Science Review: AXTAR

Reviewed by CST and Support Team

Overview/General Notes:

AXTAR is a medium sized (~$500M including launch vehicle) timing mission (1us resolution, 90% throughput at 10Crab) that is a scaled up/improved version of RXTE, with 5 to 10x the area ($3m^2$ at 6keV, bandpass 1.8-80 keV, energy resolution 600-250 eV), in a low inclination LEO for reduced background. It has been around for several years and has been well studied, for example the cost estimate is from the MSFC Advanced Concepts Office. It is very similar to LOFT, an ESA-M class mission currently in phase-A study, and the proposers state that if LOFT goes they would not pursue AXTAR. It is a non-imaging mission (FOV 1 degree, positions to 1 arcmin), so it limited to observing bright (>1 mCrab) sources and indeed would spend most of its time observing sources much brighter. Its coverage of IXO science topics is therefore limited.

1) What happens close to a Black Hole?

Concept	Measurement
strong gravity predicts effects on X-ray spectra	time resolved LOW resolution spectroscopy, mainly continuum fitting rather than Fe-Kα line

Concept	Measurement
Strong gravity effects via high frequency QPOs modeling	timing studies, harmonic content, at high count rates with high throughput

This is a key science area for AXTAR. While AXTAR will measure the FeK line (the preferred IXO method) it has modest energy resolution (600eV to 250eV) so will be limited here. Instead it will use continuum fitting and QPO analysis to probe close to the BH. While both techniques clearly probe very close to the event horizon, understanding the QPO requires detailed modeling. The theory for this has been developing, but is somewhat uncertain. Within a specific theory, BH spin rates can be measured to 10% to 20%.
Here you cannot test GR in the same way IXO does by looking at hot spots – you need to assume GR is correct in order to make the models, and you don't know if the linear or non-linear modes are dominant.

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

Concept	Measurement
n/a	n/a

There was no discussion of this science in this submission, and it is not clear if there is any way to do this science with AXTAR.

3) How does large-scale structure evolve?

Concept	Measurement
n/a	n/a

There was no discussion of this science in this submission, and it is not clear if there is any way to do this science with AXTAR.

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

Concept	Measurement
n/a	n/a

There was no discussion of this science in this submission, and it is not clear if there is any way to do this science with AXTAR.

5) How does matter behave at very high density?

Concept	Measurement
Neutron star Equation of State can be mapped by measuring R, M for a range of NS	Waveform fitting of X-ray burst oscillations from hot spot on NS surface; broadband spectrum of NS surface

This is the other key area for AXTAR. Again, the IXO technique - photospheric absorption lines – is not possible here, but there are other techniques. The preferred technique here is modeling the burst oscillations, in particular their harmonic content. Relativistic effects are important and probe the M/R of the NS. An additional technique is modeling the overall spectrum from the NS surface. AXTAR can determine M/R for ~20 NS to an accuracy of 5%.