Novel analysis method levels the quasar playing field

April 18 2013, by Lori Ann White

The interaction of a supermassive black hole and a disk of accreting matter, called a quasar, can be seen at the center of a faraway galaxy in this artist's concept. It consists of a dusty, doughnut-shaped cloud of gas and dust that feeds a central supermassive black hole. As the black hole feeds, the gas and dust heat up and spray out different kinds of light, as illustrated by the white rays.

(Phys.org) —In the nearly six decades since quasars were discovered, the list of these energetic galaxies powered by supermassive black holes has grown to more than 100,000 – enough examples to reveal important information about the quasar population as a whole. But attempts to conduct a celestial census of these powerful objects have been limited by a fundamental problem: Although quasars are bright, they also span billions of light years in distance from Earth. Just as with stars in an urban sky, the closest quasars can be seen even if they are dim, while the oldest and most distant ones can be seen only if they are bright. This means astrophysicists have to study a sample with big differences among individual members, including distance, age, brightness and type of radiation emitted.

Astrophysicists with the Kavli Institute for Particle Astrophysics and Cosmology, a joint SLAC-Stanford institute, found a way to reach past these limitations: They improved an algorithm that homes in on important commonalities of a population of objects while taking into account the limitations and biases for observations made in multiple types of electromagnetic radiation, such as optical light or radio waves – two of the most important wavelengths for studying quasars.

In the process they shed new light on a contentious question: Are there two types of quasars, with one "louder" in radio than the other, or is there just one type with emissions that vary widely across the electromagnetic spectrum?

A recent paper in *The Astrophysical Journal* details how the team, including KIPAC scientist Jack Singal, KIPAC member and Stanford professor Vahe Petrosian and KIPAC alumnus Lukasz Stawarz, improved upon an algorithm developed more than a decade ago by Petrosian and Bradley Efron, a respected statistics professor at Stanford.

After validating their algorithm with a small sample, the team turned it loose on the largest sample of quasars yet available: the Sloan Digital Sky Survey (SDSS) Data Release 7 catalog, which has optical-light measurements for more than 100,000 quasars, plus data from the FIRST radio survey, which has more than 400,000 celestial radio sources, to achieve a huge combined sample of radio and optical quasars for analysis.

The team found that quasars have, on average, grown steadily dimmer in both radio and optical light over the history of the universe, but have dimmed more in radio than in optical – dramatically so. This analysis also supports the "one quasar population" model, and both that and the greater dimming in radio relative to optical light are sure to spark controversy. Regardless, the work represents what the authors consider to be the most rigorous analysis yet of the evolution of quasars in both radio and optical emissions. According to Singal, the technique is also useful for studying any population of objects that can be found at widely varying distances – for example, blazars or gamma-ray bursts.

More information: iopscience.iop.org/0004-637X/764/1/43

Provided by SLAC National Accelerator Laboratory