Science Review: SMART-X Reviewed by CST and Support Team

Overview/General Notes:

SMART-X, 'Square Meter, Arcsecond Resolution X-ray Telescope' is a large mission concept that uses adjustable optics to focus to ~1/2 arscecond on axis, has an estimated 2.3 m^2 at 1 keV effective area, covers 0.1-10 keV, and would be in an L2 orbit. Its focal plane would contain a 5eV calorimeter with a 5 arcmin FOV and 9e4 pixels, an active pixel sensor with a 22 arcmin FOV and moderate energy resolution, and a grating spectrograph. The optics are currently at TRL-2 and require an investment of technology funding to reach TRL-6 by the end of this decade. Given this investment, the mission could be ready to start in the early 2020s. The cost is estimated at $2.3B, putting it above the upper RFI cost bin of $2B. Quoting from the RFI response, such a mission would meet "almost all of the IXO science goals...in many areas transcending" them. It would not be able to do the high energy IXO science. It is a highly capable in the areas of early AGN, feedback, and cluster evolution/cosmology.

1) What happens close to a Black Hole?

Concept	Measurement
Strong gravity predicts effects on X-ray spectra	Time resolved high resolution spectroscopy of the relativistically-broadened Fe K features

The effective area at 6 keV is 0.17 m^2; the RFI response estimates 5 to 10 AGN would be bright enough for orbitally revolved spectra. This compares to 0.6 m^2 for IXO, which puts 20 to 30 AGN within reach.

2) When and how did super massive Black Holes grow?

Concept	Measurement
Distribution of spins determines whether black holes grow primarily via accretion or mergers.	Measure the spin in supermassive black holes from broad Fe K line

Concept	Measurement
wide field, deep surveys can count AGN at high z	deep surveys will get to z=10

SMART-X can do time averaged measurements of the Fe line to get spin measurements for about 40 SMBH, vs. 300 for IXO. In addition, SMART-X has the sensitivity to detect the first black holes in the process of formation at z=10.

3) How does large-scale structure evolve?

Concept	Measurement
Find and characterize the missing baryons in the IGM	High resolution absorption line spectroscopy of the WHIM over many lines of sight using AGN as illumination sources.

Concept	Measurement
Detect the growth of cosmic structure and the evolution of the elements	Measure the mass and composition of a survey of clusters of galaxies at redshift < 2

The gratings have about 3x the area and slightly better resolving power as compared to IXO, so SMART-X has ~2x the sensitivity for detecting the WHIM in absorption. SMART-X also is better than IXO at measuring cluster masses and abundances. Clusters are resolved out to all z, and a 10Ms observing program will be able to do precision cosmology tests out to z~1.5.

4) What is the connection between supermassive black hole formation and evolution of large-scale structure (i.e., cosmic feedback)?

Concept	Measurement
Resolve cluster bubbles and cavities and AGN jets where energy from AGN is deposited	Measure the metallicity and velocity structure of hot gas in galaxies and clusters

Concept	Measurement
Galaxy dark matter halos, and AGN, have formed by z=6, and both are x-ray bright	Measure the co-evolution of AGN/SMBH and their associated dark matter halos from z=6 to z=0, via spatially resolved imaging/spectroscopy

Due to its improved PSF, SMART-X is more capable than IXO in this area. Spatially resolved velocity measurements of AGN/cluster interactions, which directly probe cosmic feedback, are possible out to z~0.5. It is possible to detect feedback at z=1.

5) How does matter behave at very high density?

Concept	Measurement
Neutron star Equation of State can be mapped by measuring M,R for a range of NS	Measure redshift, pressure broadening in Fe absorption lines during X-ray bursts to determine M and/or R

Concept	Measurement
Neutron star Equation of State can be mapped by measuring R, M for a range of NS	Not discussed in RFI, but likely: Waveform fitting of X-ray burst oscillations from hot spot on NS surface

The gratings have several times the area of the IXO gratings, so can be used to search for metal lines in the atmospheres of slowly spinning NS. The APSI can count at high rates, so pulsation studies are possible at CCD-like (but not calorimeter like) resolution.