Science Summary: SAHARA

Reviewed by CST and Support Team

Overview/General Notes:

SAHARA, 'Spectral Analysis with High Angular Resolution Astronomy' is a medium cost ($793m) mission concept that uses the IXO slumped glass optics in a short focal length, medium FOV configuration, feeding a calorimeter, in a lower background LEO (not L2) orbit. Effective area is $0.3m^2$, PSF is 5 arcsec, FOV is 8 arcmin, energy resolution is 1.5-4.0eV. The mission is compared to ROSAT, as it is similar in concentrating on the lower x-ray band (0.2-3.0 keV) but is updated with a calorimeter and higher area. The calorimeter energy resolution allows powerful spectral diagnostics from C, N, O, Ne, Mg and Si, and the L-shells of Fe and Ni. SAHARA can address the first 4 of the 5 IXO science themes listed in the RFI, and allows substantial additional science listed in NWNH.

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 Fe-K (rather than Fe-L) lines

The prime IXO technique for this, time resolved spectra of the Fe-K line at 7keV, will not be possible with the projected effective area (or may just be possible in one or two sources); but if Fe-L lines are common it may be possible at ~1 keV, but this is somewhat speculative. Warm absorbers are listed under this topic, but really belong under 4)

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

Concept	Measurement
Number counts and spectra at moderate to high z can probe growth of SMBH	Surveys will detect numerous AGN from $1<z<2$, and some at $z=6$, many with good spectra

The 8 arcmin FOV and 5 arcsec PSF combine to allow surveys which can detect numerous AGN at z=1 to 2, and target searches will probe to z=6. Serendipitous surveys of 10^5 sec will reach 10^{-14} erg/cm^2/s and detect ~500 high quality spectra per year. This large x-ray selected sample will probe the formation and growth of SMBH. The IXO approach of a Fe-K line based 'SMBH spin survey' is not mentioned.

3) How does large-scale structure evolve?

Concept	Measurement
Precise cluster masses are critical for measuring growth of large scale structure	Map cluster dynamics, turbulence, and abundances out to z~1

SAHARA can map galaxy cluster dynamics, turbulence, and abundances out to z~1, thereby obtaining precise mass measurements which are critical for measuring the growth of large-scale structure. The virial radius of clusters at z=1 is fully encompassed in the FOV, so rastering is not necessary.

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

IXO Concept	IXO 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

SAHARA Concept	SAHARA Measurement
Warm absorbers may transport AGN energy to galaxy/cluster	Measure density and velocity of warm absorbers, therefore determining kinetic energy outflow

The angular resolution is sufficient to resolve cluster cool cores and cavities out to high z, and the calorimeter will measure turbulence, abundances and velocity flows from the nuclear AGN. This allows direct probes of the nature of cosmic feedback. Listed under topic 1, but probably really more appropriate here, SAHARA can measure the density and velocity (therefore kinetic energy) of the outflowing warm absorbers around 300 AGN with 10^6 sec exposures (total time=10years?); in the brightest 30, time resolved studies are possible.

5) How does matter behave at very high density?

Concept	Measurement
n/a	n/a

'Not known to be possible with SAHARA'