The efficient low-mass Seyfert MCG-05-23-016

or: How to build 10^8 $M_\odot$ black holes until z=7

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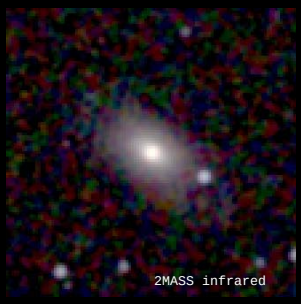
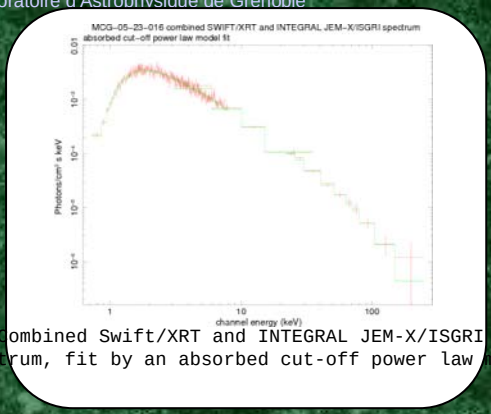
The Object

MCG -05-23-16 is one of the brightest Seyfert galaxies in the X-rays. It exhibits moderate bolometric luminosity (L_{bol} ~ 3 10^{44} erg/sec) with a comparably small central black hole mass of M_{BH} = 2 10^6 Mo (Wang & Zhang 2007). This Seyfert has been observed extensively by previous missions, like RXTE, BeppoSAX, XMM-Newton, and Suzaku (Reeves et al. 2007).



2MASS infrared image



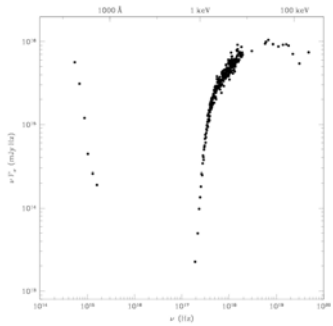
Combined Swift/XRT and INTEGRAL JEM-X/ISGRI spectrum, fit by an absorbed cut-off power law mo

The Data

We performed a simultaneous INTEGRAL and Swift observation campaign on MCG-05-23-016 in 2006 and 2007.

The spectra span from 0.5 keV up to several 100 keV. Little variation is seen in the overall luminosity during the 1.5 years ($L_{2\text{-}200\ keV}$ = 10^{44} erg/sec). The spectrum can be modelled by a cut-of power law with photon index 1.5 and cut off energy 70 keV, while one observation does not require a cut-off. The reflection component in the combined data is R < 0.3. The iron Kα line is weak (EW = 60 eV).

Applying a Compton reflection model (compTT) we get a overall plasma temperature of kT = 18 keV with an optical depth of τ=2.5. Over the 1.5 years time we see an anticorrelation of plasma temperature and optical depth



Spectral energy distribution derived from Swift and INTEGRAL observations

The Results

MCG -05-23-16 shows variable Compton reflection when compared to previous observations (R = 0 … 1). The reflection component of R>0.7 in 2005 (Reeves et al. 2007) disappeared within a year to R<0.3. At the same time, the iron line decreased from EW=130 eV to EW = 60 eV. No variability in the UV and optical range is observed. The Seyfert galaxy shows a very high Eddington ratio for a low-mass central engine. At the same time, the cut-off energy is comparably low (70 keV) when compared with other X-ray bright AGN.

Background image: INTEGRAL IBIS/ISGRI 20-40 keV signifcance map

Growing super massive black holes until z=7

Quasars have been observed up to z=6.4. How do we get 10^8 solar mass black holes at z=7 ? MCG-05-23-16 might be an example. With a black hole mass of only 2 10^6 $M_\odot$ (less than Sgr A*!) but an Eddington ratio of L_{bol}/L_{Edd} > 0.8, this Seyfert is a highly efficient accretor.

It is reasonable to assume that there are galaxies at z=10, with bulge masses of 10^9 Mo. The mass of the central black hole scales with the bulge as $M_{BH} \sim M_{bulge}^{\ 3}$. Assuming a starting mass of M_{BH}=10^6 $M_\odot$ at z=10, an Eddington ratio of 0.8 and a duty cycle of only 20% (likely to be larger at z>7, see Wang et al. 2008), one reaches black hole masses of 10^8 $M_\odot$ at z=7.

Thus, objects like MCG-05-23-16 show us how super massive black holes might have evolved in the very early universe.

Background graphic: Virgo Cluster. Credits: Cuillandre/CFHT

ISDC DATA CENTRE FOR ASTROPHYSICS

The ISDC is located near Geneva (Switzerland). It functions as the science data center for the INTEGRAL mission, provides services and software for Planck and Gaia, and will be involved in the XEUS mission as well as