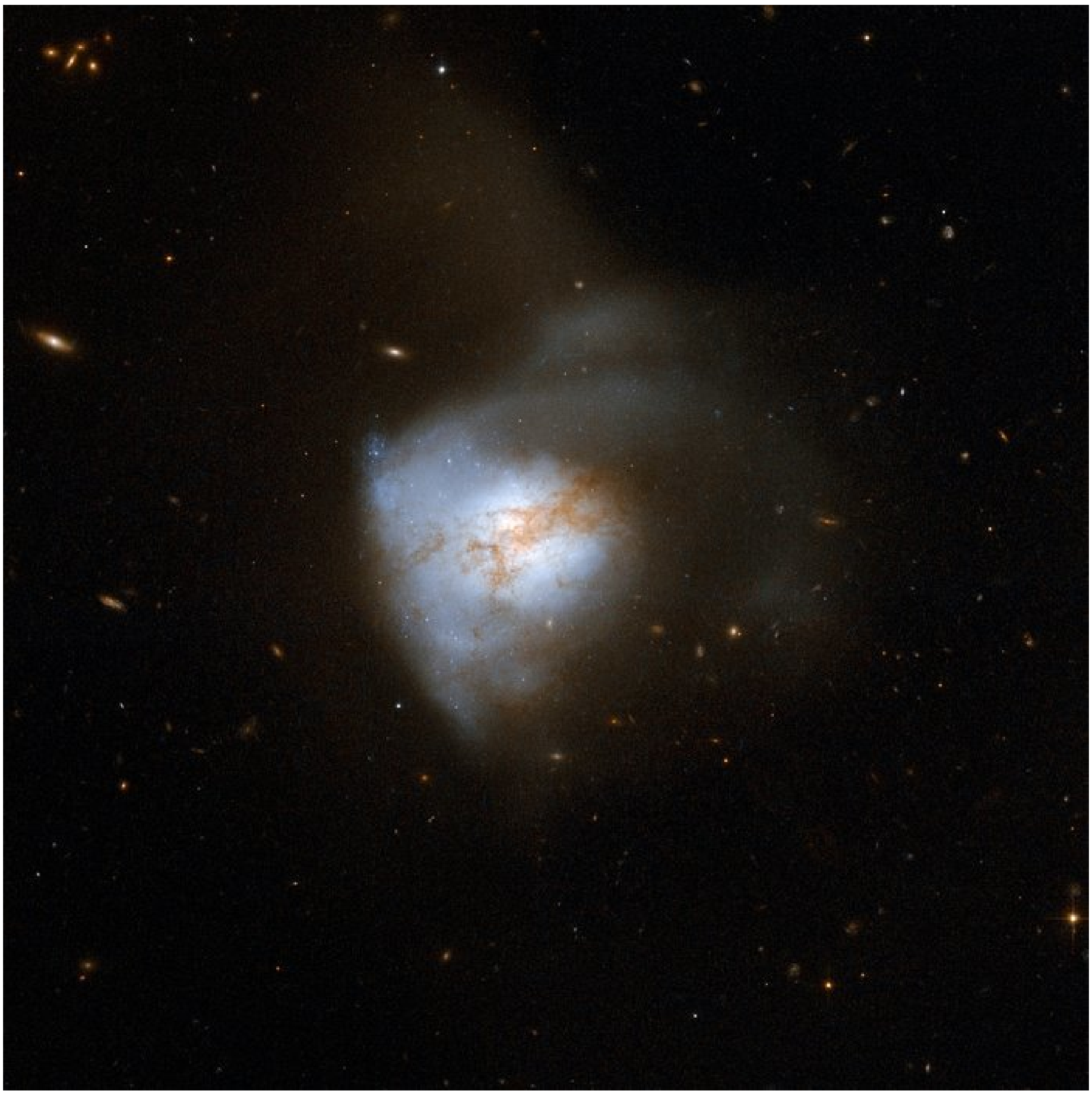
The structure of an active galactic nucleus

January 24 2018



A Hubble image of the superluminous merging galaxy Arp220. Astronomers have measured structures only a hundreds of light-years in size around the two supermassive black holes in the nuclear region, as well as evidece for an outflow. Credit: NASA, ESA, the Hubble Heritage Team (STScI/AURA)-ESA/Hubble Collaboration and A. Evans (University of Virginia, Charlottesville/NRAO/Stony Brook University

The nuclei of most galaxies host supermassive black holes containing millions to billions of solar-masses of material. The immediate environments of these black holes typically include a tori of dust and gas and, as material falls toward the black hole, the gas radiates copiously at all wavelengths. Although the models for these active galactic nuclei (AGN) work reasonably well, it is difficult to obtain direct evidence of the inner structures of AGN because they are so far away and their dimensions are thought to be only tens to hundreds of light-years.

CfA astronomer David Wilner and his colleagues used the ALMA millimeter telescope facility to study the nearest AGN, Arp 220, which is thought to be particularly active after having recently undergone a merger with another galaxy. The two merging nuclei are about 1200 light-years apart, and each has a rotating disk of molecular gas a few hundred light-years in scale. Vigorous star formation is evident in the region as well as at least one molecular outflow inferred from the large velocities seen. But there are numerous unresolved structural issues about these inner regions, including how gas flows to, from, and between the two mergering nuclei and precisely which subregions are responsible for the dominant luminosity sources. The astronomers used these high-resolution millimeter observations to tackle these questions because thick dust, which blocks much of the view at shorter wavelengths, is relatively transparent in these bands.

The scientists are able to resolve the continuum emission structure of the two individual nuclei into its dust and hot gas components. They report that each nucleus has two concentric components, the larger ones probably associated with starburst disks somehow activated by the black holes; the smaller ones, roughly 60 light-years in size, contribute as much as 50% of the submillimeter luminosity, nearly double the previous estimates. In fact one of the cores alone has a luminosity of about three trillion suns, larger than the entire emission of other AGN, not to mention the relatively small volume that is producing it. The cores in Arp220 also seems to have a third, extended linear feature that could represent the outflow seen before only in the spectroscopic (velocity) data.

More information: Kazushi Sakamoto et al. Resolved Structure of the Arp 220 Nuclei at $\lambda \approx 3$ mm, *The Astrophysical Journal* (2017). DOI: 10.3847/1538-4357/aa8f4b

Provided by Harvard-Smithsonian Center for Astrophysics