

Project : A “Senior” Review of NASA’s High-Energy Astrophysics Missions

Write-up due date; Tuesday 2nd May 2006

1 Background

Every few years, NASA conducts a major review of all of its currently operating astrophysics missions. This is known as the “senior review”. The review is conducted as follows. A team from each mission (e.g., Chandra X-ray Observatory, Hubble Space Telescope etc.) gives a presentation to the senior review panel about the status and scientific accomplishments of the mission. The team also submits a written report. On the basis of these presentations and reports, the senior review panel will recommend to NASA which missions should have their funding continued.

2 The project

We are going to conduct our own review of NASA’s high-energy astrophysics related missions¹. We will also include some of NASA’s future programs in our discussions. By the end of this process, the class will collectively have formed an opinion about the relative merits of present and future NASA projects. Along the way, you will learn about NASA’s fleet of high-energy observatories and some of the exciting science that these observatories are doing.

2.1 Review of currently operating missions (10 students)

The logistics of the review will be as follows. There are 15 people in this class. Ten of you will be involved in reviewing the currently operating missions. You will form pairs, and each pair will review one of the five currently operating high-energy astrophysics missions in which NASA has an involvement:

1. Chandra X-ray Observatory
2. Rossi X-ray Timing Explorer

¹Due to the limited number of people we have to conduct this review, there are a couple of missions that we will be omitting. Firstly, since this course is mainly focused on X-ray astronomy, we will not be discussing the *Gamma-ray Large Area Space Telescope* (GLAST). This observatory is currently under construction and will launch in 2007. Secondly, we will not be discussing the High-Energy Transient Explorer (HETE). This is somewhat similar to the Swift observatory that we will be including. If you are interested in learning more about these very important missions, go to <http://science.hq.nasa.gov/missions/universe.html>

3. Suzaku
4. Swift
5. XMM-Newton

The two-person team should work closely together to research the capabilities and scientific achievements of your chosen observatory. Each member of the pair should focus on slightly different aspects, however. One of you (Team Member A) should focus on the specifications and status of the observatory itself. The other (Team Member B) should discuss the main scientific achievements of the observatory. Your final report should be structured as follows:

- **Title page** (1 page; Team Members A and B)
 - State the title and authors of the report
 - Choose one relevant and striking graphic to include on the title page
- **Section 1 : Executive summary** (1 page max; Team Member A and B)
 - Repeat title and author information
 - Summarize in a concise and clear way the main points of the report. Aim to write about two paragraphs.
- **Section 2 : Mission description and status** (4 pages max, including figures/graphics; written by Team Member A)
 - **Section 2.1 : Mission status** : Summarize the operating history and status of the observatory. Relevant pieces of information to include are:
 - * When and how was it launched? What kind of orbit is it in?
 - * Has it encountered any problems during launch? If so, were they solved or do they continue to present a challenge to NASA.
 - * Are there any factors limiting the continued lifetime of the mission.
 - **Section 2.2 : Mission design** : Discuss the basic design and architecture of the observatory. Relevant pieces of information to include are:
 - * What are the various types of instruments on board the observatory?
 - * For a given instrument, does it utilize X-ray telescopes or some other kind of technology for collecting X-rays.
 - **Section 2.3 : Mission capabilities** : Discuss the basic capabilities of the mission of relevance to the scientists who are using it to study X-ray emissions from cosmic objects. Relevant pieces of information to include are:
 - * What range of wavelengths (or X-ray energies) do the various instruments work over? What is its collecting area at various different X-ray energies?
 - * What is the spatial resolution?
 - * Can it perform spectroscopy? If so, what is its spectral resolution?

- * Are there any other special capabilities such as the ability to re-point very quickly or the ability to time-tag incoming photons very accurately? What is the scientific rationale for these special capabilities?

- **Section 3: Scientific accomplishments** (4 pages max, including figures/graphics; written by Team Member B)

- Highlight up to four important scientific contributions made by the observatory. For each of these four cases, you should:
 - * Clearly describe the scientific result and why it is of importance
 - * Discuss how the observatory’s capabilities allowed the discovery to be made.
 - * Appropriately credit the scientific team that produced the result

After the period of joint research and discussions, each Team Member should write their part of the report independently. However, my preference would be for you to combine your separate contributions into a single document before handing it in. Please type your reports using 12pt font. Do not exceed your page limits.

In addition to the write-up, you will also make a joint presentation to the class. As in the written report, Team Member A will discuss details of the observatory design, capabilities and status. Team Member B presents the four scientific accomplishments highlighted in the written report. Each team will have 20 minutes to make the presentation, i.e., 10 minutes per person. This will be followed by 5 minutes of questions from the rest of the class.

2.2 Review of the Beyond Einstein program (5 students)

NASA’s Beyond Einstein program is a series of future medium-to-large size missions that will explore many of the issues we have been discussing (and will continue to discuss) in this class. Two major observatories associated with the Beyond Einstein program are the Constellation X-ray telescope and the Laser Interferometer Space Antenna (LISA; the space-based gravitational wave observatory).

A team of five students will review the Beyond Einstein program and its major components. One student will write an umbrella report on the Beyond Einstein program as a whole, two students will review the LISA project and two students will review the Constellation-X project. The structure of the final (joint) report should be as follows:

- **Title page** (1 page; All team members)
 - State the title and authors of the report
 - Choose one relevant and striking graphic to include on the title page
- **Section 1 : Executive summary** (1 page max; All team members)
 - Repeat title and author information
 - Summarize in a concise and clear way the main points of the report. Aim to write about three paragraphs.
- **Section 2 : Beyond Einstein** (4 pages including figures/graphics, Team Member A)

- **Section 2.1 : Motivation and the questions :** Describe the main motivation for the Beyond Einstein program and the three questions that it is designed to answer.
- **Section 2.2 : The program :** Give a brief description of the various missions that constitute the Beyond Einstein program. Describe how these missions complement and build upon each other in order to answer the questions described in Section 2.1.
- **Section 3 : The Constellation X-ray Observatory**
 - **Section 3.1 : Mission description and status** (4 pages, Team Member B)
 - * **Section 3.1.1 : Mission design :** Discuss the current “baseline” design for Constellation-X. What telescopes and instruments will it possess?
 - * **Section 3.1.2 : Mission capabilities :** What will be the capabilities of this observatory? In what ways will it be superior to current X-ray observatories?
 - * **Section 3.1.3 : Technology development :** Which technologies need to be developed further before Constellation-X can be built and launched?
 - **Section 3.2 : Scientific goals** (4 pages, Team Member C).
 - * Discuss four specific scientific goals of Constellation-X. For each of these goals, describe the investigation that will be performed, the expected results, and the aspect of Constellation-X that will make this investigation possible.
- **Section 4 : The Laser Interferometry Space Antenna**
 - **Section 4.1 : Mission description and status** (4 pages, Team Member D)
 - * **Section 4.1.1 : Mission design :** Discuss the current design for LISA. How does it operate to detect gravitational waves?
 - * **Section 4.1.2 : Mission capabilities :** What will be the capabilities of this observatory? What amplitudes of gravitational waves will it be able to detect? What frequencies will it be able to detect?
 - * **Section 4.1.3 : Technology development :** Which technologies need to be developed further before LISA can be built and launched?
 - **Section 4.2 : Scientific goals** (4 pages, Team Member E).
 - * Discuss four specific scientific goals of LISA.

2.3 Timetable

- 28-March-2006 : Review opened
- 4-April-2006 : Teams formed and assigned to missions
- 20-April-2006 : Progress report due. This should take the form of an email to me summarizing the principal content of your report. This can take the form of brief notes sent to me in an email (chris@astro.umd.edu).
- 2-May-2006 : Final written report due (hardcopy format due in class).

- 4-May-2006 : Presentations of the first three operating missions.
- 9-May-2006 : Presentations of the remaining two operating missions, plus discussion of all of the operating missions.
- 11-May-2006 : Presentations and discussion of Beyond Einstein and its major missions.
- 12-May-2006 : Class votes on priorities in high-energy astrophysics (in form of email to me). I will compile results and send them out to you. This will end the project.

2.4 Resources

Your most valuable tool will be the web — NASA has extensive webpages on its missions, their design/capabilities, and their scientific achievements and/or goals. The central NASA web-site from which the official mission pages can be accessed is <http://science.hq.nasa.gov/missions/universe.html>. The usual rules concerning referencing apply — **you must list and give credit to all references used in the preparation of your report.**

In order to be fair, I will have to limit the amount of information that I directly give to you. However, I will help you out in two ways. Firstly, once each team has been assigned its mission, I will email the team members with some preliminary information to get you started and some specific resources that you should use. Secondly, I will meet with each team for 20 minutes (1 hour for the 5-person Beyond Einstein team) *after* the progress report has been submitted in order to help you “fine tune” your report and presentation.

3 Grading

Each student will be graded on their individual portion of the written report, their presentation, and their team-work. The grade will be split as follows

- Written report (60%) — to obtain a high grade, you must
 1. Lay out your report in a logical and systematic manner
 2. Write in a coherent and articulate manner
 3. Use appropriate figures or graphics where necessary
 4. Stick to the page limits and submit on time!
- Presentation (30%) — to obtain a high grade you must
 1. Lay out your presentation in a logical and systematic manner
 2. Use clearly written power-point or overhead projector slides
 3. Stick to your time limits.
- Team-work (10%)