Supermassive Black Hole Winds in X-rays

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(1) RATIONALE:
It has been proposed that gas flows in the form of energetic winds may play a pivotal role in galaxy evolution (e.g. King & Pounds 2015, ARA&A 53, 115): 1) their presence regulates both accretion and ejection of material onto and from the Supermassive Black Holes (SMBH, $10^6$-$10^{10}$ $M_{\odot}$) sitting in the nuclei of virtually all galaxies; 2) the gas accelerated by the radiation pressure from the accretion disc in sources accreting near the Eddington limit interacts with the host galaxy Interstellar Medium (ISM), propagating momentum and energy and providing an efficient feedback mechanism (e.g. Zubovas & King 2012, ApJ 745, L34).

The outflows developing in AGN host galaxies have a multiphase nature, as revealed by observations and expected from simulations (Cicone+18, Nat. As. 2, 176; see Figure 1). Theoretical models ascribe an important diagnostic role to relativistic hot, ultrafast outflows (UFOs) produced by the innermost gas close to the accretion disc (<1 pc) that first feels the pressure from the AGN radiation field. These winds are detectable through strongly blue-shifted absorption lines associated with highly ionized iron atoms (Fe xxv and Fe xxvi) observable at energies E>6 keV (e.g. Tombesi+10, A&A521, A57).

From an observational point of view, the characterisation of UFOs in terms of physical properties (e.g. mass outflow rates, duty cycle) and their incidence in relation to the AGN properties has been mainly carried out so far through studies based on archival data, focusing mainly on two cosmic epochs and two luminosity regimes (Figure 2 upper panel; z<0.1 and z>1).

(2) SUBWAYS PROJECT
In order to shed light on the role of UFOs and winds in galaxy evolution, we have been awarded a Large Program of ~1.6 Ms with XMM-Newton in AO18, SUBWAYS (“Supermassive Black Hole Winds in X-rays”). This is the largest program ever approved in a single XMM-Newton cycle in the scientific category “Active Galactic Nuclei, Quasars, BL-Lac Objects and Tidal Disruption Events” over 20 years.

SUBWAYS has been designed to provide a direct test of QSO feedback models via observations of ~25 sources at z=0.1-0.5 and $L_{bol}>10^{45}$ erg/s, carefully preselected from existing XMM-Newton archival snapshot observations. This enabled us to envisage an observational strategy to obtain X-ray spectra of unprecedented quality (~10,000 net counts in the rest-frame 4-10 keV, comparable to that obtained for local Seyferts; see Figure 2 lower panel). With such high counting statistics will obtain homogeneous characterisation of UFOs properties in a luminosity and redshift range not yet explored, and perform robust measurements of the underlying physical parameters (e.g. ionization parameter, velocity vout, column density NH, covering factor) needed to constrain models.

SUBWAYS represents the indispensable step needed to subsequently investigate the appearance of outflows phenomena across various galaxy scales, gas phases and wavelengths. We already secured 27 HST orbits in cycle 27 (PI:G. Kriss) to obtain COS spectra and cover all strong UV lines, and we plan to extend the multiwavelength coverage in the optical (MUSE), millimeter (NOEMA, ALMA) and radio (JVLA) bands, as well as at higher X-ray energies (NuSTAR).

(3) STATUS OF THE XMM-NEWTON OBSERVATIONS
Observations started in May 2019 and 4 sources have been observed and PPS processed so far. The PPS images in the 0.2-12 keV band, obtained combining MOS1, MOS2 and pn are shown below, along with the detected net counts in the 4-10 keV band, on average in very good agreement with our estimations!

(4) WE WANT YOU!
Next month we will open a position at DIFA & INAF-OAS on data reduction and analysis of the XMM-Newton SUBWAYS observations (funded by ASI from the agreement ASI-INAF n.2017-14-H.0).

STAY TUNED & APPLY!