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The high energy emission of nearby supermassive black holes

S. Pellegrini

Dipartimento di Astronomia, Università di Bologna, Via Ranzani 1, I-40127 Bologna, Italy
e-mail: silvia.pellegrini@unibo.it

Abstract. The formation and evolution of the central massive black hole and of the host galaxy are intimately related; the understanding of how accretion (and its related feedback) work, though, and of their evolution over cosmic time, is still uncomplete. After the bright AGN phase accretion may switch to a radiatively inefficient mode, possibly associated with outflows, and/or accretion may be intermittent. I shortly present currently debated scenarios for the accretion modalities in the local Universe, and the role of Simbol-X to establish their importance.

Key words. Galaxies: elliptical and lenticular, cD – Galaxies: evolution – Galaxies: ISM – Galaxies: nuclei – X-rays: galaxies

1. Introduction

Supermassive black holes (MBH) are present at the center of the spheroids of the local universe, with MBH$\sim$ 10^7 – 10^9 $M_\odot$ and important correlations link MBHs and the host galaxies (Tremaine et al. 2002). Therefore the MBH birth, growth and activity cycle must be linked to the formation and evolution of the spheroid, however our understanding of how MBHs and galaxies coexist is still uncomplete. For example, feedback from the MBH should regulate starformation at early epochs; in later epochs, feedback is required to solve the "cooling flow" problem (Ciotti & Ostriker 2001; Omma et al. 2004). Observationally the nuclei of most spheroids of the local Universe are either radiatively quiescent or show low levels of activity (Ho 2005). *Chandra* observations allowed to measure X-ray emission (a key symptom of accretion) from a significant number of nuclei [Fig. 1, Pellegrini (2005)].

Thanks to the angular resolution of *Chandra*, the mass accretion rate at the accretion radius (~few 10^5 Schwarzschild radii) within the Bondi theory could be determined; numerical simulations of the hot ISM evolution also show accreting flows [at a rate $\dot{M}$ $\sim$ 0.1 – 10^{-4} $M_\odot$/yr at the present epoch; e.g., Pellegrini et al. (2007)].

Send offprint requests to: S. Pellegrini

2. The Main Questions

1) How is the MBH activity switched off while the accretion rate decreases?

After the bright AGN phase, if the mass accretion rate goes below $\dot{M}$ $\sim$ $0.01\dot{M}_{Edd}$, the standard disk may transit to an optically thin radiatively inefficient accretion flow [RIAF; Quataert & Narayan (1999)]. This could concern a few of the nuclei in Fig. 1, if the Bondi

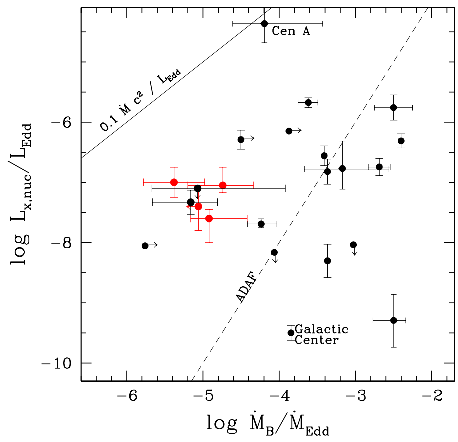

Fig. 1. $L_{X,nuc}$ and $\dot{M}_{Bondi}$ measured from *Chandra* data [from the sample of Pellegrini (2005); red points from Soria et al. (2006)]. The dotted line is the predicted emission for a standard optically thick accretion disk, the dashed one the predicted emission level for RIAFs without winds (see Sect. 2).

rate is close to the true accretion rate. Also intermittent AGN activity is suggested by hydrodynamical simulations with nuclear feedback (Ciotti & Ostriker 2001; Omma et al. 2004). Finally, scaled-down AGN emission, possibly highly obscured, has been studied for some cases [e.g., Pellegrini et al. (2007); Panessa et al. (2007)].

2) The best studied MBH resides at the Galactic Center. Can its radiatively inefficient model (Yuan, Quataert, & Narayan 2004) be considered a baseline model for local spheroids? Actually, early type galaxies lack complicacies as central massive stars and/or supernovae linked to central starformation. Therefore they are ideal laboratories for studying low accretion rate physics.

In the RIAF case, the hot thermal electrons produce bremsstrahlung (with kT∼few to 100 keV) and Inverse Compton of synchrotron photons (with photon index $\Gamma \sim 2$) in the X-rays. Sensitivity at the hard X-rays up to 70 keV, such as that expected for Simbol-X, would allow us to determine reliably the spectral shape in this band for the first time. We could then contrast the normal AGN scenario vs. the RIAF scenario. For Seyfert-like spectra we expect an X-ray slope of $\Gamma \sim 1.8$, plus possibly a reflection hump, strong variability on short timescale, Fe K line emission at 6.4 keV (see De Cia et al., this meeting). However, from Fig. 1, $\dot{M}$ must be $<< \dot{M}_{Bondi}$ (due to feedback?) or emission must be highly obscured, as discussed in Pellegrini 2005; Pellegrini et al. 2007. For RIAFs, taking $\dot{M} \sim \dot{M}_{Bondi}$ of Fig. 1 at their outer boundary, and MBH from dynamical studies, one expects the hard X-rays dominated by Comptonized emission (if no wind), and by bremsstrahlung emission, with an inner $\dot{M} << \dot{M}_{Bondi}$, if a wind is important (Quataert & Narayan 1999). Also, no variability is expected on scales < 1 yr (Di Matteo et al. 2000).

The feasibility has been checked for the SDD and CZT detectors with the Simbol-X data simulator at http://www.asdc.asi.it/simbol-x/index.php?page=/simulator/simbol-x/index.php. The Simbol-X HPD of 10 – 15″ (see documents at www.asdc.asi.it) implies that only the brightest nuclei of the Pellegrini (2005) sample can be studied, due to contamination from the collective emission of unresolved X-ray binaries for $L_{X,nuc} < 10^{40}$ erg s^{-1}. Then, for a few nuclei with a 2–10 keV flux of > 10^{-12} erg cm^{-2} s^{-1} good quality spectra (so to discriminate between the possibilities above) can be obtained in exposure times of ∼ 100 ksec.

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