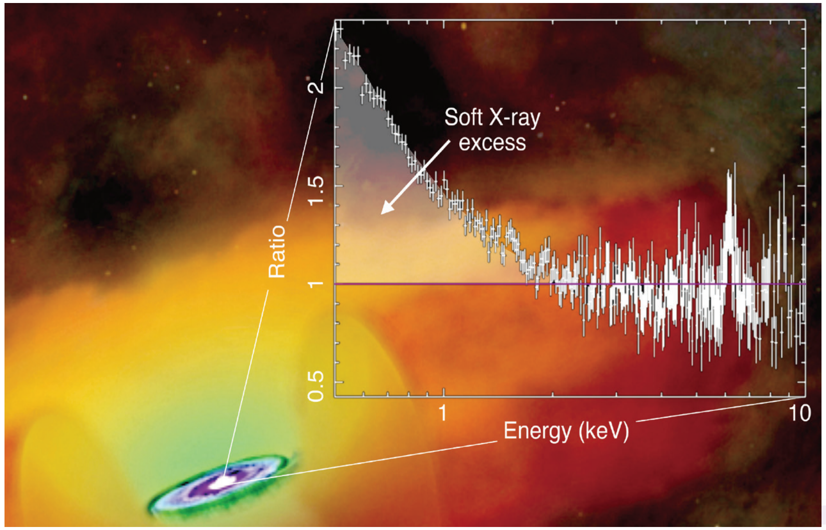
# Unveiling the Nature of the Mysterious Soft X-ray Excess in Active Galactic Nuclei


**Francesco Ursini, Giorgio Matt**
(Roma Tre University, Italy)

**Pierre-Olivier Petrucci**
(IPAG, France)


*The XMM-Newton/PN spectrum of Mkn 841 fitted in the 3-10 keV band and extrapolated to soft X-rays. The excess is clearly apparent, but different models provide equally good fits to the data. Only Athena will have the sensitivity to distinguish between them. In the background an artist's view of an AGN (credits: NASA/CXC/M.Weiss).*

While all galaxies are believed to host a supermassive (millions to billions of solar masses) black hole at their center, only a fraction are considered 'active' (Active Galactic Nuclei, hereinafter AGN). This activity occurs when there is a sufficient supply of matter that can accrete onto the black hole. The matter flows via an accretion disk, a flattened configuration in which particles spiral around the black hole in quasi-Keplerian orbits, releasing energy via dissipative processes. This energy is then radiated away, mostly as optical-UV light, in what is the most efficient mechanism in the Universe to convert energy into radiation.

AGN are also strong X-ray emitters. Close to the black hole, a cloud of very hot electrons (temperatures up to hundreds of millions degrees!) may form. This so-called 'hot corona' emits X-rays by transferring energy to the optical-UV photons from the accretion disk. In most sources, however, a further component – discovered already in the 80s, and called the soft X-ray excess - arises, dominating the emission below 1-2 keV. It is widely believed that this component is related to the accretion flow, but its exact nature is still a matter of debate. There are two main models for this emission. The first one is blurred reflection: the hot corona illuminates the rotating disk which, if significantly ionized, efficiently reflects the soft X-ray photons. Strong gravity effects from the central black hole then modify the spectral shape of this reflection component, further blurring any emission line. The second contender is the warm corona: a layer of highly ionized matter above the disk which, similarly to the hot corona, transfers energy to the accretion disk photons but, having a much lower temperature (less than a million degrees), emits mostly in soft X-rays. Depending on the process at work, different effects on the dynamical, spectral and temporal properties of the accretion flow are expected.

Understanding the nature of the soft X-ray excess can therefore provide an important missing piece in our view of how matter accretes onto black holes. Is one of the two processes always the dominant one? Or are both present and, if so, what parameter regulates their relative importance? Unfortunately, the present X-ray observatories just fall short to solve this puzzle: too often, both models fit the data acceptably. But, fortunately, *Athena* will enter the game. A large effective area in soft X-rays, in order to reveal the subtle differences in the spectral shape between the two models, is in fact what is most needed, especially if coupled with high spectral resolution to detect the – likely faint – emission lines possibly arising in the warm corona scenario. *Athena* will distinguish among models in a large sample of sources, promising to finally solve this problem after 50 years of its discovery.