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The Ultimate Fate of the Universe

Washington, DC -- Astrophysicists announced today new predictions of the ultimate fate of the universe obtained by calculating the characteristic or maximum size of very distant radio galaxies. Reports being presented by Dr. Ruth A. Daly, and Dr. Erick Guerra, both of Princeton University, in Princeton, New Jersey, to the American Astronomical Society meeting in Washington, DC, suggest that the expanding universe will continue to expand forever, and will expand more and more rapidly as time goes by.

Fourteen radio galaxies with redshifts between zero and two were used for this study. All of the radio galaxies included in the study are classical double radio sources similar to the nearby radio galaxy Cygnus A. Such classical double radio sources are cigar -shaped, with a black hole at the center and a radio "hot spot" at either end of the gaseous cigar. Astrophysicists consider the size of a classical double radio galaxy to be the distance between the two radio hot spots.

Previous work by the Princeton group had established that all classical double radio galaxies at a given redshift, or distance from earth, are of similar maximum or characteristic size; this size depends on the inverse of the distance from earth. The apparent characteristic or maximum size of the full population of radio galaxies at the same redshift depends on the distance to the sources. Thus, equating the two measures of the characteristic or maximum size of the sources allows an estimate of the distance to the sources. Knowing this distance is equivalent to knowing the global geometry of the universe, or the ultimate fate of the universe. This new work measures more radio galaxies, and radio galaxies at higher redshift, or greater distance from earth; it also involves more sophisticated statistical manipulations of the measurements.

The apparent size, or distance from hotspot to hotspot, of a high redshift radio galaxy is a clue to which of the competing models of the nature of the universe is most likely. A relatively small size at great distance from earth would suggest a universe that will halt its current expansion and recollapse; a larger size suggests a universe that will continue to expand forever, but at an ever decreasing rate; an even larger size suggests the universe will continue to expand, and will expand at a faster and faster rate. The current work finds that at high redshift the galaxies are very large, with widely separated radio

hotspots. Thus, the universe will continue to expand forever and will expand at a faster and faster rate as time goes by.

The only other tool currently being used to investigate the global geometry of the universe is the maximum brightness of supernovae. These new measurements obtained using radio galaxies are derived by methods entirely different than the supernovae method, yet yield essentially the same result. "We can say, with 95% confidence, that the universe is open and will continue to expand forever," says Daly.

Daly and collaborators have identified 62 additional classical double radio galaxies with redshifts between zero and two that can be used to more tightly constrain the global geometry of the universe. They are moving forward with an observing program at the Very Large Array (VLA) in New Mexico to obtain the radio surface brightness maps that are needed to determine the characteristic size of each source. This will allow even more detailed measurements of the global geometry of the universe.

The same sources may be used to study evolution of gas in clusters of galaxies, and the Princeton group (including doctoral students Lin Wan and Greg Wellman) has used the sources to study evolution of clusters of galaxies to redshifts of two.

This work was supported by the National Science Foundation through a Graduate Student Fellowship to Guerra, and a National Young Investigator Award to Daly. The work was also funded by the Independent College Fund of New Jersey.

The URL for the figure showing our data points relative to expectations of 3 illustrative models of the universe (courtesy of Dr. Lin Wan) is http://pulsar.princeton.edu/~eddie/press.gif).

The URLs for the false color and grey scale images of Cygnus A (courtesy of Dr. Chris Carilli) are http://pulsar.princeton.edu/~eddie/cyga.gif and http://www.nrao.edu/~gtaylor/cyga6cm.jpg, respectively.

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