Overview

The Energetic Physics Explorer (EPE) is envisioned to perfom high spectral resolution resolution (~2.5 eV) spectroscopy over a large range of source intensities. The response nicely summarizes in its Table 1 how the IXO objectives are addressed, and quantifies the number of targets available to address each objective.

The instrumentation consists of a conical foil mirror with 1 arc minute angular resolution, 10 m focal length, and effective area of 5000 cm^2 at 1 keV, plus a 40x40 pixel calorimeter, with pixels designed to handle high count rates. A lower TRL option is the use of a microchannel plate optic, which would dramatically increase the collecting area. The calorimeter subtends a field of view of 2 arc minutes. The small field of view makes the instrument effectively a "light bucket."

The fixed optical bench and spacecraft components are all essentially off the shelf, making this a relatively low risk mission. The mission would be launched to L2 on a Falcon 9 or equivalent and have a 3-year lifetime with a goal of five. This mission cost is estimated to be between $600M and $1B, placing it squarely in the medium class. Further, the prudent selection of instrumentation and components make EPE a mission that could be developed in the very near term.

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 combination of large collecting area and high spectral resolution allows EPE to perform the premier IXO strong gravity measurement – tracking blobs of gas as they spiral in toward the black hole. EPE will be able to do this for approximately a dozen sources, fewer than IXO, but still a substantial number.

Additionally, the winds from the disks of Galactic black holes can be characterized by high resolution absorption spectroscopy in the Fe K band. Such studies reveal how energy from the black hole systems escapes.

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

EPE will measure the shape of the broad Fe line as a function of redshift in a sample of bright AGN. Approximately ~40 sources are available to EPE, compared with ~300 available to IXO.

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 ~100 nearby. Resolved clusters from REFLEX catalog

EPE can perform absorption studies of the WHIM/IGM using bright AGN as illumination sources. Approximately 20 sources are available for such measurements. The spectral resolution of the calorimeter below 1 keV is worse than a grating, but the assertion is made that the much higher collecting area of EPE will compensate for the reduced spectral resolution. The ability to perform these observations depends critically on what bandpass filters need to be placed in front of the calorimeter.

EPE can also measure the properties of outflows from approximately three dozen starburst galaxies. The flows from approximately one dozen of these can be spatially resolved. Note that obtaining independent measurements to perform spatially resolved studies requires extents of several arc minutes (to compensate for the angular resolution) and multiple pointings.

EPE will measure the mass and composition of ~100 clusters. Because multiple pointings are required to perform these kinds of measurements, they will be time consuming.

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

Concept	Measurement
Turbulent pressure support is one of the crucial remaining uncertainties in precisions mass measurements	Turbulence can be mapped in nearby clusters, and measured in more distant unresolved clusters

EPE will measure the turbulent velocities in clusters of galaxies. It is unclear how well such measurements on arc minute scales constrains models. Mapping requires multiple pointings.

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

EPE's ability to observe bright sources allow it to search for features in the spectra of X-ray bursts. Such features might reveal relativistic broadening and/or gravitiational redshift, thereby allowing measurements of neutron star mass and radius. A handful of sources are accessible to EPE for these kinds of observation.