eROSITA's Window into the X-ray-Transient Sky: AGN Accretion in the Era of Big Data

Przegląd nieba rentgenowskiego za pomocą eROSITA: akrecja w Galaktykach Aktywnych w erze danych masowych

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A supermassive black hole, weighing millions to billions times the mass of our Sun, resides at the center of most large galaxies. When gas and dust from the galaxy accrete onto the black hole, an Active Galactic Nucleus (AGN) is formed; the AGN releases large amounts of light across the electromagnetic spectrum as well as collimated jets of outflowing gas. AGN are the brightest persistent sources of light in the Universe; in fact, due to their brightness, these objects can be seen across almost the entire Universe. Astronomers seek to understand how black holes grow over cosmological time, as well as their connections to their host galaxies' supply of gas and dust. We aim to study the exact geometry of the infalling gas and how this gas gets transported past the event horizon and onto the black hole, thereby causing it to grow. We also need to understand the fraction of time that the average black hole is actively gaining mass: is accretion continuous or intermittent? How fast can an AGN be started, once fuel is supplied? How does the structure and distribution of matter evolve when the fuel supply varies?

X-rays are emitted from the innermost and hottest parts of the accretion flow onto the black hole, so studying X-rays is the key to unlocking the structure of the innermost flow. But because these regions are too small to image, we must use other tools, namely energy spectra and studying how AGNs' brightness levels and spectra vary over time. This variability, when studied in the X-rays, tells us the amount of gas falling onto the black hole and the distribution and structure of that gas, and how it depends on the mass accretion rate.

To answer these questions, we have formed a German-Polish collaboration of AGN experts to use eROSITA, a new X-ray telescope. The German-built eROSITA instrument is the primary X-ray telescope aboard *Spectrum Roentgen Gamma* (*SRG*), a new spacecraft that Russia will launch into space in April 2019. Not only will eROSITA detect by far the largest amount of X-ray-emitting AGN, it will observe these objects at least eight times during its four year mission as it scans the entire X-ray sky repeatedly. Our team will monitor a sample of roughly one million X-ray-emitting AGN, compare X-ray emission measured every six months, study how the X-ray emission varies, and accumulate statistics on how frequently major brightness or spectral changes occur. No other current or future X-ray mission will be able to match eROSITA in terms of target numbers and baseline timescale. This means that our collaboration is best poised to observationally determine the average AGN X-ray activity lifetime and test models of the structure and distribution of the accreting gas. We will then better understand major changes in AGN output as well as the likelihood of observing such changes.

Both countries will benefit from the international cooperation as it will transfer knowledge in both directions. Current and future Polish scientists will be able to work with the unique German eROSITA data set, while Poland is leading critical follow-up observations of the most dramatic changes found in eROSITA AGN.