

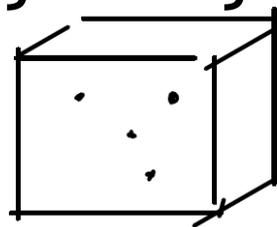
# Aktivne galaksije v zgodovini vesolja

Nastanek in razvoj populacije aktivnih galaksij

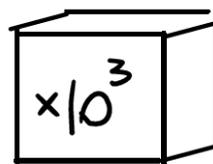
# Kvazarji v zgodovini vesolja

- so aktivne galaksije res razred zase ali gre večina galaksij med razvojem skozi fazo aktivnosti?

--> kako dolgo živijo AGJji?



$z = 0$



$z = 2-3$

pred 10 mlrd let



$z > 3$

kvazarji!

Ne samo AGJji imajo SMBH!

Tudi:

- Galaktika:  $M_{\bullet} \sim 4,3 \cdot 10^6 M_{\odot}$

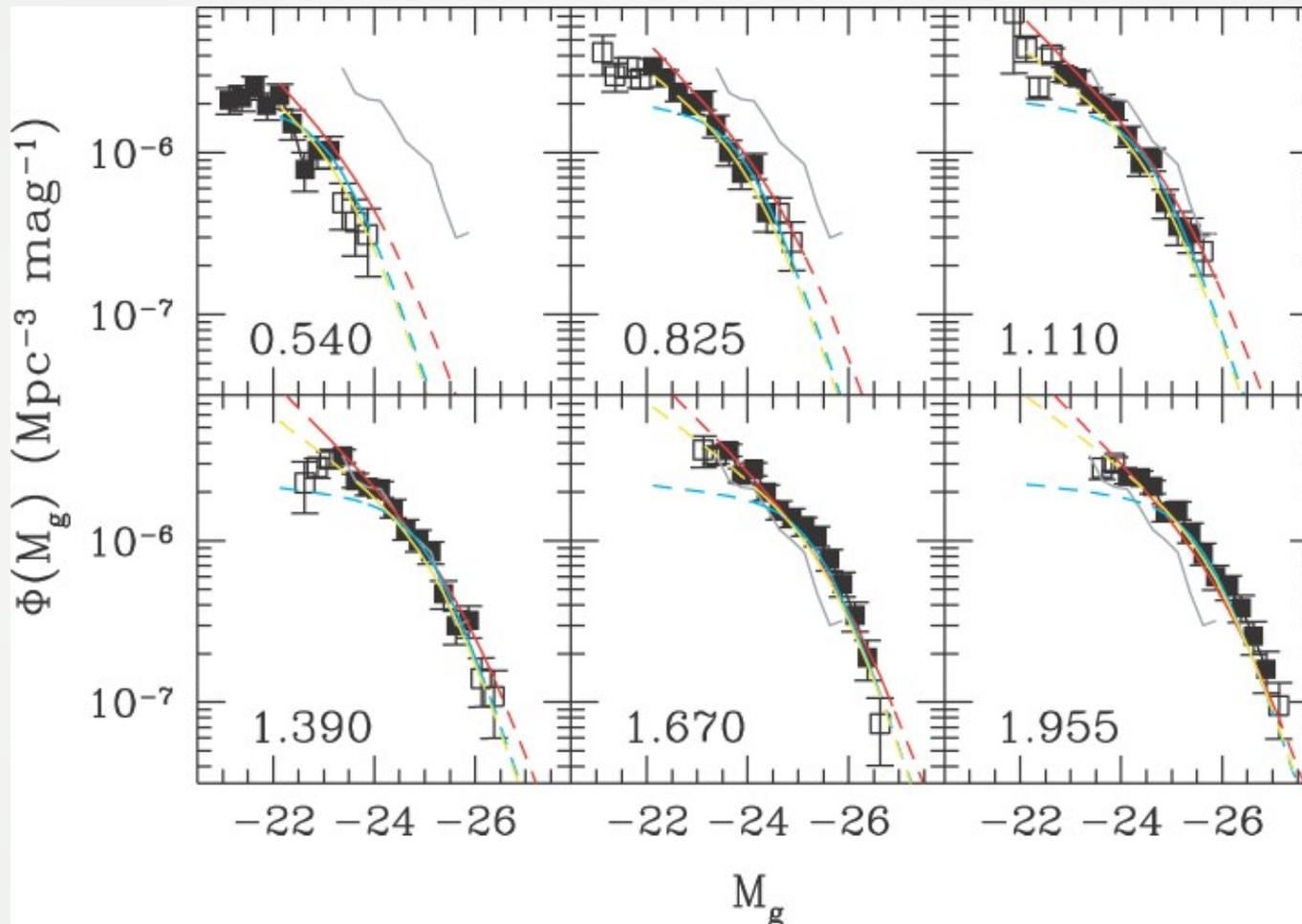
- M31 (Andromeda):  $\sim 10^8 M_{\odot}$

čprav jih ne uvrstimo med Aktivne.

SMBH =  
= supermasivne  
black hole

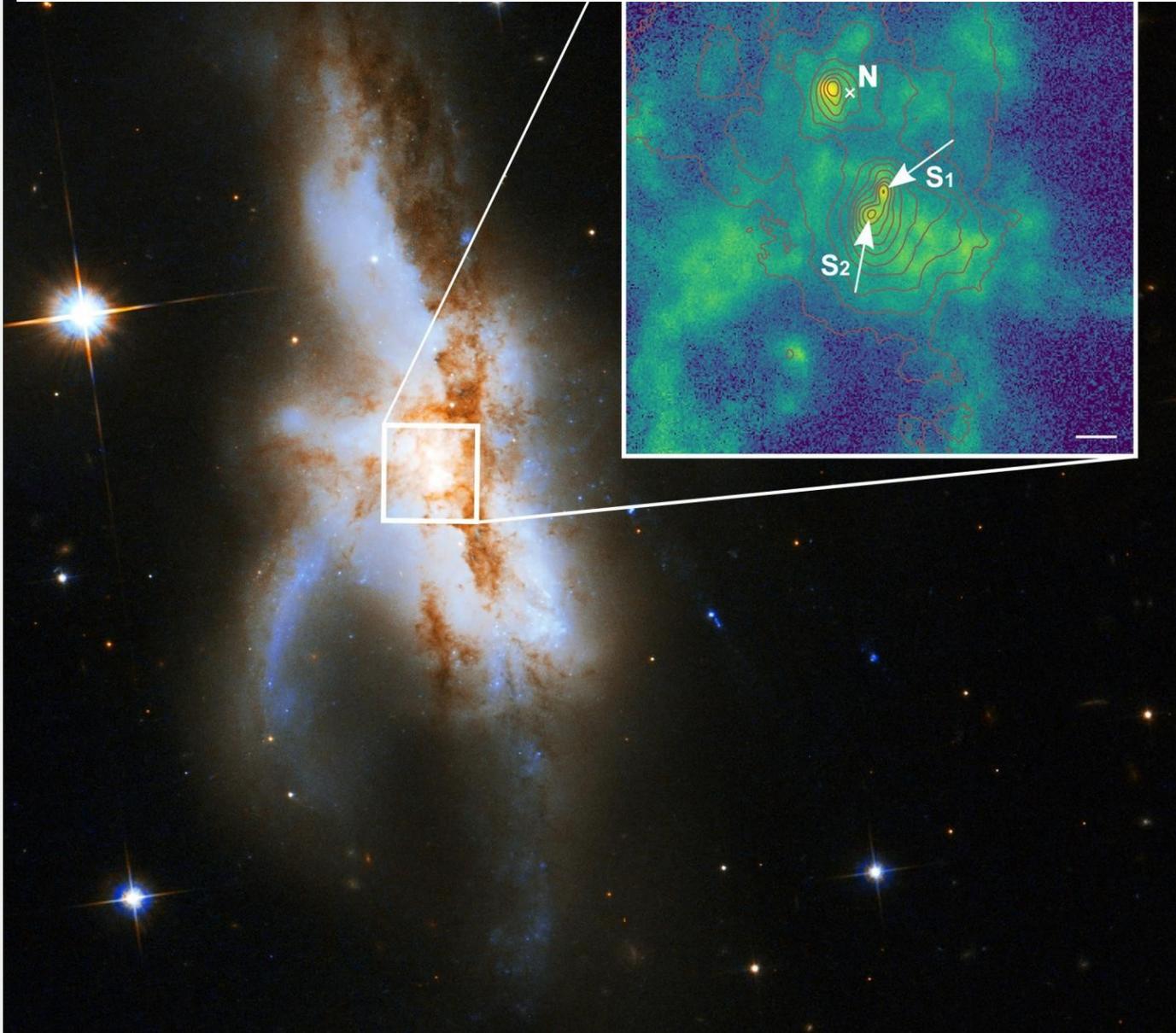
⇒ aktivnost galaksije je faza razvoja galaksije

# Razvoj AGJ-jev v vesolju



The 2dF-SDSS LRG and QSO (2SLAQ) Survey: the  $z < 2.1$  quasar luminosity function from 5645 quasars to  $g = 21.85$  (Richards et al. 2005)

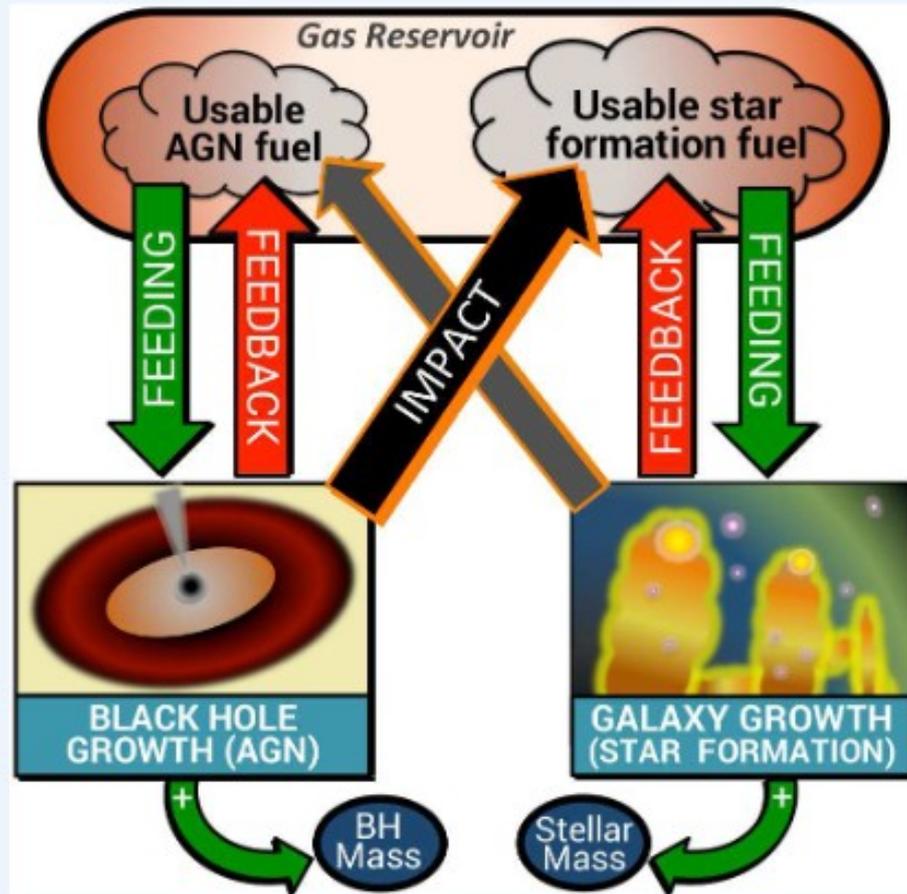
# Aktivne galaksije v scenariju trkov



nepravilna galaksija  
NGC 6240 vsebuje  
tri črne luknje

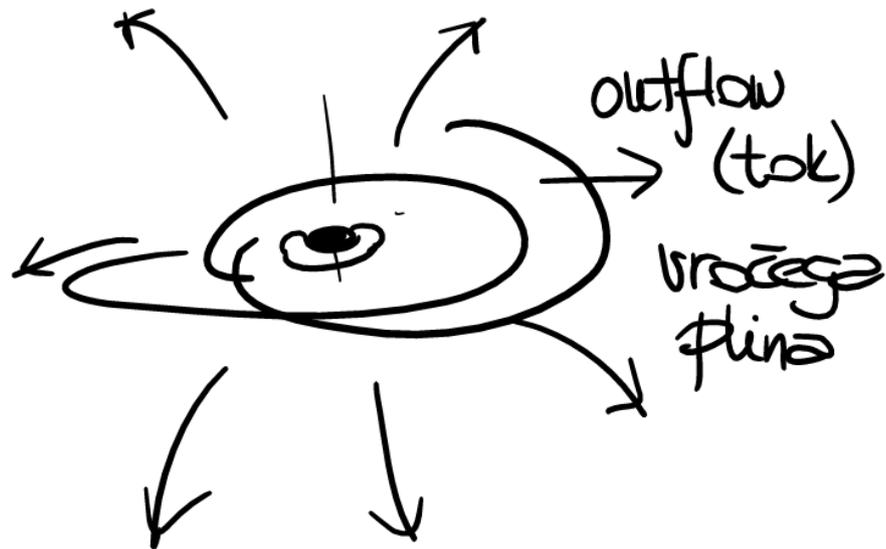
The irregular galaxy NGC 6240. New observations show that it harbours not two but three supermassive black holes at its core. The northern black hole (N) is active and was known before. The zoomed-in new high-spatial resolution image shows that the southern component consists of two supermassive black holes (S1 and S2). The green colour indicates the distribution of gas ionized by radiation surrounding the black holes. The red lines show the contours of the starlight from the galaxy and the **length of the white bar corresponds to 1000 light years**. Credit: P.Weilbacher (AIP), NASA, ESA, the Hubble Heritage (STScI/AURA)-ESA/Hubble Collaboration, in A. Evans (University of Virginia, Charlottesville/NRAO/Stony Brook University)

# Katero vlogo imajo aktivne galaksije v razvoju samih galaksij?



Box 1 | A schematic diagram to illustrate the relationships between fuel supply, galaxy growth and black hole growth.

Both AGN and star formation are fuelled by cold gas that originates from a shared (potentially hot) *gas reservoir* inside the galaxy halo. This gas reservoir can be fed by gas-rich mergers, by recycled material from internal galactic processes and by accretion of gas from intergalactic material. The amount of gas and the ability for this gas to cool determines the amount of usable fuel that can be used for *feeding* black hole growth and star formation. In the case of providing the fuel for black hole growth the material has the additional challenge of losing sufficient angular momentum to reach the inner sub-parsec region of the galaxy. Both processes are known to inject energy and momentum (via radiation, winds and jets) that can reduce the availability of usable fuel through ionising, heating, shocking or expelling material, and hence provide self-regulatory *feedback* mechanisms. A key component of most galaxy formation models is that these two processes can also have a positive or negative *impact* on the usable fuel supply for the other process (black and grey arrows). The focus of this article is observational results on the impact of black hole growth on star formation.



+ ENERGIJA (TERMIČNA)

→ U središču ni več hladnega plina

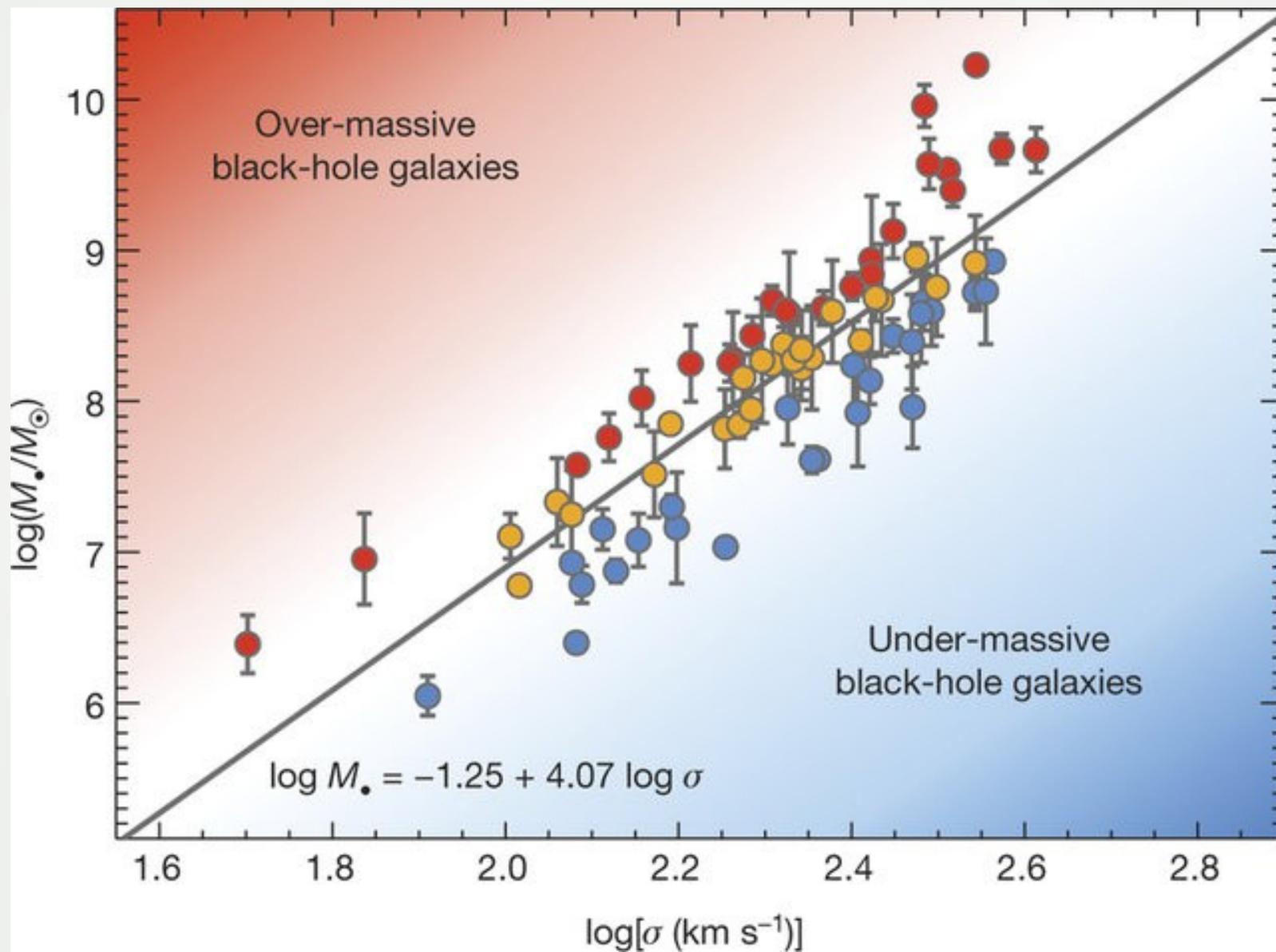
→ ni nastanka novih zvezd

+ ENERGIJA (KINETIČNA)

→ globlje vročega plina učiinkaje na molekularni plin (kolarni valni)

→ sproži nastanek novih zvezd

# M- $\sigma$ relacija



Kaj nastane prej : galaksija ali SMBH?

$$2 \times \text{masa}_{\text{BH}} \rightarrow 3,4 \cdot 10^7 \text{ let (znan podatek)}$$

Primer:

Kvazarji,  $z \sim 7$  (starost verolja  $750 \cdot 10^6 \text{ yr}$ )

$$M_{\text{seed}} = 10 M_{\odot}$$

$$M_{\text{BH}} = M_{\text{seed}} \cdot 2$$

n-korakov

$$M_{\text{BH}} = M_{\text{seed}} \cdot 2^n$$

$$n = \frac{750 \cdot 10^6 \text{ yr}}{34 \cdot 10^6 \text{ yr}} = 22$$

$$M_{\text{BH}} = 4,5 \cdot 10^7 M_{\odot}$$