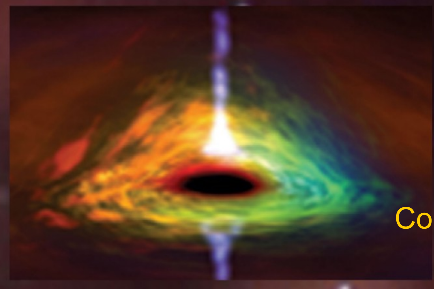
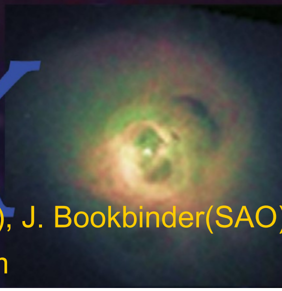
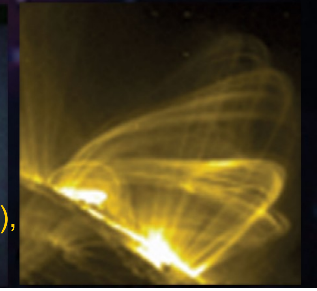


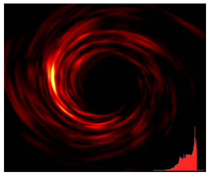

Constellation X

The Constellation X-Ray Mission

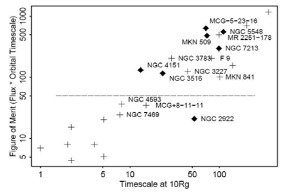
Constellation-X Science and Technology: M. Garcia(SAO), A. Hornschemeier(GSFS), J. Bookbinder(SAO), N. White (GSFC), H. Tananbaum (SAO), and the Con-X Team

Con-X Science



MHD/GR SIMULATION OF HOT SPOTS ORBITING NEAR EVENT HORIZON

Con-X will bring the dimension of TIME to the study of accretion disks in the strong gravity region, by being the first observatory with sufficient collecting area to track the orbital motion of individual hot spots at the event horizon. In the thin disk model appropriate for numerous BH, the hot spots act as free-falling test particles to 1% accuracy.

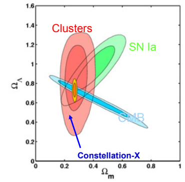


SUITABLE TARGET BLACK HOLES KNOWN AND NUMEROUS

The capability to perform these tests of strong gravity can be described by a figure of merit which is the product of the orbital timescale and observed flux. Black holes above the dashed line have sufficient figure of merit. The objects shown by diamonds are already known to have strong FeK lines; the others are assumed to have average strength lines. Ongoing observations may double target list.

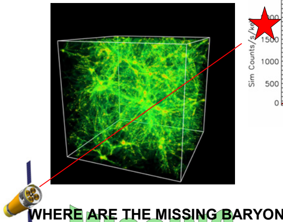
MAJORITY (6/7) OF INTERACTING, BARYONIC MATTER IN CLUSTERS IS HOT

Chandra X-ray Observations of a merging Cluster where the non-interacting dark matter in the clusters (blue) is clearly separate from the normal interacting matter (pink), directly ruling out modified gravity models (Markevitch et al 2006). Constellation-X will enable the first mapping of the velocity field of merging Galaxy Clusters to ~200 km/s (or better)



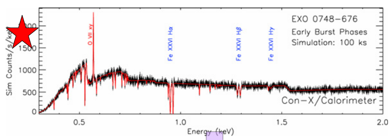
CLUSTERS ARE EXCELLENT FOR TESTING COSMOLOGY

Con-X observations can give a factor of 10 improvement in dark energy parameters via the control of systematics enabled by the excellent energy(=velocity) resolution inherent in imaging calorimeters. This result is competitive with the best that can be done with SN Ia and other techniques. Furthermore, the cluster observations can give this improvement via three independent methods. 1) Using the gas mass fraction as a standard ruler, 2) In combination with sub-mm data to measure absolute cluster distances via the S-Z effect, and 3) Measuring the evolution of the cluster mass function with redshift and thereby revealing the growth of cosmic structure.



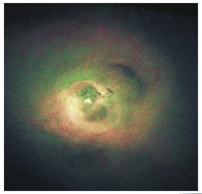
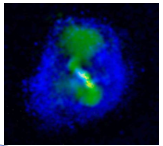
WHERE ARE THE MISSING BARYONS?

Approximately 60% of the baryons at z<2 are undetected, and expected to exist in as warm/hot intergalactic matter (WHIM). Con-X can make the first unambiguous detections of this matter by detecting atomic absorption lines at various z superposed on the spectra of background QSOs.



WHAT HAPPENS AT SUPER-NUCLEAR DENSITIES?

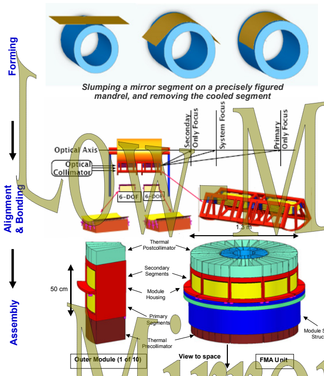
By determining the Neutron Star (NS) equation of state (radius vs mass) Con-X can probe a region of phase space unachievable in Earth based accelerators. Con-X will make numerous measurements of absorption lines in the atmosphere of bursting NS (as above), allowing the mass and radius to be determined to a few percent.

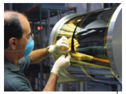



COSMIC FEEDBACK, COEVAEL GROWTH OF SMBH and GALAXIES

These Chandra and radio images of Perseus (left) and Hydra A (right) show the newly discovered feedback that exists between SMBH jets and the cluster gas that feeds them (on right, in green and blue). Simulations of the growth of cosmic large-scale structure suggest that this feedback regulates the growth of galaxies. Understanding this feedback may explain the M-σ relation. The spatially resolved spectroscopy allowed by Con-X is required to probe the interactions between the jets and gas, and the high spectral resolution is required to determine the mass outflow rates.

Con-X Technology



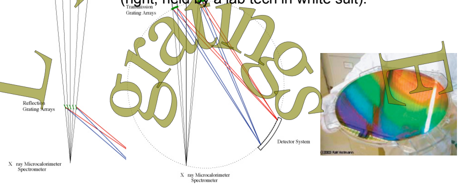


BREAKTHROUGH MIRROR TECHNOLOGY

The Con-X Mirrors are a quantum leap forward in providing very large effective areas at very low mass. Mirror shells are 0.4mm thick, as compared to ~1inch thick for the Chandra mirrors.

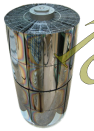
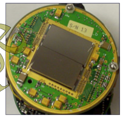
X-ray Grating Spectrometer (XGS): Dispersive, High Throughput, Low Energy

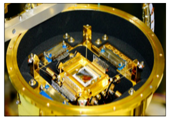
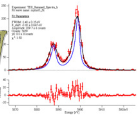
Two concepts are under study for the grating arrays – a fixed transmission grating (below) or an off-plane deployed reflection grating (far left). Either can provide the required effective area and spectral resolution at low energies (0.3 keV to 1.0 keV). This low energy capability compliments the XGS, which has fixed Δe with energy and therefore lower resolution at low energies. Gratings of the required large size are being developed in the lab (right, held by a lab tech in white suit).



EXTENDING ENERGY BAND TO 40 KEV

The Hard X-ray Telescope (HXT) will provide >150 cm² from 6 keV to 40 keV, with moderate spectral resolution of ~10. Two potential technologies are being considered, full circular nickel shells and segmented glass optics similar to the larger, lower energy mirrors. The technology is well understood extensions of existing technologies, for example the HEFT segmented glass optics (left) and the CdZnTe imaging detectors used in HERO, HEFT, and InFocus (on right)

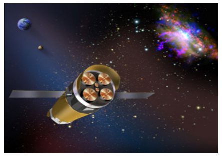



Large Format Imaging Spectroscopy at High Resolution

The X-ray Microcalorimeter Spectrometer (XMS) will finally realize the potential of x-ray calorimeters. It will provide a field of view similar to that provided by today's x-ray CCD detectors, but with spectral resolution more than 10 times higher. Combined with the larger collecting area, Con-X will provide a factor of 100x improvement in sensitivity for high resolution spectroscopy. The detector heritage traces directly back to the Suzaku calorimeter (show on left). The required energy resolution has been met (figure on right) on small flight like arrays. It will operate over the 0.6 keV to 10 keV bandpass.

The 2000-2010 Decadal Survey ranks Con-X next in priority after JWST. The BEPAC reports: "Con-X will make the broadest and most diverse contributions to astronomy of any of the candidate Beyond Einstein missions"

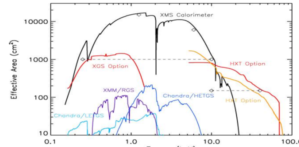


CONSTELLATION-X @ L2

Con-X will operate at L2 with an observing efficiency approaching 90%. Design lifetime is at least 5 years. The baseline configuration of four large X-ray telescopes and two smaller high energy telescopes can be seen.

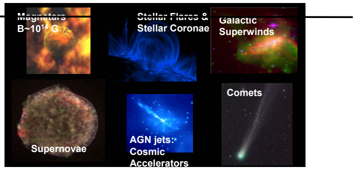
Effective Area:	15,000 cm² @1.25 keV 6,000 cm² @6 keV 150 cm² @40 keV
Bandpass:	0.3 – 40 keV
Spectral Resolution:	1250 @0.3 – 1 keV 2400 @6 keV
Angular Resolution	15 arcsec 0.3 – 7 keV (5 arcsec goal) 30 arcsec 7.0 – 40 keV
Field of View	5 x 5 arcmin (10 arcmin goal)

CONSTELLATION-X PERFORMANCE REQUIREMENTS



100x INCREASE IN EFFECTIVE AREA

Con-X will provide a 100x increase in effective area for high resolution spectroscopy as compared to currently available and/or planned missions.



ALL AREAS OF ASTROPHYSICS ADDRESSED

As an observatory class mission, Con-X will allow breakthroughs in a wide range of astrophysics. Observations will be open to the entire astronomical community and selected via a peer-review process.