

Unveiling the mystery of the Milky Way black hole in gamma-rays

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Postdoctoral Symposium
October 11, 2013

Supermassive black hole at the center of our galaxy

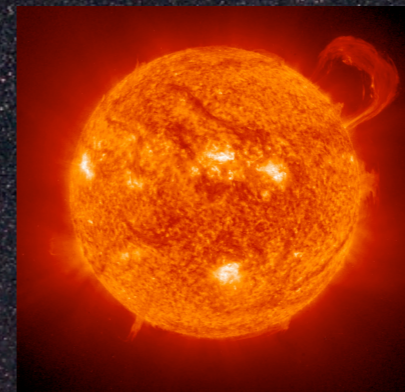
- Four million times more massive than the Sun!
- Where does this mass come from?



- Eat a molecular cloud
- Few million years



- Eat a planet
- Every 3 days
- Weekly schedule:
 - Monday: eat a planet
 - Thursday: eat a planet

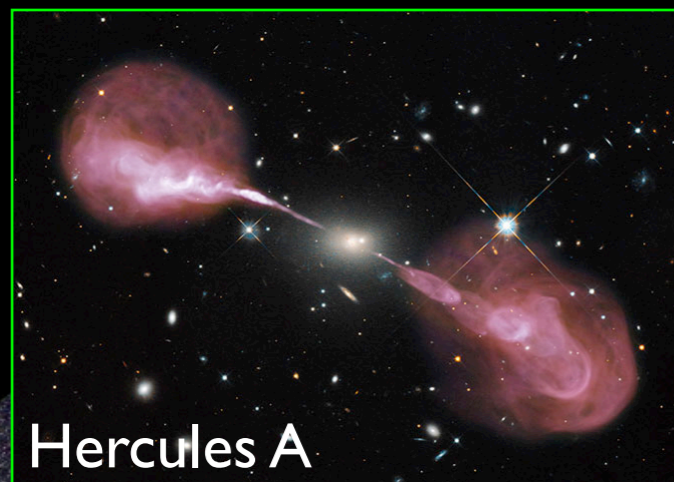


- Eat a star
- Every 3 thousand years

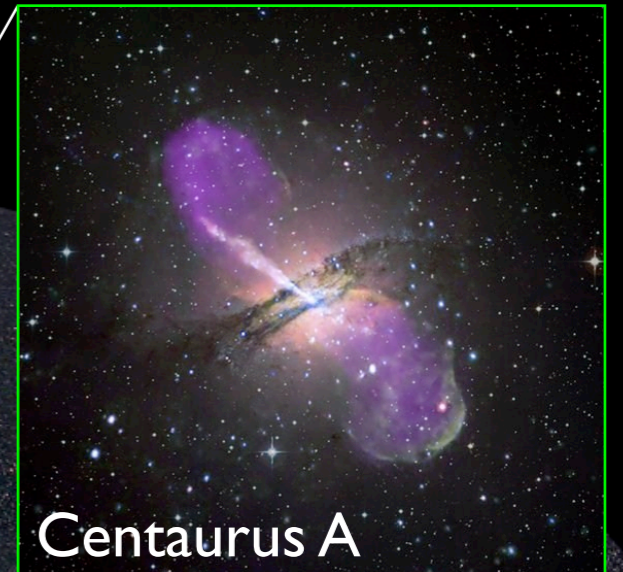


Black hole dinner etiquette

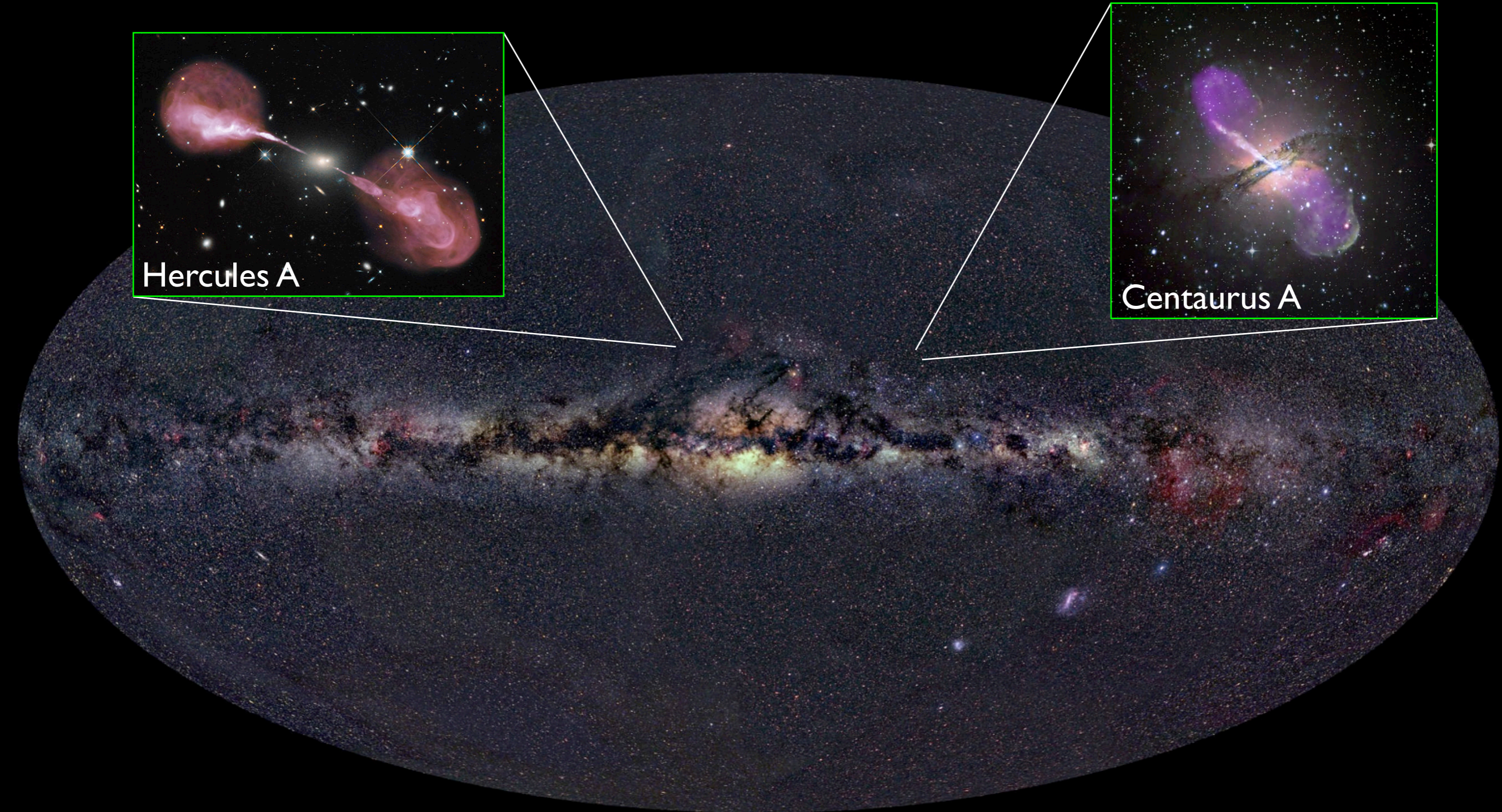
While you eat planets, stars or molecular clouds:
emit a jet of high energy particles



Hercules A



Centaurus A



Did our black hole eat enough?

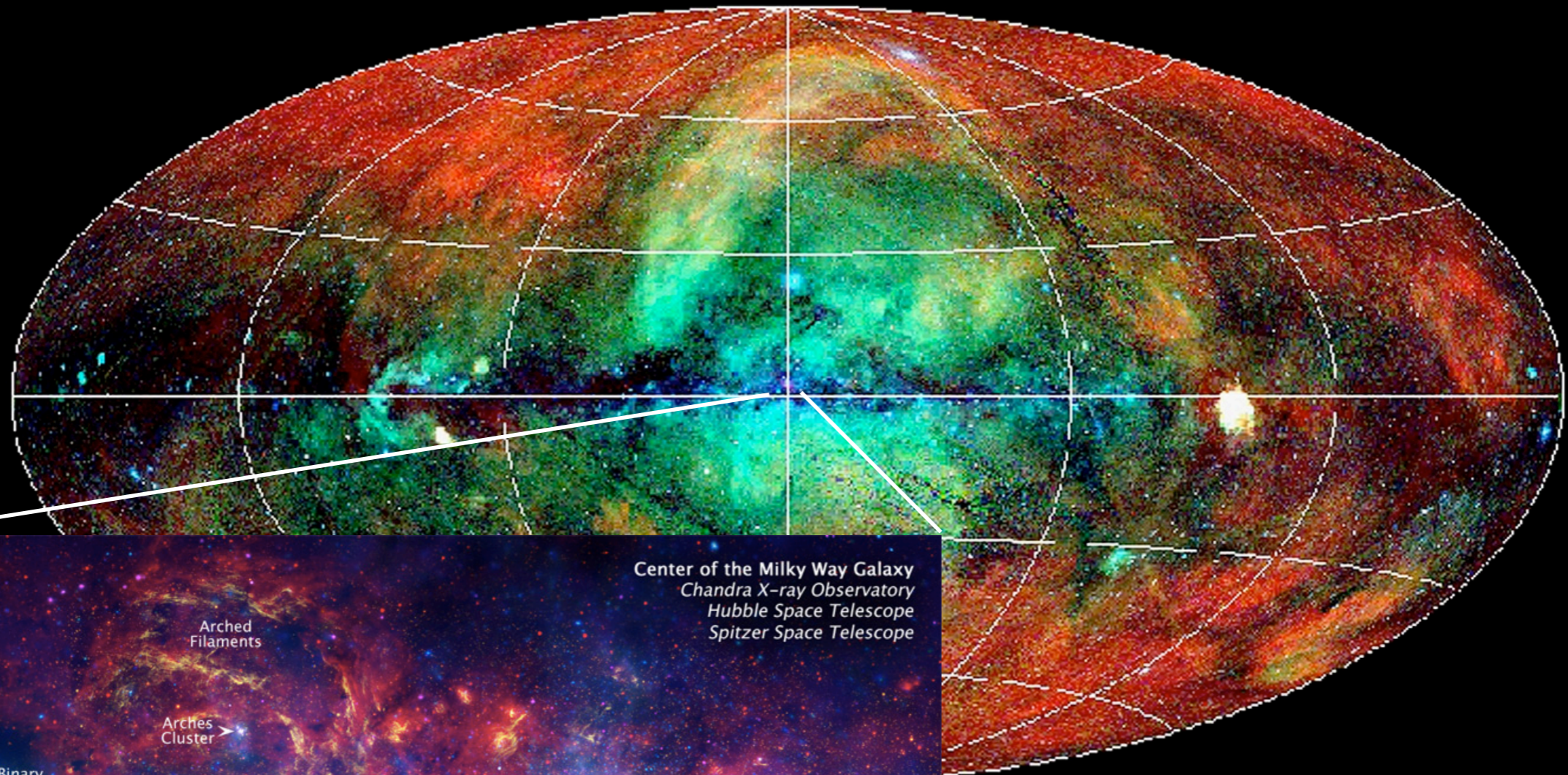
A map of the sky in radio frequencies



A lot of activity but no large jets or lobes around the Galactic center.

Did our black hole eat enough?

A map of the sky in X-ray frequencies



Center of the Milky Way Galaxy
Chandra X-ray Observatory
Hubble Space Telescope
Spitzer Space Telescope

Arched Filaments
Arches Cluster
X-ray Binary 1E 1743.1-2843
Sickle
Quintuplet Cluster
Pistol Star
Sagittarius A

50 light-years
15.3 parsecs 6'35"



No signs of large jets in X-rays.
Not much in the vicinity of the
Galactic center either.

Fermi Gamma-ray Space Telescope

There is a new super detector in space that is able of catching gamma-rays - photons of energies billions times larger than visible light, millions times larger than x-rays.



Fermi satellite in space
(artists perception)



2:1 model of the Fermi satellite
(KIPAC building at SLAC)

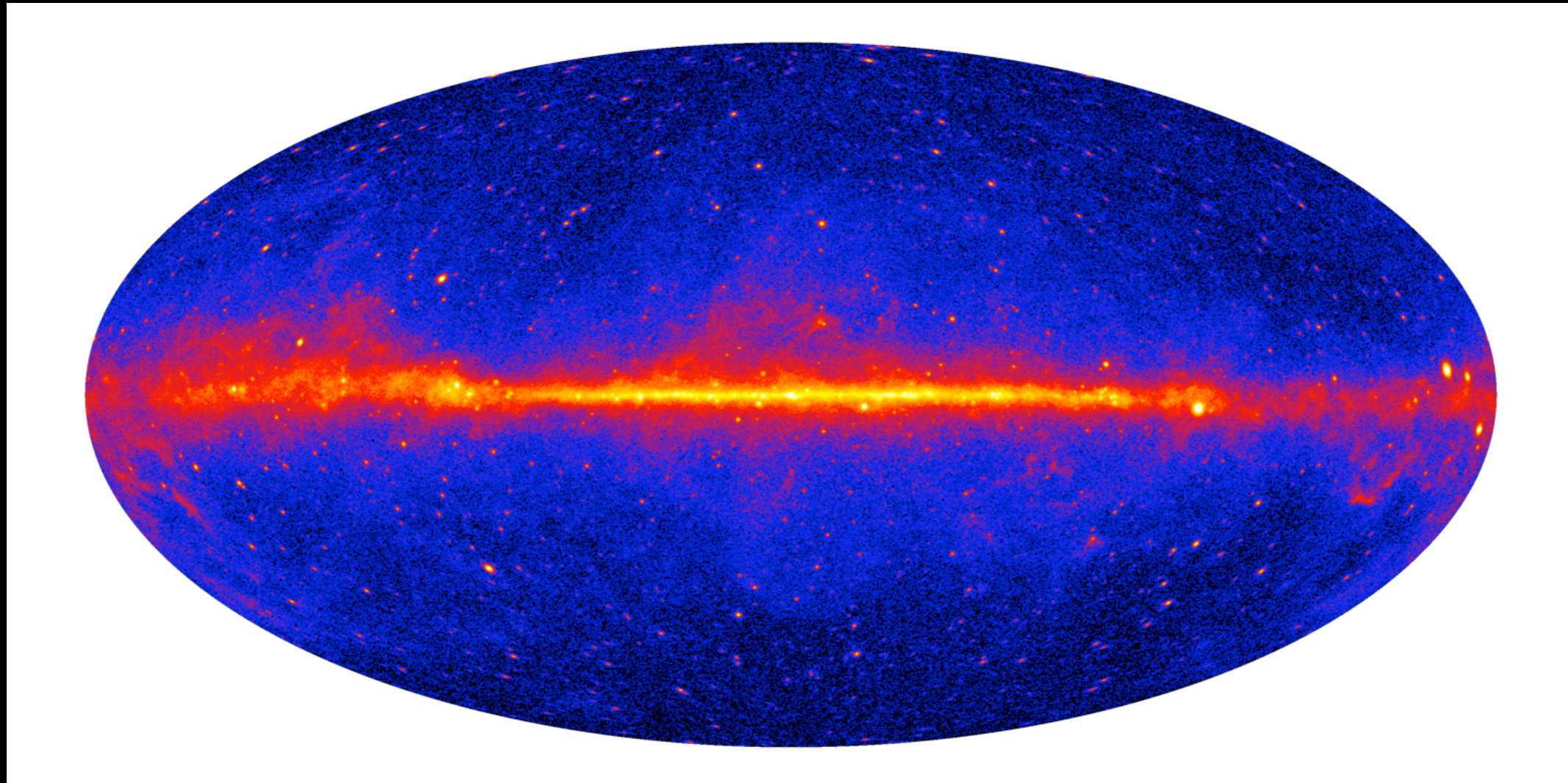
Fermi Gamma-ray Space Telescope



1. It weighs 3 tonnes.
2. Consumes 650 Watts (like a toaster).
3. With this little power it can:
 1. Separate gamma-rays from other cosmic particles
 2. Detect their direction and energy
 3. Send the info down to the Earth
 4. Point to an interesting event or maneuver to avoid a collision with an old Soviet satellite
4. Advancement in technology, e.g., low power electronics fueled by solar cells.

What do we see with Fermi?

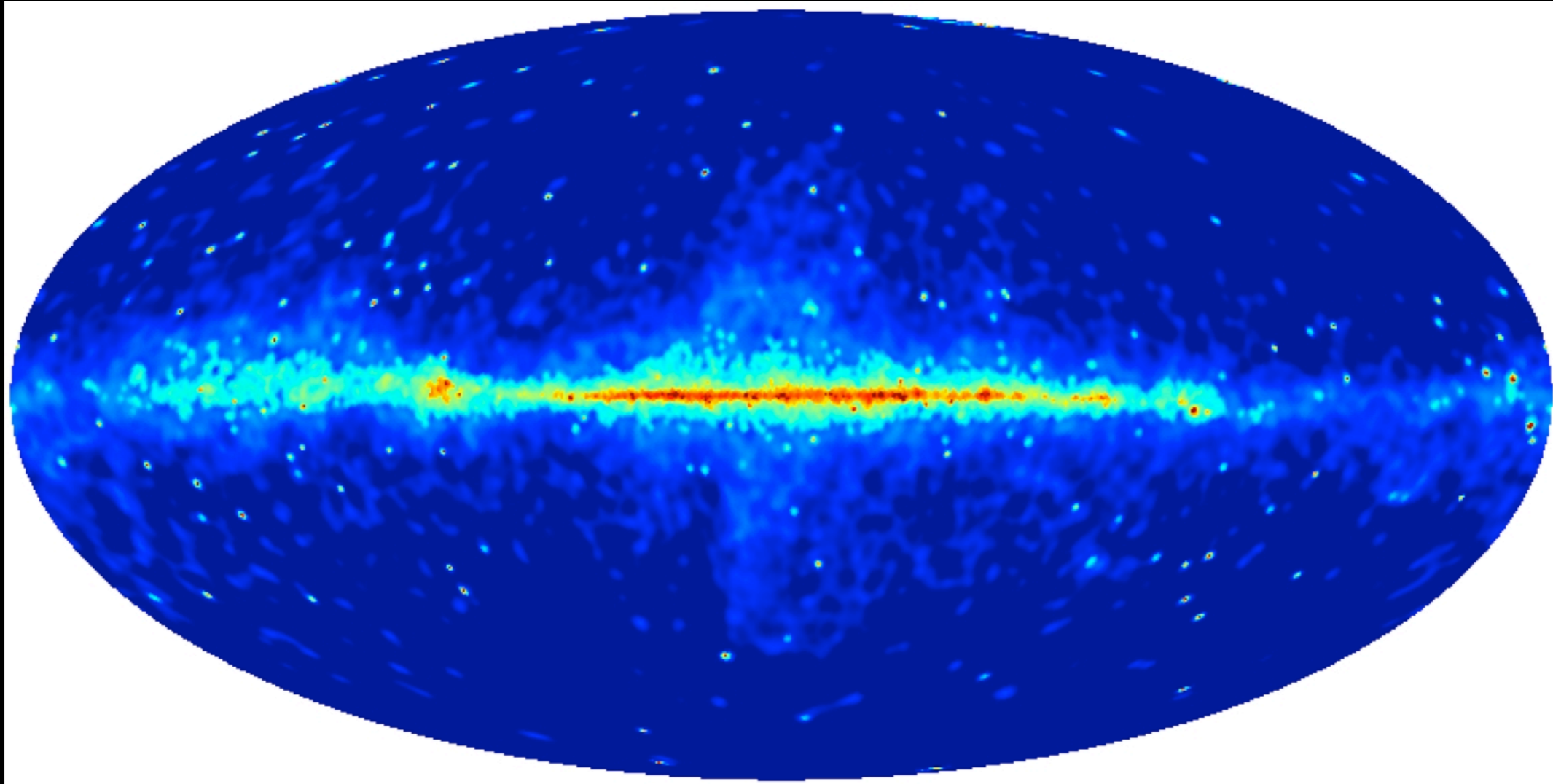
$E > 1 \text{ GeV}$



1. A lot of point sources: most of them are black holes in other galaxies.
2. A lot of emission from the Galactic plane: mostly from high energy protons hitting gas and creating showers of particles.

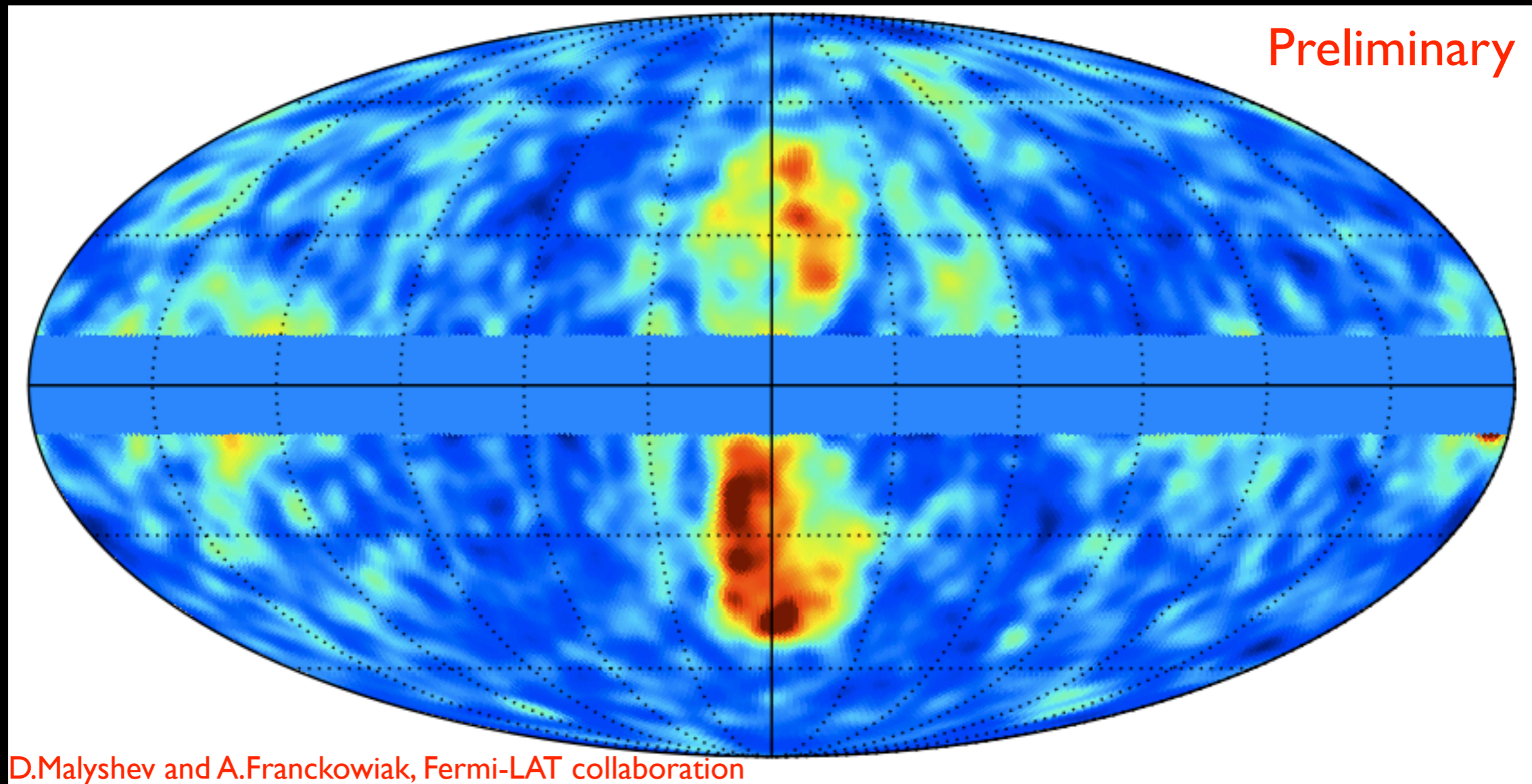
Larger energy?

$E > 10 \text{ GeV}$



One can see a hint of bubbles. Need to get rid of the Galactic foreground gamma-ray emission.

Subtract the Galactic foreground?



Two large bubbles are evident, possibly related to accretion of mass on the black hole (first discovered by Su et al 2010).

1. We study the shape and the energy content of the bubbles.
2. If they are related to the black hole, then we can find out how much did the black hole eat in the last few million years.

Summary

1. There is a supermassive black hole at the center of our Galaxy.
2. The mystery is: how did it grow so large?
3. Before we didn't have any evidence of jets or lobes related to accretion of matter on the black hole.
4. Fermi gamma-ray space telescope is a new amazing tool that can detect gamma-rays from space.
5. With Fermi data we see two large bubbles.
6. If we prove that the bubbles are created by the black hole, then we can find out how much did the black hole eat in the last few million years.
7. This can help us solve the mystery of the black hole mass.