The Sound of Creation

USEM 170-34 (Sch. # 303U0, Fall 2005)

Mark Whittle, Professor, Astronomy Department

Overview

Despite its title – "The Big Bang" – our modern understanding of the birth and youth of the Universe has only recently included **sound** — pressure waves coursing through the hot thin gas of an ancient expanding fireball. And yet, it transpires, those sound waves are the seeds from which all future structure grows — from stars, to galaxies, to the galactic tapestry which extends to the cosmic horizon. Even more remarkable, the cosmic sound is an evolving chord, with a fundamental and harmonics — the Universe acts like a giant musical instrument! This seminar explores these newly discovered acoustic aspects of modern cosmology: how we study the ancient Universe; how sound was generated; how we use sound to measure the Universe's properties; and how sound is ultimately transformed into the first generation of stars. By the end of the seminar you will be quite familiar with the first million years in the life of the Universe — a time equivalent to the first day in the life of a human. The style and content of the seminar does not require prior knowledge of astronomy or physics.

Texts and Resources

Since this subject is so new there is no single text which includes all that we need (in fact, my aim is to use this course to start writing such a book). We will therefore make use of several resources.

1) "The Big Bang" by Joe Silk (3rd ed. UVa Bookstore). This is an excellent treatment of most of modern cosmology. It includes **some** of what we need, but much that we don't.

2) A CD ROM which contains a number of resources for our class. (a) An distilled treatment of our subject, in powerpoint and pdf format. This includes many useful diagrams and sounds. (b) A more fluent narrative of the topic, also with figures and sounds. This was written for a magazine, though is in html format. (c) A Sonogram software package that we will use to experiment with the nature of sound and harmonics.

Some of these CD ROM materials you can also find on my home page:
http://www.astro.virginia.edu/∼dmw8f

3) Various articles which will relate directly to our subject. I will make these available on the web for you to download as and when we need them.

Format and Assignments

The format of our seminar will be targetted readings prior to each class with discussion and presentation during class. My intention is to strike a balance between involving the class in discussion, and giving brief "lectures" on specific themes. Depending on the material, I may "cold call" on students to answer questions or summarise our readings.

Your grades will be derived from four assignments, which together total 100 points. The **approximate** grade boundaries are A/B/C/D = 90/80/70/60.

1) Paper I (30 pts) : Due in class on Oct 18.
2) Paper II (30 pts) : Due in class on Dec 6th.
3) 15 minute oral exam (20 pts) : scheduled during Dec $6-9$.
4) Class participation (20 pts)

Your papers are to be structured essays (section headings, subheadings etc to provide clarity) of roughly 3000 - 5000 words (I'm not word-counting here, but they should represent a significant piece of work). Choose a title relating to our subject matter which is not too broad. Imagine you are writing an article for "Astronomy" or "Sky & Telescope" Magazines, whose readers are motivated but have no specialized knowledge of astronomy and high-school knowledge of physics. You will be graded on your comprehension of your chosen topic, your clarity of exposition, and your quality of English and expression. Ideally, you would be proud to have your parents read it.

The oral exam will target your **overall** comprehension of the course material. I will **not** be looking for isolated details or topics from the wider field of cosmology, but rather the broad picture we've been discussing in class. As long as you have followed and remembered the main points from our class discussions, you have nothing to worry about.

Your class participation is basically your willingness to engage and contribute usefully. It will help to have digested the readings, though even if you haven't understood them fully, your ability to ask good questions is an adequate substitute for answering one of my questions.

Needless to say, I assume you are all familiar with the **Honor code**, and its application to this (and all other) classes. While I encourage you to engage in discussion with other classmates and research using books or the web, when it comes to actually writing your papers you **must not** give or receive help from anyone. Nor can you construct your essays by cutting and pasting from any document (paper or electronic), unless you cite it properly. Our aim is (a) to ensure that your grade applies to you, and not anyone else; and (b) that you experience the satisfaction of creating a significant piece of work yourself, and learn as much as possible in the process.