

GAVRT Teachers contribute vital data information to Spitzer Space Telescope project scientists!

Looking for a Relation Between Black Hole Mass and Radio/IR Emission in Active Galactic Nuclei

Gorjan, V. (JPL/Caltech) and the GAVRT/Spitzer Team

ABSTRACT

We have combined space-based Spitzer data at 8 μ m with ground-based, continuum radio data to search for a relation between the ratio of radio to infrared emission and the black hole mass in a sample of nearby active Galactic Nuclei. The radio data were collected at 2.3 GHz (S-band) and 8.5 GHz (X-band), by middle and high-school students using the Goldstone-Apple Valley Radio Telescope (GAVRT). The IR data were collected with the IRAC imaging instrument on Spitzer. The GAVRT students carried out the initial data analysis at both IR and radio wavelengths. GAVRT is a science-education partnership between NASA, JPL, and the Lewis Center for Educational Research, which allows K-12 students to participate in real research as part of their standard classroom education. The GAVRT-Spitzer Team is a collaboration among GAVRT, the Spitzer Science Center, and K-12 students across the country to carry out research projects utilizing both radio and IR data.

The Sample

1. 21 AGN from the 3C catalog with known black hole masses were chosen from West & Fink (2005) which were then divided at 10⁷ solar masses and 10⁸ solar masses.
2. The standard J-factor pipeline pipeline images were provided to the students and they used the IRA tool to generate images to analyze the images.
3. The resulting photometry was then provided by the following schools which we need to provide to you below.

Teacher	School	Grade Level
Holly Strand	The Mary's School, Maryland, OR	6th Grade
Chad Taylor	Wilson's Park School, Drexel, UT	High School
Dan Rich	Montclair High School, Montclair, NJ	High School
Paul Fisher	Montclair High School, Montclair, NJ	High School

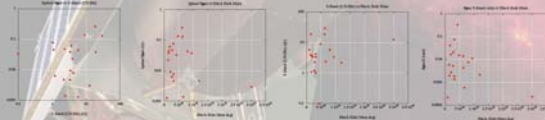
The GAVRT Program

The Goldstone Apple Valley Radio Telescope (GAVRT) is a decommissioned NASA Deep Space Network. The radio dish that is operated by the Lewis Center for Educational Research (LCEER) located in Apple Valley, CA, in partnership with NASA, JPL, LCEER provides an opportunity for K-12 students and teachers from across the globe to join scientists on an intensive science education team on real science projects.



The GAVRT-Spitzer collaboration

The GAVRT-Spitzer collaboration is an effort to bring the wide reach of the GAVRT program to the Spitzer Science Center's outreach program. The collaboration has brought the excitement of data from a space based mission to the large number of students and teachers who are involved with GAVRT's successful ground based radio program, thus enhancing both programs.



Conclusions

There seems to be no trend that relates the IR flux to the radio flux. The black hole mass also seems to be uncorrelated to the IR or S-band emission. Finally, the ratio of the radio to the IR does not seem to correlate to the black hole mass. The 1- σ uncertainty in the IR band ratio is currently around 10% (dominated by the uncertainty in the continuum), but the well known with more detailed analysis. The final lack of correlation indicates that the thermal and non-thermal processes that generate the infrared and the radio emission do not depend on the black hole mass. There are two caveats in the conclusion. The radio emission originates on a much larger physical scale and hence on a different timescale than the IR and so may be representing a different epoch of the black hole emission than that represented by the IR emission. Also, the size of black hole masses is limited to a larger mass range may yield a different result.

Happy New Year! Dr. Varoujan Gorjian presented the poster on the left at the AAS (American Astronomical Society) Conference in Austin, TX the week of January 7, 2008. This was a culmination of over one years worth of data collection and analysis by many GAVRT classrooms. Four GAVRT teachers from New Jersey, Oregon, Utah, and Wisconsin submitted detailed reports their students compiled utilizing both radio and IR data. They were researching the relationship between black hole mass and the radio and IR emission in Active Galactic Nuclei (AGNs). GAVRT classrooms collected radio data on Spitzer target sources. They then compared radio data from GAVRT's DSS-12 antenna with IR data collected by the Spitzer Space Telescope to see whether the ratio of the non-thermal radiation to the thermal radiation is related to the mass of the supermassive black hole. In conclusion, no trend was determined at this time but further study is needed. Will you join us in our quest for answers as we combine data from these two wavelengths of the Electromagnetic (EM) Spectrum?



Dr. Varoujan Gorjian is an astronomer working at JPL on the Spitzer Space Telescope (www.spitzer.caltech.edu). He received his B.S. degree in astronomy from the California Institute of Technology and his Masters and Ph.D. degrees from UCLA. He originally started with GAVRT as a volunteer with the Student Science phone meetings, but then joined in full force with the joint GAVRT/Spitzer Project. His main scientific interests are giant black holes at the centers of galaxies and the star formation history of the universe. When he's not working, he enjoys movies and T.V. (especially science fiction), doing magic, and any type of physical activity - as long as it's in the sun!

Happy 2008!

