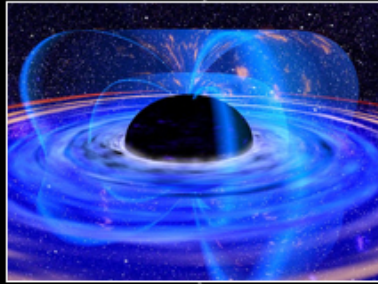
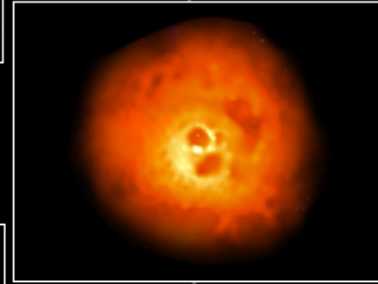
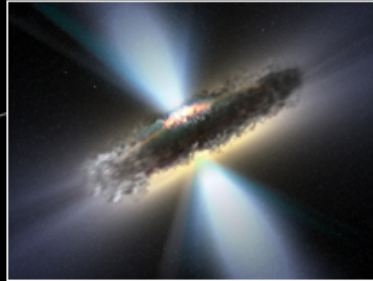


ATHENA

How do black holes grow and influence the Universe?



How does ordinary matter assemble into the large scale structures we see today?



**US Athena Study
Office Activities
Rob Petre (NASA / GSFC)**

The Hot and Energetic Universe



A T H E N A

The US Athena Study Office

Roles:

- Advocate within the Athena project, instrument consortia, and SST for a substantive and meaningful NASA role
- Study and make recommendations to NASA regarding potential contributions
- Participate in SST studies of science and mission topics
- Interface with the PCOS program office
- Support activities by NASA-appointed SWG members
- Carry out advocacy for Athena within the US

Potential NASA contributions and rationale

- A contribution to the X-IFU (sensor and front end assembly)
 - Unique microcalorimeter capabilities and experience within the US
- A contribution to the mirror (rings of inner modules)
 - Complementary technology development of slumped glass optics that is at least on par with the silicon pore optics, and has already solved problems facing the silicon pore optics at small radii
- A contribution to the WFI
- Participation in the Athena Science Ground System
 - Anticipated to be a mirror site of the ESA Athena data center
- Use of US calibration & test facilities
 - Facilities like XRCF are unique

Status of potential NASA contributions

- NASA has a representative on the Athena Science Study Team
- Participation in the X-IFU has been agreed
 - NASA will provide sensor array, calorimeter systems expertise through a GSFC/Stanford/NIST collaboration
- NASA is considering a proposal for a contribution to the WFI
- ESA is currently not interested in a contribution to the mirror
 - This could change, depending on mirror technology development progress
- NASA contribution to calibration being studied (e.g., XRCF)
- Science ground system concept still under formulation
 - NASA envisions having an XMM-like mirror site, so there is no need to start development until much closer to launch
 - There is a possibility of an expanded NASA role; we will study this when appropriate

Studies currently underway

- **Slumped glass mirror accommodation study**
 - ESA has provided design parameters for the baseline mirror
 - We are developing conceptual design for slumped glass inner ring modules
 - We will share our design with ESA; jointly agree on feasibility
 - Using slumped glass is not a cost savings for ESA, but could be represent a substantial risk reduction
- **XRCF accommodation study**
 - Investigating advantages and disadvantages of using the XRCF to calibrate the Athena mirror and perform end-to-end tests (there are many)
 - Understand cost to NASA
 - ESA investigating feasibility of building 500m facility for Athena
 - Much guesswork, as Athena calibration requirements have not yet been developed

Advocacy: Presentation to mid-decadal panel

- First meeting of mid-decadal panel met October 8-9, 2015
- Panel heard presentations about all major decadal-related activities (WFIRST, L3, Athena)
- Little guidance from panel about content
- Presentation focused on:
 - Comparison of Athena science objectives and capabilities to IXO's
 - Potential participation by NASA
 - Opportunities for US scientists
 - Responses to questions provided in advance by panel

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How do Athena objectives compare with IXO's? From the NWNH science objectives:

- *From the cosmic dawn science plan:*
 - Use GSMT and **IXO** to monitor the exchange of gas between the galaxies and the surrounding intergalactic medium
 - Study the rate of formation and growth of black holes in the nuclei of young galaxies using **IXO** and WFIRST
- *From the Physics of the Universe Science Plan:*
 - Find and study distant clusters of galaxies to measure the rate of growth of structure in the universe using **IXO** and microwave background observations
 - Observe X-rays from gas orbiting close to the event horizon of black holes using **IXO**...
- *From the New Worlds Science Plan:*
 - Assess habitability by using **IXO** to characterize the frequency and intensity of flares on host stars

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Questions from committee

- 1.) Please describe the status of Athena and NASA support in the context of the recommendations of NWNH.
- Athena Status
 - Athena has been selected as the L2 mission for launch in 2028
 - Currently in ESA Phase A1
 - Science requirements and flowdown to instrument and mission requirements under development
 - Two industry mission studies have been started (Airbus and Thales Alenia)
 - Instrument proto-teams have been formed
 - Mission concept review will take place in Spring 2016
- NASA support
 - NWNH recommended \$200M over the decade for IXO technology development (\$4M in first few years, \$20-30M later)
 - Total NASA funding for Athena-related technology development through the SAT program for 2012-2015 has been \$12.5M

Questions from committee -2

- 2.) We understand that NASA has budgeted \$100M - \$150M for a hardware contribution to Athena, plus a U.S. GO program and a U.S. data center. How does the level of U.S. participation affect the design/performance of Athena and access to Athena data by U.S. scientists?
 - Instrument design/performance:
 - X-IFU: The sensor arrays available from the US provides for a composite focal plane design. They might also make possible a larger field of view.
 - WFI: The proposed US contribution would allow for sophisticated onboard event processing to identify flaring sources and anomalous background intervals.
 - Access to data (explained in previous slides)
 - GTO data become available to instrument teams.
 - NASA participation would likely result in US scientists being awarded observation time meeting or exceeding some agreed minimum (XMM model).

