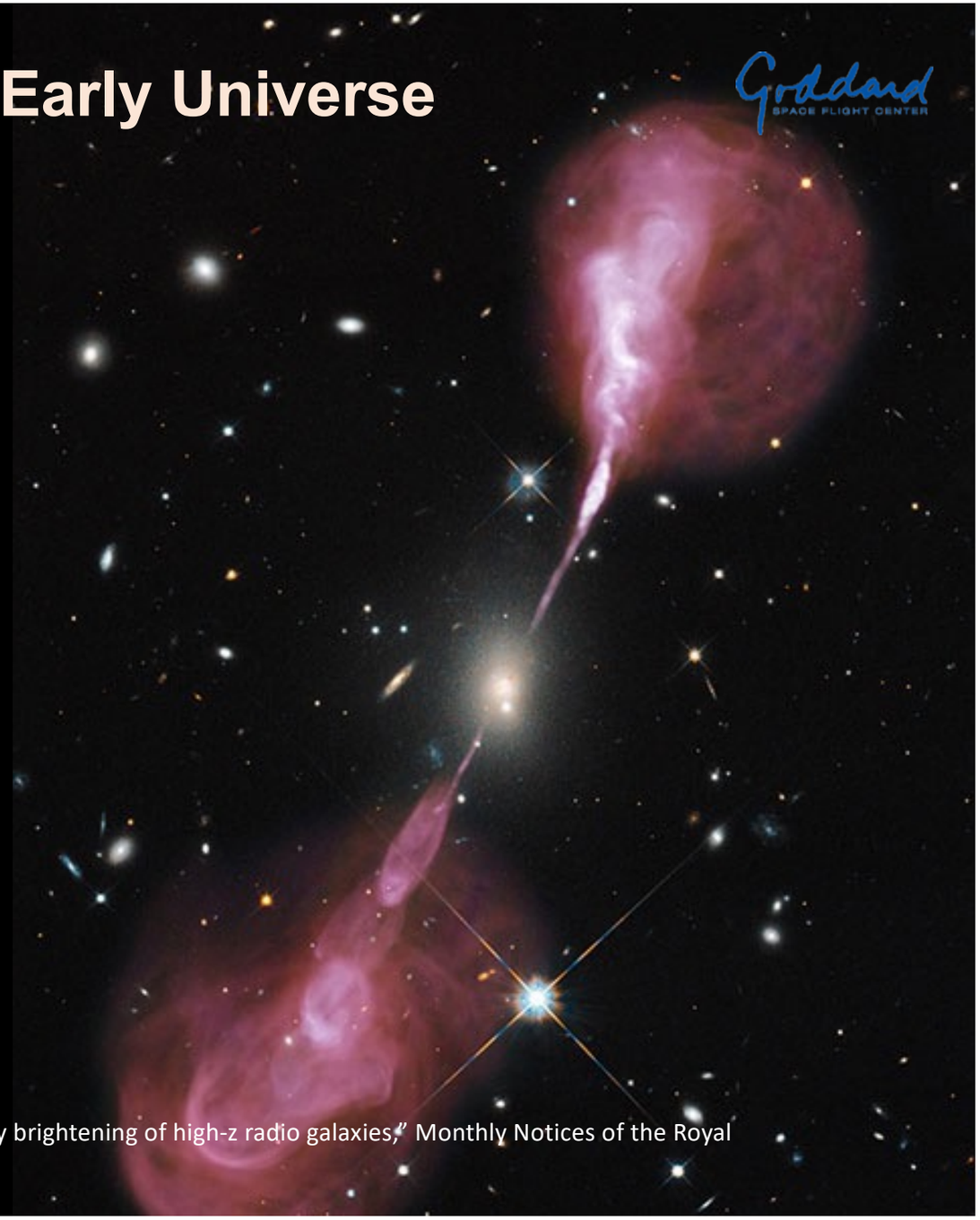
Black Hole Jets in the Early Universe

Black holes in distant galaxies can spew out jets of particles moving close to the speed of light, reaching tens of thousands of light years across. These jets are some of the brightest objects in the universe, and therefore help us to see far away in space and back in time.

These galaxies look different depending on the angle we see them. Viewed side-on (as in the image to the right) we mainly see radio light from the huge lobes at either end of the jet (a radio galaxy). If the jet is pointed right at earth, we see a blazar, a more variable object that has higher-energy emissions associated with the super-accelerated particles in the jet itself.

When the universe was 1/10th its current age, we see more blazars in proportion to radio galaxies. Is there some difference in the early universe that can affect the brightness of these jets? The Cosmic Microwave Background is leftover radiation from the Big Bang that fills the universe and was stronger and hotter farther back in time. It may be that the jets interact with this hotter background radiation, glowing more hotly and brightly, but also losing energy more quickly. The lobes would fade faster, but the jet itself would not be affected –more blazars and fewer radio galaxies!

Our work may confirm this: In our survey of 11 distant galaxies, we find that while the jets at each era seem to contain the same amount of energy (based on our measurements of the magnetic fields and high energy particles in the jets), they become brighter in X-rays the farther back in time we see them.



E. Hodges-Kluck (662), E. Gallo, G. Ghisellini, F. Haardt, J. Wu, B. Ciardi, 2021: “Proof of CMB-driven X-ray brightening of high-z radio galaxies,” Monthly Notices of the Royal Astronomical Society, doi: 10.1093/mnras/stab1314