Science Review: AEGIS Reviewed by CST and Support Team

Overview/General Notes:

AEGIS has one instrument, a CAT grating spectrometer, which works with segmented glass optics as planned for IXO except with a much shorter focal length (4 m) and over the soft energy bandpass (0.2-1 keV). The CAT grating has relaxed figure and alignment tolerances than e.g., the Chandra transmission gratings. The strategy is to use an optic with 10" HPD with sub-aperturing to produce a 3" Line Spread Function for each grating module. The combination is a high collecting area at E<1 keV (1400 cm^2 at 0.89 keV) and very high spectral resolving power ($E/\Delta E > 3000$). This is estimated to be a $760M mission.

A major question is how will the gratings be used to measure the mass and composition of clusters of galaxies to z=2?

1) What happens close to a Black Hole?

Concept	Measurement
Accretion disk structure: Study behavior of wind and disk-dominated "soft state" in Galactic black holes	Measure absorption features in 0.3-1 keV spectra

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

AEGIS operates at E<1 keV and will thus probe well the accretion flow and the rich set of ionization states available in the 0.3-1 keV band. The science focus is on short timescale variations in Galactic black holes. Specifically, AEGIS will excel at studying the wind and disk-dominated "soft state" in Galactic binaries. The absorption features visible in the soft state are thought to be associated with magnetic processes in the disk. AEGIS will need to rely on external means to alert it to new black hole transients and transitions in state in Galactic sources.

The focus is thus more towards accretion physics rather than strong gravity.

However, the team does mention that broad Fe L may test the physics of strong gravity (3 AGN have been observed to have relativistically broadened Fe L). These measurements would be complicated by line blends (not a problem for Fe K).

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

This science question is not addressed by this RFI submission.

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.*

The gratings are similar (in fact somewhat better) to those proposed for IXO and will make measurements of the WHIM/IGM in absorption to probe Large Scale Structure as were planned for the IXO original mission.

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

Concept	Measurement
Determine the impact of AGN outflows on surrounding environments	High resolution spectroscopy of warm absorbers and higher velocity outflows in AGN

AEGIS will make spectroscopic measurements of outflows from AGN (warm absorbers as well as higher-velocity flows). There will be precision density and ionization measurements that will allow a precise determination of the output from these sources. The measurement of AGN outflows are of course in velocity and thus only along the line of sight. With six CAT grating spectrographs, AEGIS has the ability to take measurements at six different observing angles simultaneously.

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*

Since the gratings are similar to the IXO gratings, the NS EOS measurements described for the IXO gratings are very similar. AEGIS will make precise spectroscopic measurements of absorption lines in slowly rotating neutron stars, permitting measurement of properties of the NS atmosphere and thus constraining mass, radius and the NS EOS.