Science Review: WHIMex   Reviewed by CST and Support Team

Overview/General Notes:

There are two RFI rsponses combined here; one by C. Lillie and one by W. Cash. Neither contains significant scientific detail, but instead both focus on the mission and community issues, respectively, with a brief discussion of the science capabilities.

The primary instrumental elements are the grazing incidence mirrors, an off-plane reflection grating, a deployable optical bench (7 m focal length), and CCD detectors. Spectral resolving power ~4000 is maintained with ~ 300 cm^2 effective area over 0.2 – 0.8 keV, and 20-40 cm^2 over 0.9 - 1.4 keV. WHIMex was proposed in the recent Explorer competition (but not selected) with an estimated cost of $200 M (excluding launch vehicle).

Technical challenges include the mirrors and gratings, which the RFI response describes as being at TRL 5.

1) What happens close to a Black Hole?

Strong gravity predicts effects on X-ray spectra	*No discussion in RFI, but if Fe-L lines in H1H0707-495 are common, this may provide an approach*

There was no discussion of this science. If the broad iron L-shell lines in 1H0707-495 are confirmed, then WHIMex could detect them. However, calculations are needed to determine whether the detection time is less than the orbital time scale.

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

There was no discussion of this topic in either submission, and it is not clear if there is any way for WHIMex to do this science.

3) How does large-scale structure evolve?

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.*

The mission will 'Find and characterize the missing baryons in the IGM' using high-resolution absorption line spectroscopy of the WHIM over many lines of sight using AGN as illumination sources. This was the primary goal of the WHIMex explorer proposal. IXO was committed to WHIM-finding (~20% of the planned exposures). But with ~1/4 of the effective area of the IXO XGS, a 3-5 year WHIMex mission would need to spend the majority of its time on blazars to characterize the WHIM. The redshift distribution and limit for such targets needs to be defined, although it appears the majority of detections will be at a range of relatively low ($z<\sim 0.3$) redshifts. How will this affect the resulting constraints on structure evolution?

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

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

The mission will `Measure mass/energy outflow from AGN' by determining the density of warm absorbers (which combined with the velocity gives the kinetic energy). This will be done by measuring the time-delayed response of the warm absorbing cloud to a change in the central engine, as well as via density-dependent line ratios. Velocities will be measured via Doppler shifts. Feasibility needs review.

5) How does matter behave at very high density?

Neutron star Equation of State can be mapped by measuring M,R for a range of NS	*Not discussed in RFI, but presumably can search for atmospheric absorption lines*

This was not discussed in the submission, although the same techniques used by the IXO XGS – measuring gravitational redshift and pressure broadening in Fe absorption lines during X-ray bursts – can be used to determine the mass and/or radius of neutron stars, and thus constrain their equation of state.