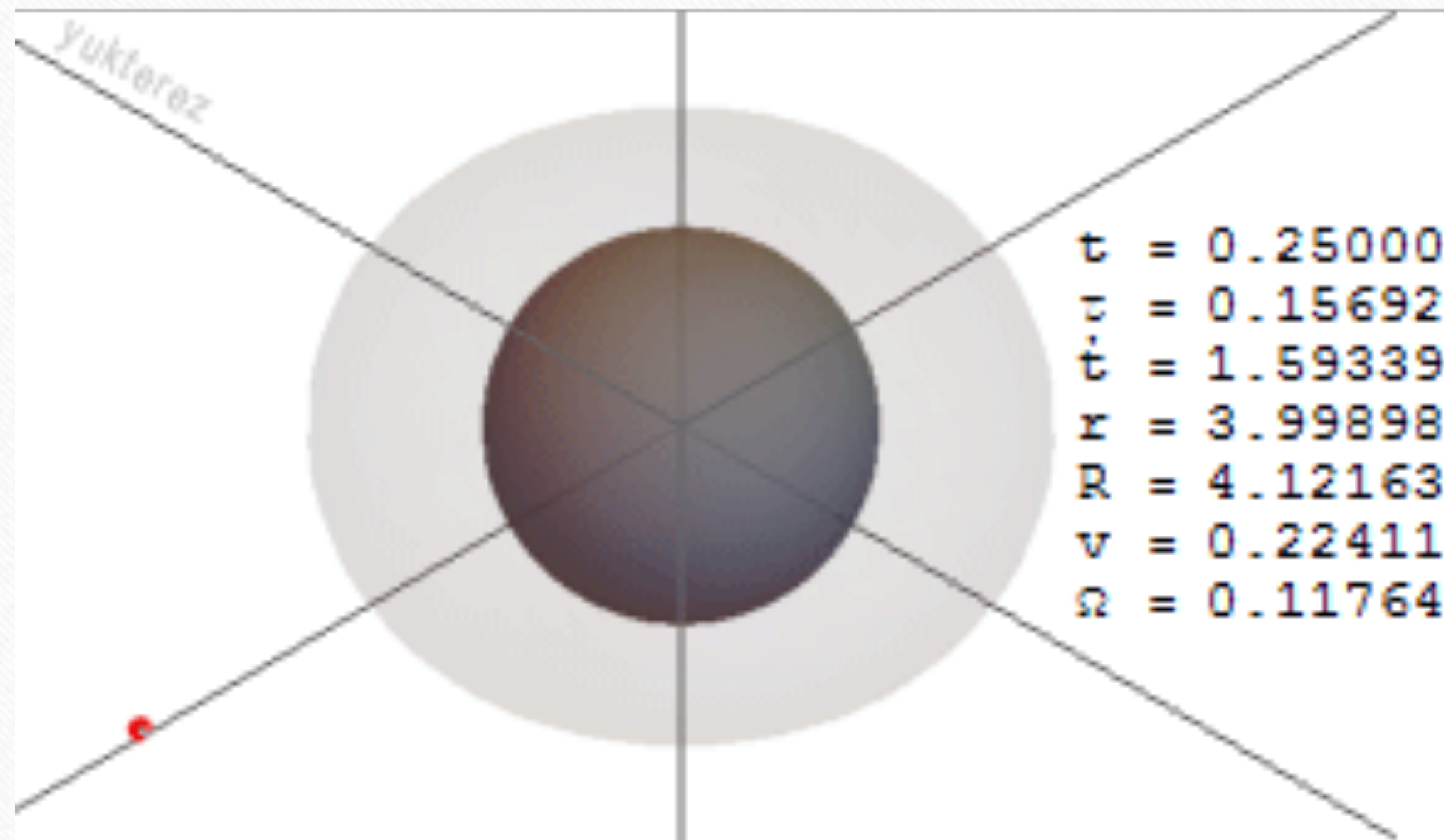


Credit: Jean-Pierre Luminet



Credit: Nemmen et al. 2014

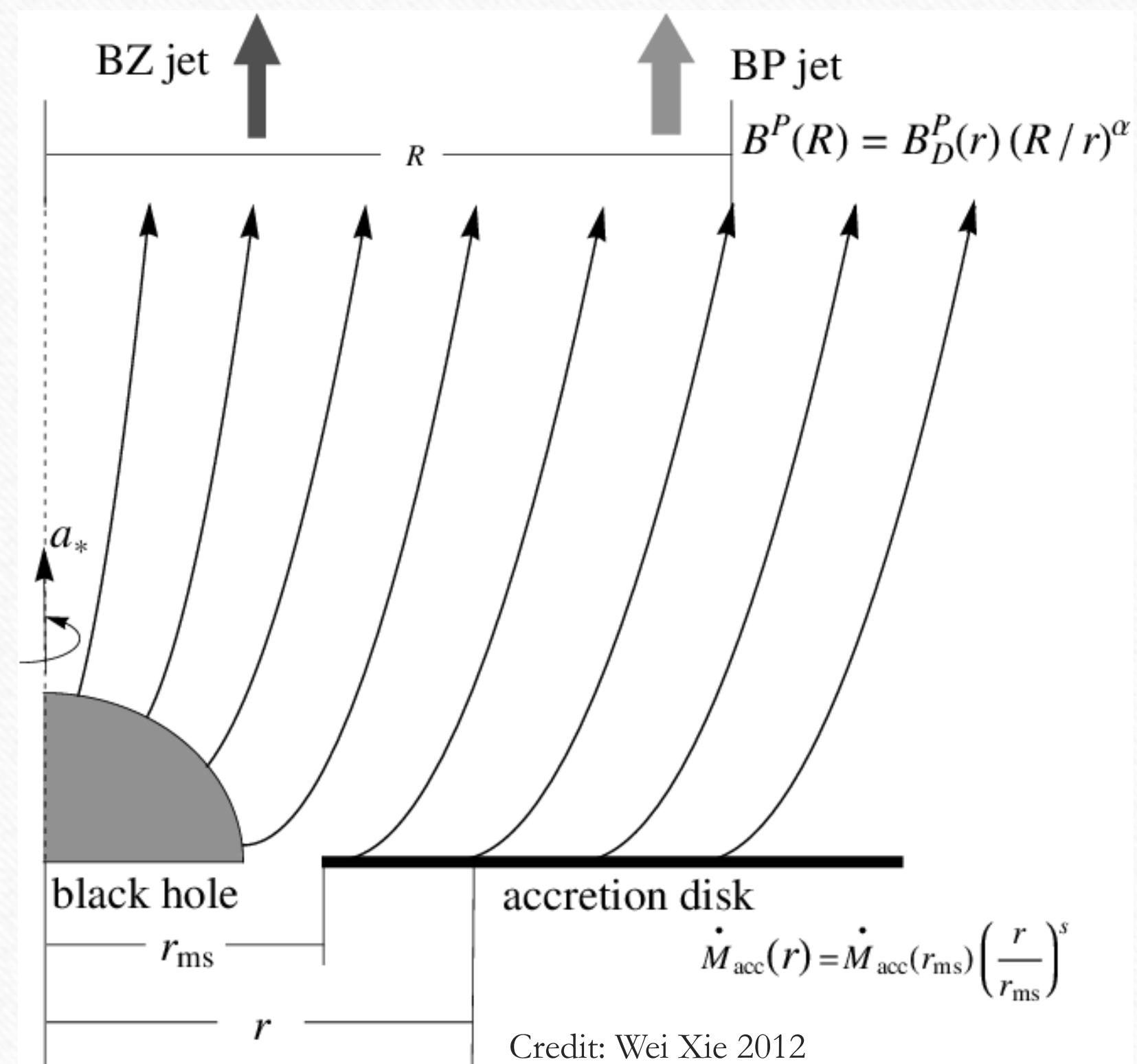
Buchi neri rotanti ed ergosfera



Credit: Simon Tyran

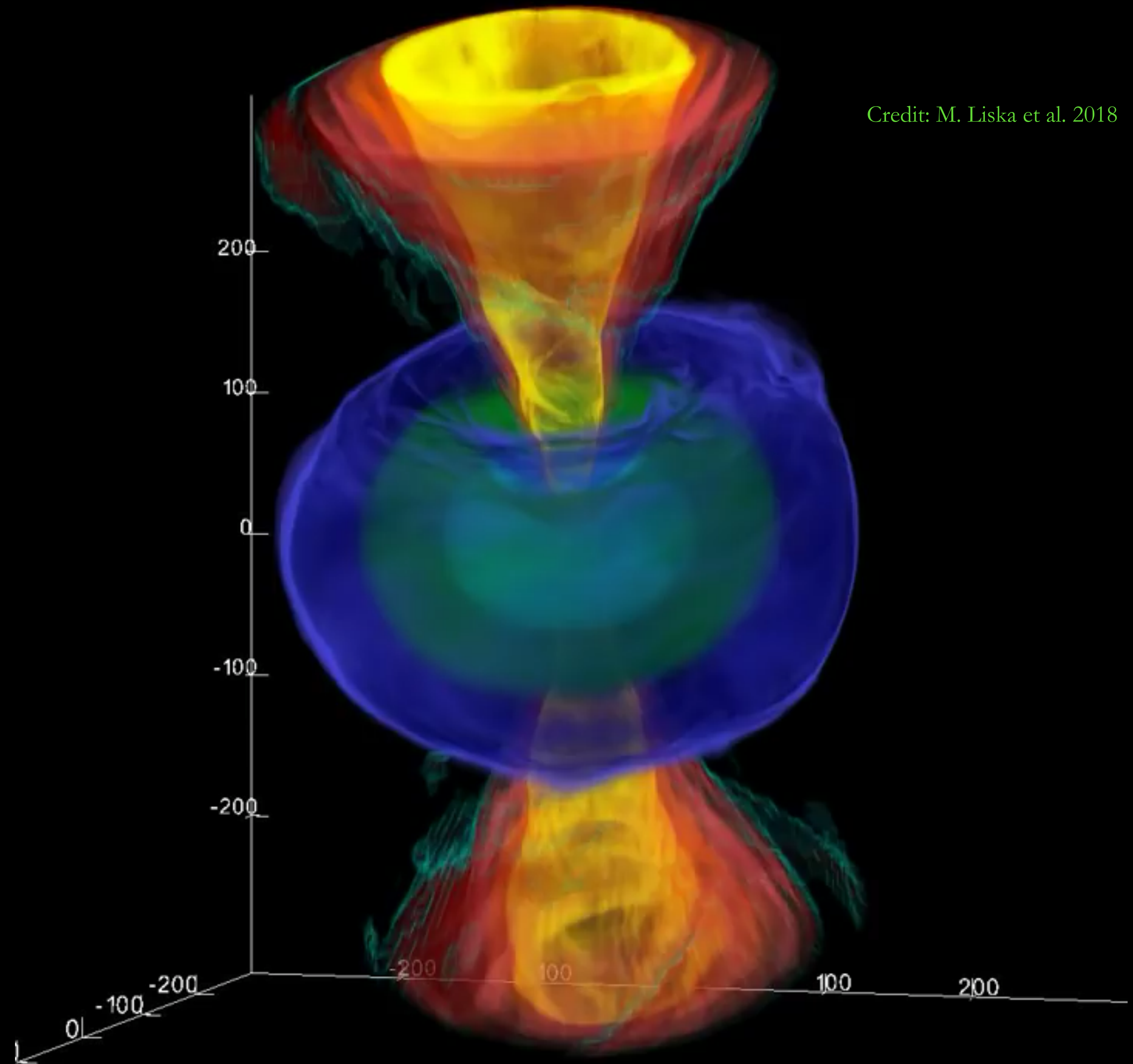
- Rotational frame-dragging: trascinamento dello spazio-tempo;
- Dall'ergosfera si può scappare, ma non rimanere statici;
- Processo di Penrose: energia prelevata dal SMBH.

Formazione dei getti relativistici



- Processo BZ (getti):
campo magnetico preleva energia dal BH e crea torre magnetica (spin BH importante);
- Processo BP (venti):
campo magnetico preleva energia dal disco (spin BH poco importante);
- Processo Meier: combinazione di entrambi.

Magneto- idrodinamica 3D in Relatività Generale



Super-unificazione degli AGN

- Esistono AGN intrinsecamente diversi (per esempio FR-I e FR-II);
- Proprietà necessarie: M_{BH} , $\dot{M}_{\text{BH}}$, spin, verso di rotazione e prospettiva.



Disco controrotante:
AGN radio-loud
(FR-I, FR-II, Blazar , ...)

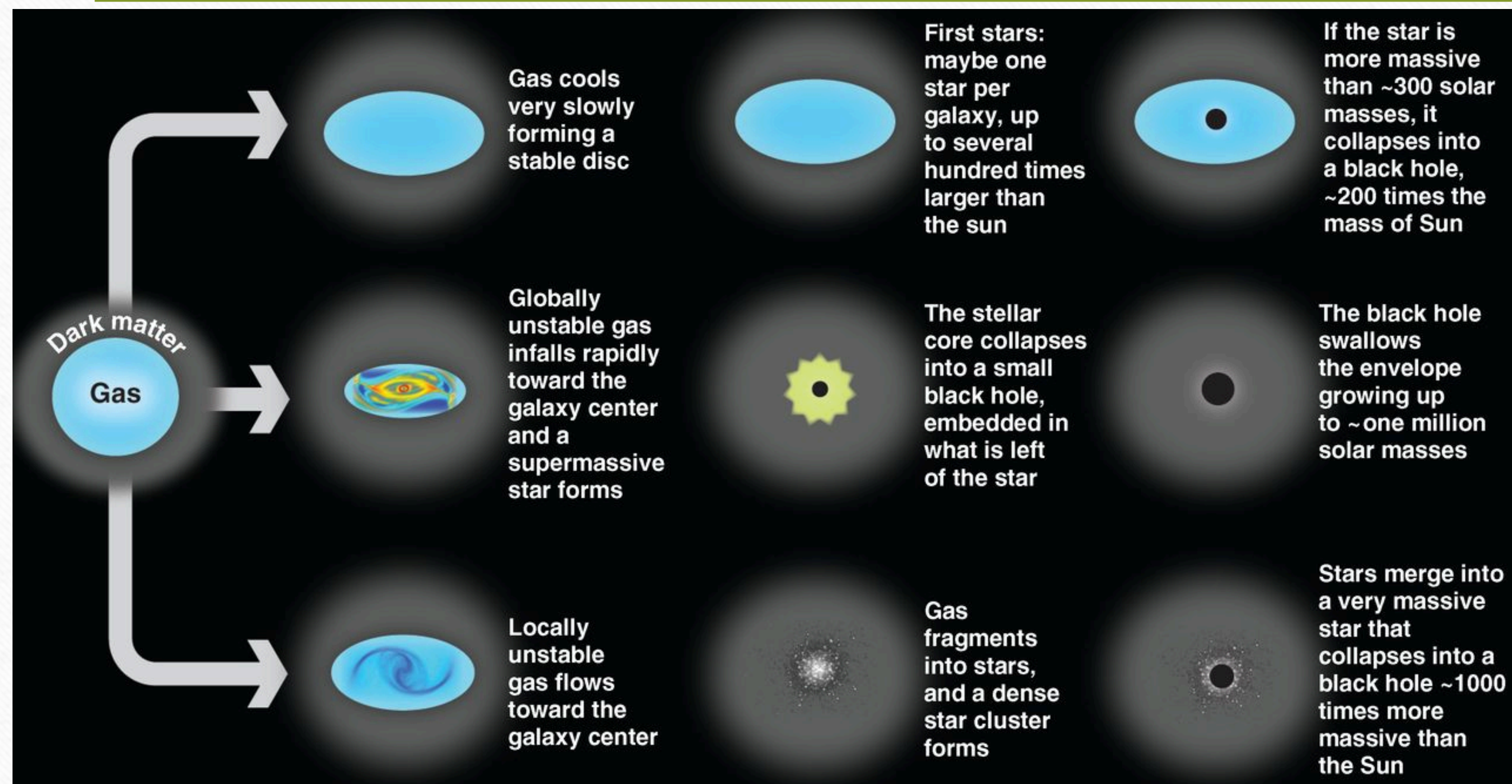


Disco corotante:
AGN radio-quiete
(Seyfert, QSO, ...);

Super-unificazione degli AGN

- A parità di spin, maggiore è l'accrescimento, maggiore sarà la luminosità;
- FR-I e BL Lac: disco controrotante, basso accrescimento;
- FR-II e FSRQ: disco controrotante, alto spin, alto accrescimento;
- Seyfert: disco corotante (spin e accrescimento alti non creano getti stabili).

“Seed” di formazione dei SMBHs



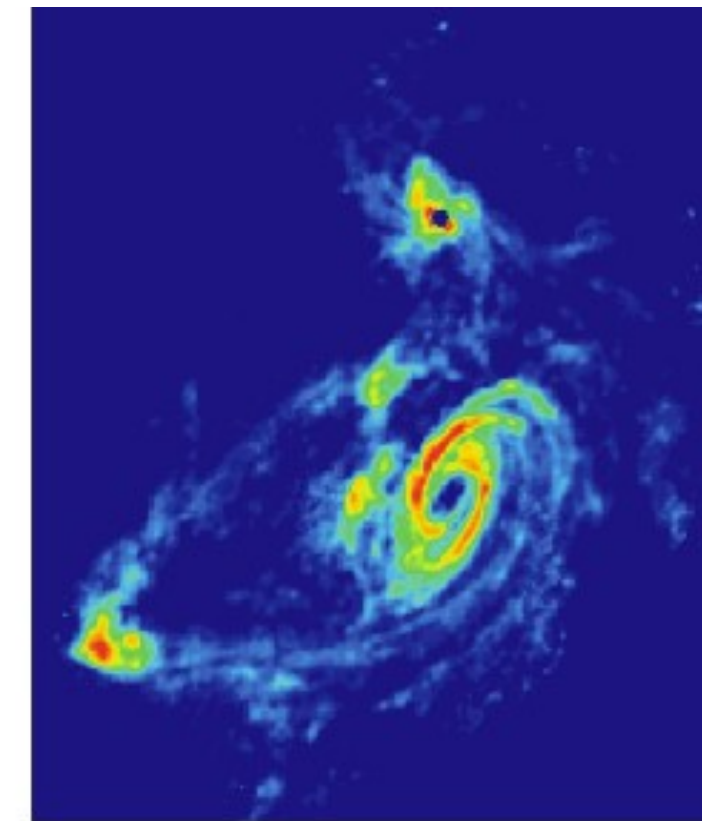
- Canali di formazione dei SMBHs;
- Conteggio di AGN: vincolo per la cosmologia.

Credit: Volonteri 2012

Formazione FR-II: fusione di galassie



(a)



(b)



(c)



(d)



(e)



(f)

Credit: NASA

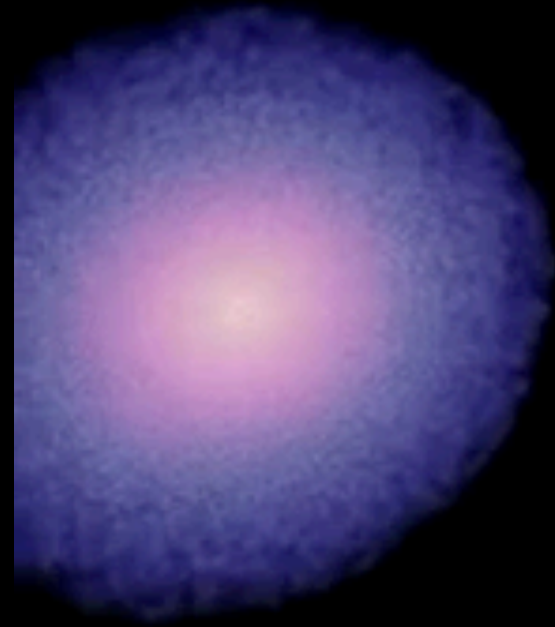
T = 0 Myr

Gas

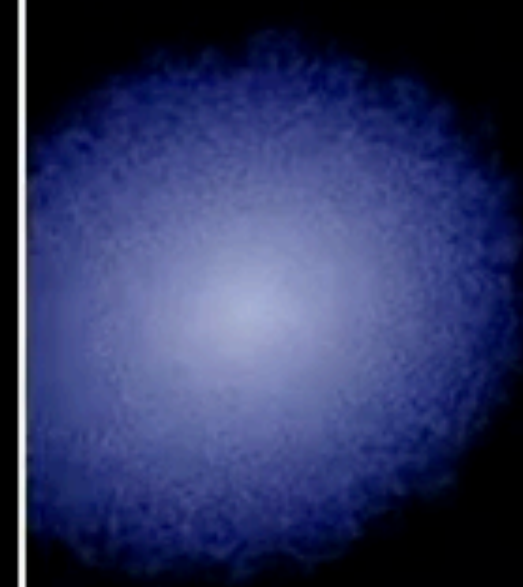


T = 0 Myr

Stars



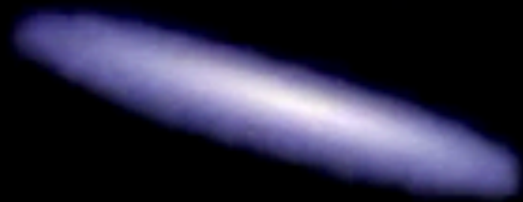
face on view



face on view

T = 0 Myr

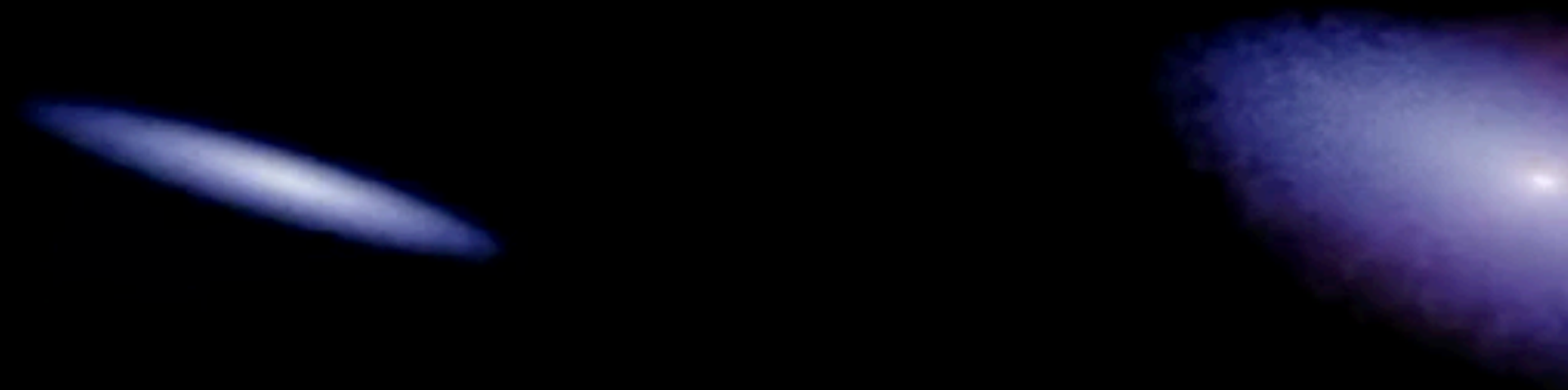
Gas



edge on view

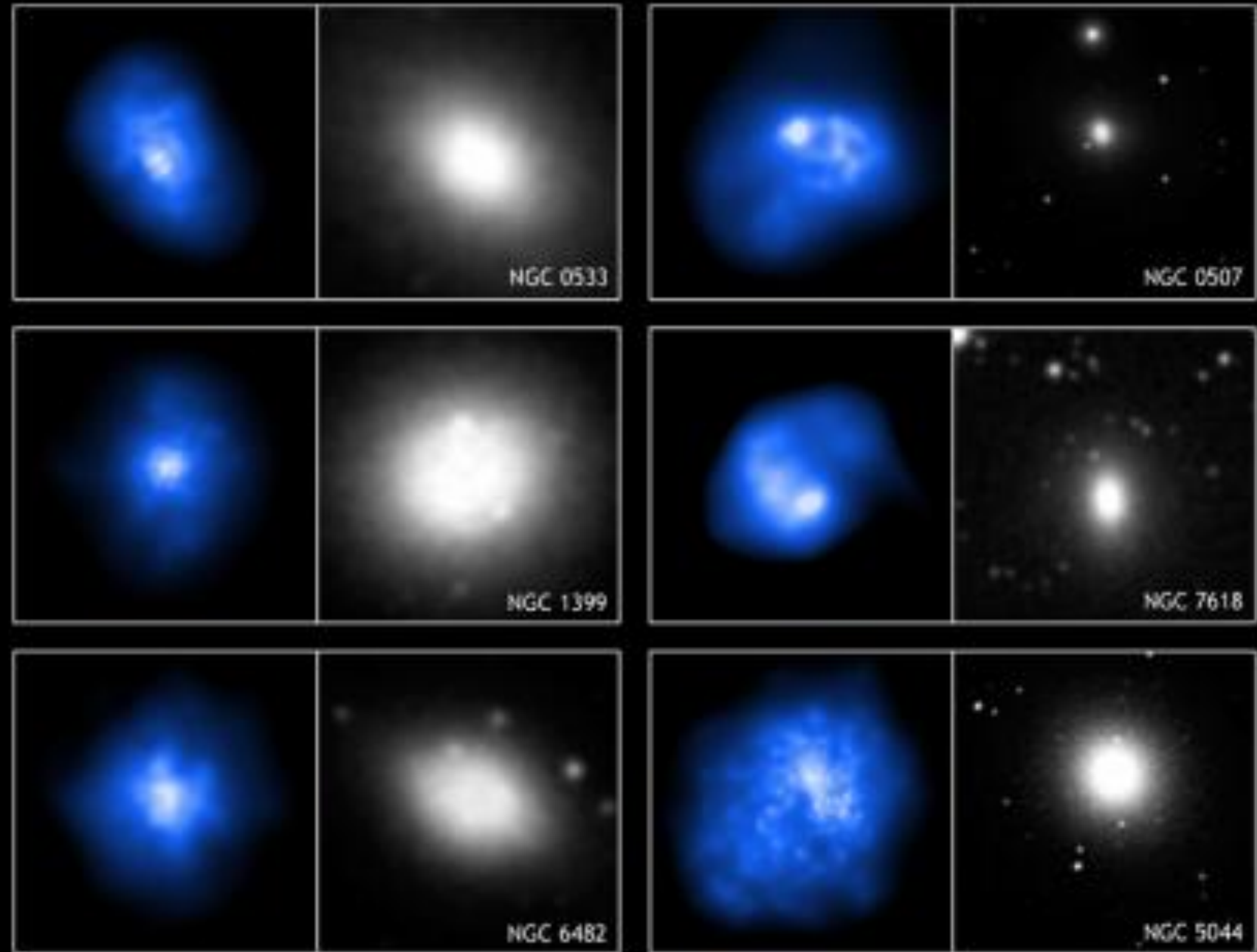
T = 0 Myr

Stars



edge on view

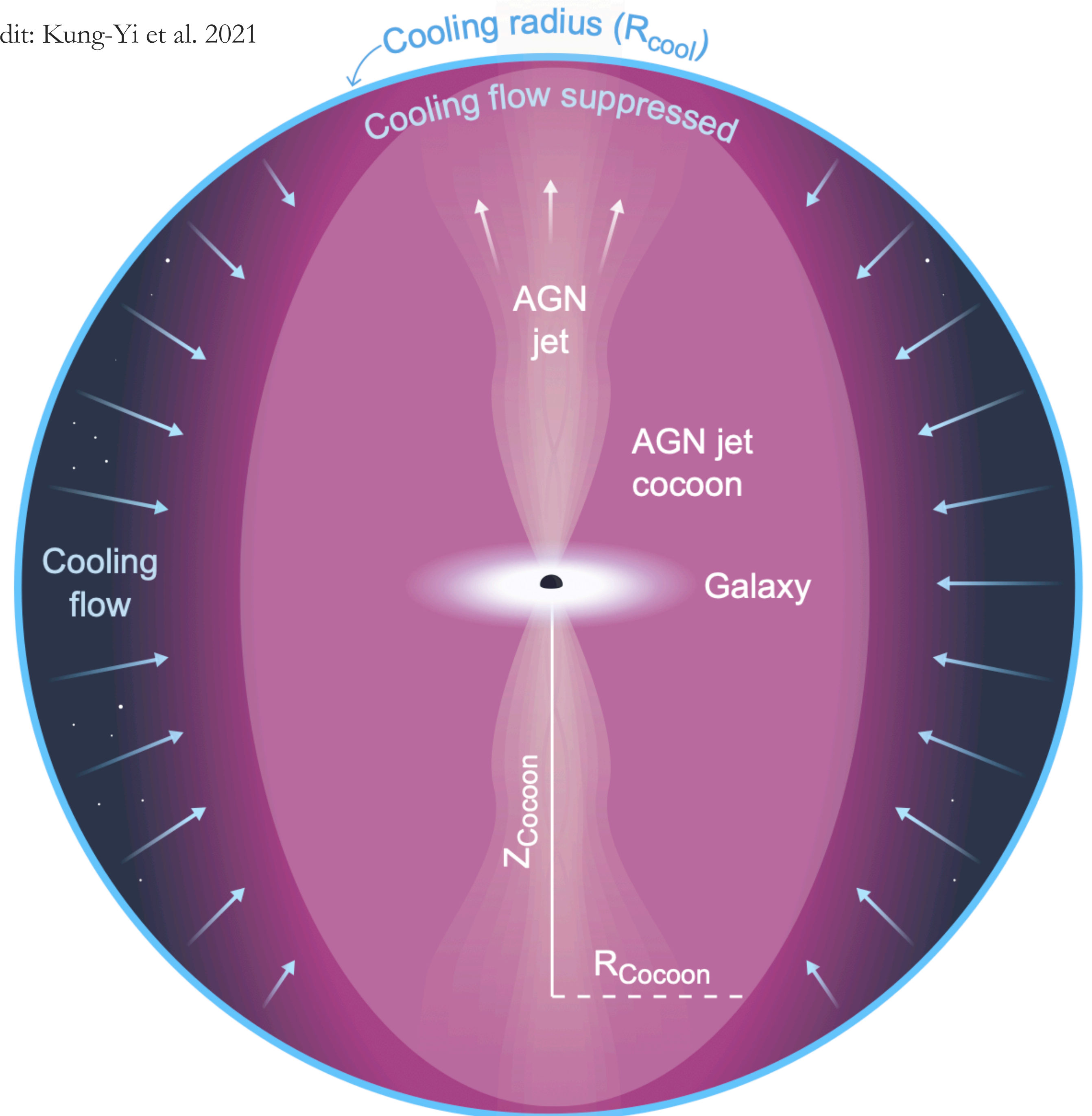
Formazione FR-I: inflow di gas caldo



Credit: NASA

Formazione FR-I:
inflow di gas caldo

Credit: Kung-Yi et al. 2021



Feedback da AGN: Cavità X

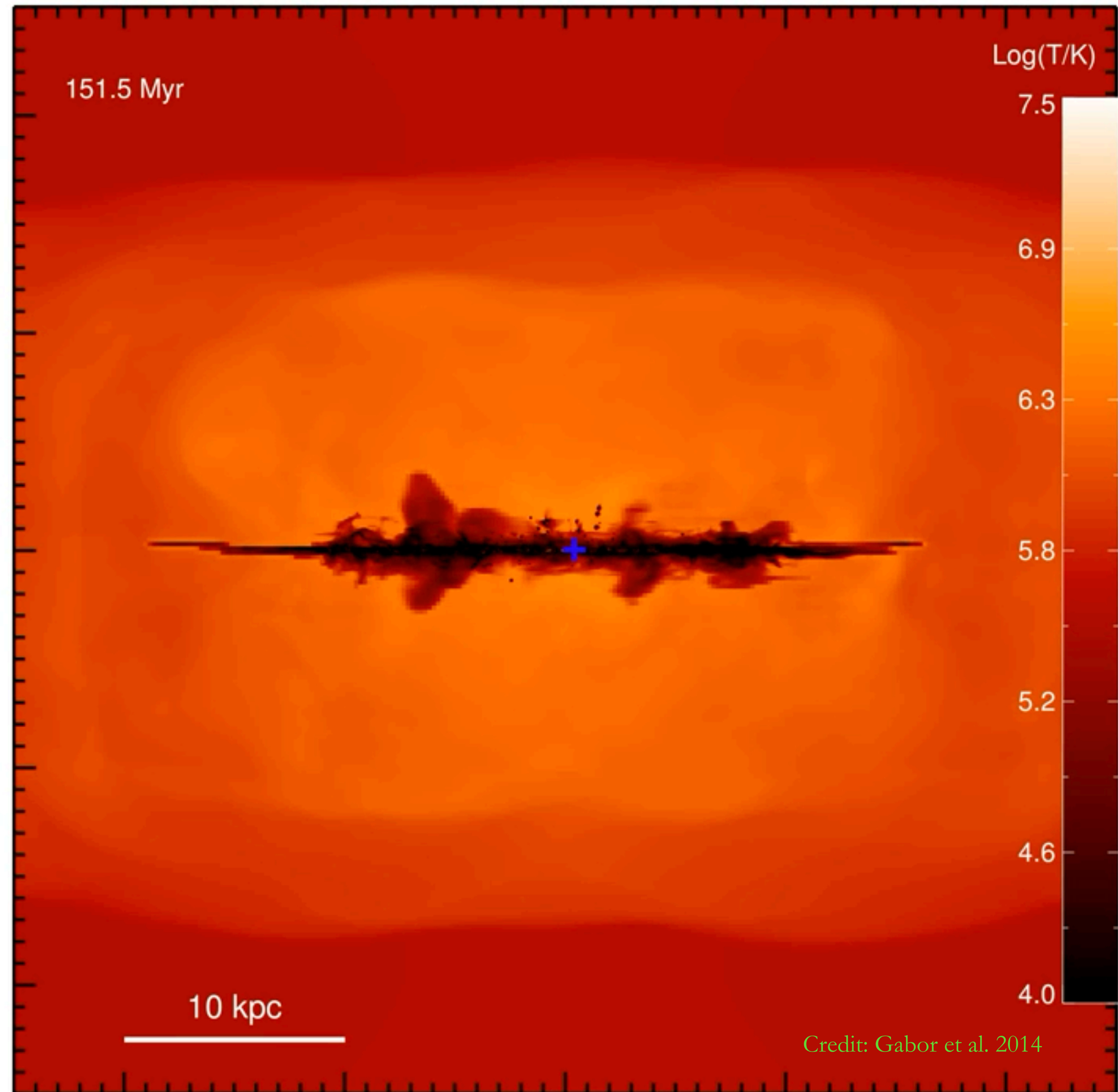


Credit: Gitti M. et al. 2011

Feedback da AGN:
getto fisso

Feedback da AGN:
getto variabile

Feedback da AGN: galassie a spirale



Massimiliano Matteuzzi, Corso di Astrofisica, 03/03/2023

Grazie mille per l'attenzione!

Domande?

Video usati per la presentazione

- <https://www.youtube.com/watch?v=kc7au9Gst3U>
- [https://upload.wikimedia.org/wikipedia/commons/1/19/Retrograde entry into the ergosphere of a rotating black hole.gif](https://upload.wikimedia.org/wikipedia/commons/1/19/Retrograde_entry_into_the_ergosphere_of_a_rotating_black_hole.gif)
- https://www.youtube.com/watch?v=Aq_McDaByGk
- <https://web.phys.cmu.edu/~tiziana/NatureSI/>
- <https://www.aanda.org/articles/aa/olm/2018/09/aa32582-18/aa32582-18.html>
- <https://www.youtube.com/watch?v=g5UIVf2dEG4>