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EVIDENCE FOR BLACK HOLES IN ACTIVE GALACTIC NUCLEI (AGN)

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ABSTRACT

Active galactic nuclei are the most powerful, long-lived objects in the Universe. Recent data confirm the theoretical idea that the power source is accretion into a massive black hole. The common occurrence of obscuration and outflows probably means that the contribution of active galactic nuclei to the power density of the Universe has been generally underestimated. Black hole mass, along with mass accretion rate, is a fundamental property of active galactic nuclei (AGNs). Black hole mass sets an approximate upper limit to AGN energetics via the Eddington limit. We collect and compare all AGN black hole mass estimates from the literature; these 177 masses are mostly based on the virial assumption for the broad emission lines, with the broad-line region size determined from either reverberation mapping or optical luminosity. We introduce 200 additional black hole mass estimates based on properties of the host galaxy bulges, using either the observed stellar velocity dispersion or the fundamental plane relation to infer; these methods assume that AGN hosts are normal galaxies. We compare 36 cases for which black hole mass has been generated by different methods and find, for individual objects, a scatter as high as a couple of orders of magnitude. The less direct the method, the larger the discrepancy with other estimates, probably due to the large scatter in the underlying correlations assumed. Using published fluxes, we calculate bolometric luminosities for 234 AGNs and investigate the relation between black hole mass and luminosity. In contrast to other studies, we find no significant correlation of black hole mass with luminosity, other than those induced by circular reasoning in the estimation of black hole mass. The Eddington limit defines an approximate upper envelope to the distribution of luminosities, but the lower envelope depends entirely on the sample of AGNs included. For any given black hole mass, there is a range in Eddington ratio of up to 3 orders of magnitude.

Keywords: - Active Galactic Nuclei (AGN), Black Hole, X-ray, Radio, Magnetic.

I. INTRODUCTION

Active galactic nuclei (AGN) involve the most powerful, steady sources of luminosity in the Universe. They range from the nuclei of some nearby galaxies emitting about 1040 ergzs21 (1 erg 5 0.1 mJ) to distant quasars emitting more than 1047 ergzs21. The emission is spread widely across the electromagnetic spectrum, often peaking in the UV, but with significant luminosity in the x-ray and infrared bands. It is spatially unresolved except in the radio band, where there is sometimes evidence for collimated outflows at relativistic speeds. The power output of AGN is often variable on time scales of years and sometimes on time scales of days, hours, or even minutes. Causality implies that an object that varies rapidly in time t must be smaller than the light-crossing time of the object, ct (where c is the speed of light) and thus must be spatially small; if not, the variation would appear smoothed.

High luminosities imply high masses such that gravity can combat radiation pressure, which would otherwise blow the object apart (that is, the luminosity must be less than the Eddington limit). AGN therefore are of very high mass density, and it has long been assumed that they consist of a massive black hole, of say 108 solar masses (MJ) or more, accreting the gas and dust at the center of a galaxy. The gravitational energy liberated during accretion onto a black hole is '10% of the rest mass energy of that matter and is the most efficient mass–energy conversion process known involving normal matter (that is, ignoring the use of antimatter; nuclear burning releases at most 0.7% of the mass-energy). Indeed, the rapid variations seen in some powerful AGN argue for some high efficiency process, more efficient than nuclear burning (Fig. 1).

The accreting matter probably has some angular momentum, which causes it to orbit the black hole and, through dissipation of energy, flatten to form a disk within which magnetic viscosity transfers the angular momentum outward and the mass inward.

Unless the accretion rate is either high or very low, it is likely that the gravitational energy liberated is radiated locally, much of it as thermal radiation from the surface of the disk, peaking in the UV as expected. Some energy, however, is probably stored temporarily in magnetic fields before being released in flares, which make the x-ray emission particularly variable.

II. Classifying Active Galactic Nuclei

AGN have been classified in many ways. Three important classes are:

(i) theSeyfert galaxies, which have modest luminosities but tend to be the best studied since they generally lie near to us;

(ii) the quasars, which are more luminous than the host galaxy and are particularly numerous at a redshift of '2, when the Universe was about one third its present age; and

(iii) the blazars. About 10% of quasars are radio-loud; the rest are radio-quiet, although not silent. Radio loudness is generally associated either directly with a collimated relativistic outflow or jet or with regions where a jet has collided with surrounding material. A blazar is seen when our line of sight lies close to the direction of a jet.

An important issue is the obscuration of AGN by dust and gas along the line of sight, which can change or hide the spectrum of an AGN. Seyferts have long been divided into types I and II, in which the second type clearly are obscured versions of the first type (in some, the characteristic broad optical lines of type I are seen in the polarized, scattered component of type II). There are several unification schemes where the classification of an object depends on its orientation.

The local number density of Seyfert II galaxies is several times that of Seyfert I galaxies. What is not yet clear is whether quasars can or should be similarly divided. There are no good examples of a type II quasar, although there are many obscured powerful objects that may host accreting black holes, such as the ultra luminous infrared galaxies.

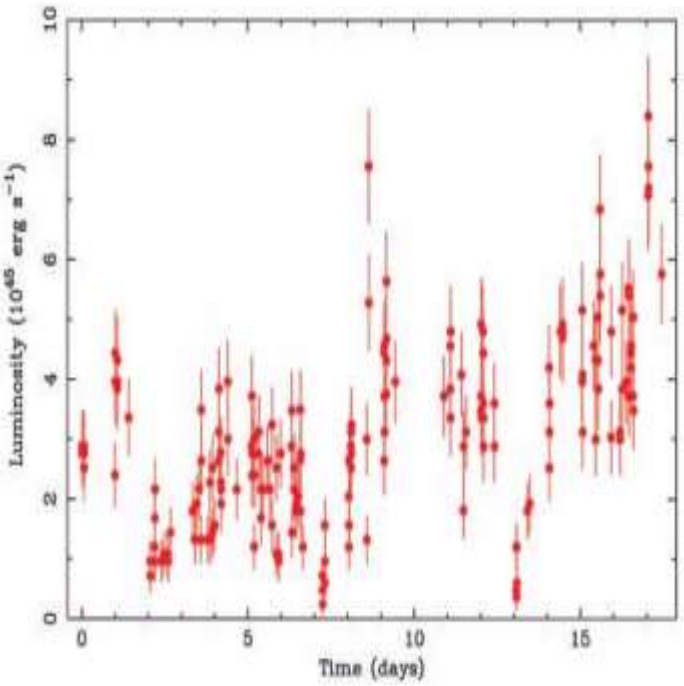

FIG. 1. X-ray light curve of the powerful, radio-quiet AGN PHL1092 (18). Note the persistent large variability. A remarkable flare on day 8 shows a change in luminosity exceeding 1042 ergzs22. This requires a mass-to-energy conversion efficiency exceeding 0.6 and cannot be associated with stellar

III. Evidence for Black Holes in AGN

Although accretion onto a massive black hole has long been seen as the explanation for AGN, obtaining unambiguous proof has been difficult. A black hole, by its very nature, is observationally elusive. Progress has, however, been made on several fronts over the past few years. Optical, infrared, and radio studies of the nuclei of several galaxies, including our own, have revealed the presence of large masses within small radii that can only plausibly be black holes. X-ray studies have revealed spectral features from the innermost accretion flow of several Seyfert galaxies. The enormous Doppler shifts and gravitational redshifts of the features show for the first time the strong gravity near the event horizon.

Radio observations of the nucleus of the nearby galaxy NGC 4258 show the presence of a water maser there. This can be resolved with very long baseline interferometry into several water masers roughly along a line extending from either side of the nucleus. The frequency of each maser can be measured accurately and shows that they lie in an edge-on disk orbiting the nucleus, which itself is a continuum radio source. The velocity and radius of the orbiting masers yields a central mass of 3.6 3 107 MJ (5).

IV. X-RAY REVERBERATION

As gas funnels in toward the SMBH at the center of a galaxy, collisions and angular momentum conservation cause the formation of an optically thick, geometrically thin accretion disk around the black hole, classically described by Author. This disk is mildly ionized and produces weak magnetic fields that are responsible for the outward transfer of angular momentum, allowing for material to fall toward the black hole. In luminous, actively accreting AGN, material flows inwards through the accretion disk up to the innermost stable circular orbit (ISCO), beyond which the gas plunges toward the black hole on a ballistic trajectory. The situation is quite different in lower accretion rate AGN, where the density of the flow is so low that very little accretion energy is radiated away, thus heating up the inner flow, and effectively truncating the inner edge of the accretion disk at radii larger than the ISCO (Narayan et al., 1996). The location of the ISCO is dictated by the spin of the black hole, as general relativistic frame dragging effects will support more orbits closer to the black hole as the spin increases. X-ray reverberation aims to exploit this fact and measure the inner edge of the accretion disk in luminous, radiatively efficient AGN, in order to measure a fundamental black hole parameter, its spin.

The spin of the black hole also has important astrophysical implications, as the overall radiative efficiency of the accretion process is largely determined by the black hole spin (6% for non-rotating black holes vs. 42% for maximally spinning black holes). Moreover, the spin is a by-product of the underlying growth mechanism of the SMBH, as gas that accretes on to the black hole via a prograde accretion disk will eventually spin up the black hole. Randomly oriented black hole-black hole mergers, on the other hand, will tend to spin down the black hole. Therefore, if we can measure a distribution of black hole spins across the universe, we can understand the relative importance of the accretion process versus mergers in the growth of SMBHs.

V. CONCLUSON

The development of reverberation mapping has allowed AGN studies to go beyond the limit of spatial resolution, bringing into view the central regions around supermassive black holes. The first use of reverberation mapping involved the broad optical and UV emission lines, and BLR reverberation has had a significant impact on measuring black hole masses. Recent campaigns have started to go to the next stage of mapping out the kinematics and geometry of the BLR. Further out, reverberation in the near-IR has set the size scale for the inner edge of the dusty torus. The application of reverberation mapping techniques to UV/optical continuum bands, especially with intensive monitoring campaigns led by Swift, has begun to probe properties of the UV/optical accretion disk but has many open questions relating to size of accretion disks, continuum emission from the BLR, and the relationship between the X-ray and UV/optical emitting regions. The development of X-ray reverberation mapping gives us a view to the inner few gravitational radii, close to the black hole, putting constraints on the size scale of the X-ray emitting region, closest to the ISCO. Putting all these techniques together covers the inner few hundred thousand gravitational radii from light-second size scales in the X-rays to light-years in near-IR.

REFERENCES:-

1. Barth, A., Ho, L., & Sargent, W. L. W. 2002, ApJ, submitted Bettoni, D., Falomo, R., Fasano, G., Govoni, F., Salvo, M., &Scarpa, R. 2001, A&A, 380, 471
2. Zu, Y., Kochanek, C. S., & Peterson, B. M. 2011, ApJ, 735, 80
3. Zacharias, N., Finch, C., &Frouard, J. 2017, VizieR Online Data Catalog,I/340
4. Woo, J.-H., Yoon, Y., Park, S., Park, D., & Kim, S. C. 2015, ApJ, 801, 38
5. Watson, D., Denney, K. D., Vestergaard, M., & Davis, T. M. 2011, ApJL,740, L49
6. Vaughan, S., Edelson, R., Warwick, R. S., &Uttley, P. 2003, MNRAS,345, 1271
7. Tomita, H., Yoshii, Y., Kobayashi, Y., et al. 2006, ApJL, 652, L13
8. Stalevski, M., Fritz, J., Baes, M., &Popovic, L. C. 2013, arXiv e-prints, arXiv:1301.4244